Chapter 4
Environmental Consequences

The impact analyses in Chapter 4 focus on those areas where the potential exists for effects on the environment. Each of the alternatives, including the four options under the No Action Alternative, the six options under the Restart Fast Flux Test Facility Alternative, the nine options under the Use Only Existing Facilities Alternative, the three options under the Construct New Accelerator(s) Alternative, the three options under the Construct New Research Reactor Alternative, and the one option under the Permanently Deactivate Fast Flux Test Facility Alternative, is discussed separately in Sections 4.2 through 4.7. The cumulative impacts associated with the alternatives are presented in Section 4.8. A detailed discussion of each alternative is given in Chapter 2; a comparison among alternatives and among options within alternatives is presented in Section 2.7.

4.1 INTRODUCTION

In this *Draft Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility* (*Nuclear Infrastructure Programmatic Environmental Impact Statement* [NI PEIS]), the impact analyses assess all disciplines where the potential exists for effects on the environment, as follows:

- Land resources
- Noise
- Air quality
- Water resources
- Geology and soils
- Ecological resources
- Cultural and paleontological resources
- Socioeconomics
- Public and occupational health and safety (associated with normal operations, facility accidents, and transportation)
- Environmental justice
- Waste management
- Spent nuclear fuel management

These disciplines are analyzed in a manner commensurate with their importance under a specific option—the sliding-scale assessment approach. For example, under all options of Alternative 2 (Use Only Existing Operational Facilities), the U.S. Department of Energy (DOE) has determined that minimal or no impacts would be associated with land resources, noise, water resources, geology and soils, ecological resources, and cultural and paleontological resources. This is because existing facilities in developed areas would be used, no new land disturbance would take place, proposed activities would be consistent with current operations, and wastewater discharges would continue through permitted outfalls. Therefore, impacts associated with these resources are assessed in less detail. Where construction and decommissioning are integral parts of an option (all options under both Alternative 3 [Construct New Accelerator(s)] and Alternative 4 [Construct New Research Reactor]), the impacts associated with such construction and decommissioning are included in the assessments, and disciplines such as land resources and noise are assessed in more detail. The sliding-scale assessment approach has been applied in the evaluation of all the options addressed in this NI PEIS.

The environmental consequences associated with the alternatives assessed in this NI PEIS were generally calculated using appropriate computer models and by comparing facility operational characteristics and requirements from Appendixes A through F with baseline environmental impacts. The analyses were performed in accordance with the impact assessment methods described in Appendix G. The results of the

assessment of environmental consequences are presented in this chapter. More detailed descriptions of the development of the impacts for some resource areas are presented in Appendixes H through L, as follows:

- Appendix H, Evaluation of Human Health Effects from Normal Facility Operations
- Appendix I, Evaluation of Human Health Effects from Facility Accidents
- Appendix J, Evaluation of Human Health Effects of Transportation
- Appendix K, Environmental Justice Analysis
- Appendix L, Socioeconomic Analysis

Portions of some alternative options are equivalent. For example, for Alternative 2 (Use Only Existing Operational Facilities), the Radiochemical Engineering Development Center (REDC) at the Oak Ridge Reservation (ORR) would be used to fabricate and process the neptunium-237 targets under Options 1, 4, and 7. Therefore, the activities at REDC would be virtually the same for these three alternative options. The organization of Chapter 4 takes advantage of these equivalencies. When the impacts have already been described for a previous alternative or alternative option, the later impacts discussion provides a reference to the earlier section, rather than repeating the information.

4.2 NO ACTION ALTERNATIVE

Under the No Action Alternative (maintain status quo), FFTF would be maintained in standby status for all or a portion of the 35-year evaluation period for operations covered in this NI PEIS. For the purpose of analysis in this NI PEIS, the maximum period of 35 years was assumed. Ongoing operations at existing facilities as described in Chapter 3, Affected Environment, would continue under this alternative. DOE would not establish a domestic plutonium-238 production capability, but could, instead, continue to purchase Russian plutonium-238 to meet the needs of future U.S. space missions. For the purpose of analysis in this NI PEIS, DOE assumed that it would continue to purchase plutonium-238 to meet the space mission needs for the 35-year evaluation period. However, DOE recognizes that any purchase beyond what is currently available to the United States through the existing contract may require additional NEPA review. DOE would continue its medical and industrial isotope production and nuclear research and development activities at the current operating levels of existing facilities. A consequence of a No Action decision would be the need to determine the future of the neptunium-237 stored at SRS. Therefore, the impacts of possible future transportation and storage of neptunium-237 are evaluated as part of the No Action Alternative. Four options are identified. If DOE decides not to establish a domestic plutonium-238 production capability in the future, the neptunium-237 would have no programmatic value and Option 1 would be selected. Conversely, if DOE decides to maintain the capability to establish a domestic plutonium-238 capability in the future, the inventory of neptunium-237 must be retained. In this case, Option 2, 3, or 4 could be selected.

- **Option 1.** Under this option, DOE would reconsider its stabilization strategy for the neptunium-237, currently stored in solution form at SRS, possibly leading to final disposition. The current plan is to stabilize the material to oxide, as described in the Supplemental Record of Decision for the *Final Environmental Impact Statement, Interim Management of Nuclear Materials at SRS* (62 FR 61099). This Record of Decision would be amended or new NEPA analysis performed, if necessary.

- **Options 2 through 4.** Under these options, the neptunium-237 oxide would be transported from SRS to one of three candidate DOE sites for up to 35 years of storage. For the purpose of analysis in this NI PEIS, the maximum period of 35 years was assumed. Option 2 would provide storage at ORNL's REDC facility, Option 3 at INEEL's Building CPP–651, and Option 4 at Hanford's FMEF.

Each of the four options under the No Action Alternative include importing plutonium–238 from Russia and maintaining FFTF in standby. Option 1 includes no other activities, whereas the other three options include the transportation of neptunium-237 from SRS to, and storage at, another DOE site. Under Option 2, this neptunium would be stored at ORR in REDC, under Option 3 at INEEL in Building CPP–651, and under Option 4 at Hanford in FMEF.

The baseline impacts at ORR, INEEL, and Hanford for the No Action Alternative are presented in **Table 4–1**. They represent impacts associated with onsite and offsite activities that are foreseeable and documented, but do not include potential NI PEIS impacts. The values in Table 4–1 are the same as those listed under the "Site Activities" columns of the tables provided in Section 4.8, Cumulative Impacts. The site baseline impacts given in those tables were developed from the information presented in the NEPA documents cited in Section 4.8, and include the impacts associated with baseline operations of facilities addressed in this NI PEIS. The environmental impacts presented in this section for each option under the No Action Alternative can be added to the baseline impacts to provide total site impacts.

Table 4–1 Baseline Environmental Impacts at ORR, INEEL, and Hanford

Parameter	Site		
	ORR	INEEL	Hanford
Air quality			
Concentration (micrograms per cubic meter)			
• Carbon monoxide			
8-hour averaging time	85.5	303	34.1
1-hour averaging time	172	1,330	48.3
• Nitrogen dioxide			
Annual averaging time	20.9	11.3	0.25
• PM_{10}			
Annual averaging time	12.9	3.01	0.0179
24-hour averaging time	55.4	43.6	0.77
• Sulfur dioxide			
Annual averaging time	50.2	6.01	1.63
24-hour averaging time	271	142	8.91
3-hour averaging time	984	616	29.6
1-hour averaging time	NA	NA	32.9
Radiation impacts (35 years)			
Latent cancer fatalities			
Maximally exposed individual (risk)	6.7×10^{-5}	8.2×10^{-7}	8.4×10^{-6}
Population within 80 kilometers (50 miles)	0.63	0.0061	0.58
Site workforce	1.8	2.8	11.8
Waste generation (cubic meters over 35 years)			
Transuranic	2,599	65,125[a]	9,880
Low-level radioactive	341,128	151,845	95,666
Mixed low-level radioactive	28,038	16,640	46,207
Hazardous	1,260,000[b]	3,637	19,600
Nonhazardous	26,457,080	275,127	8,505,000
Site employment	3,467	7,993	16,005
Developed land (hectares)	4,966	4,600	8,700
Water usage (million liters per year)	15,802	6,075	3,006

a. Includes 65,000 cubic meters in storage at the Radioactive Waste Management Complex.
b. Kilograms.
Note: To convert from cubic meters to cubic yards, multiply by 1.308; to convert from liters to gallons, multiply by 0.264; to convert from hectares to acres, multiply by 2.47; to convert from kilograms to pounds, multiply by 2.20.
Key: NA, not applicable for the site.
Source: Section 4.8.

4.2.1 No Action Alternative—Option 1

Under Option 1, the United States would continue to purchase the plutonium-238 from Russia that is needed to fabricate radioisotope power systems for future U.S. space missions. As part of this option, FFTF at Hanford would be maintained in standby. This option does not include the transportation of neptunium-237 from SRS and its storage at another DOE site, as do the other three options under the No Action Alternative.

4.2.1.1 Importation of Plutonium-238 from Russia

Activities and impacts associated with transporting plutonium-238 to the United States from Russia are evaluated in two other NEPA documents: *Environmental Assessment of the Import of Russian Plutonium-238* (*Russian Plutonium-238 EA*) (DOE 1993a), and *Finding of No Significant Impact for Import of Russian Pu-238 Fuel* (DOE 1993b). The proposed action in the *Russian Plutonium-238 EA* is to import up to 40 kilograms (88 pounds) of plutonium-238 fuel (isotopic mass) in dioxide form from Russia to supplement the current U.S. inventory. The action includes the transportation by ship of Russian plutonium-238 in 5-kilogram (11-pound) increments from St. Petersburg, Russia, to a U.S. port of entry. From the U.S. port of

entry, the plutonium-238 would be ground transported by DOE SafeGuards Transport (SGT) to Los Alamos National Laboratory (LANL) in New Mexico and would be added to LANL's portion of the existing U.S. plutonium-238 inventory. As of August 1999, two shipments had been safely and securely transported to LANL.

The dose to transportation workers associated with importing 40 kilograms (88 pounds) of plutonium-238 to LANL was reported to be 2.6 person-rem; the dose to the public would be 4.5 person-rem. Accordingly, incident-free transportation of plutonium-238 would result in 0.0011 latent cancer fatality among transportation workers and 0.0023 latent cancer fatality in the total affected population over the duration of the transportation activities. The number of nonradiological fatalities from vehicular emissions was not reported (DOE 1993a).

The reported transportation accident risks under this option are as follows: a radiological dose to the population of 0.2 person-rem, resulting in 1.0×10^{-4} latent cancer fatality; and traffic accidents resulting in 0.0032 traffic fatality. These estimates include the risk to the crew, handlers, and the public during both ocean and highway transportation. DOE considered the environmental consequences on global commons (i.e., portions of the ocean not within the territorial boundary of any nation) in accordance with Executive Order 12114 (44 FR 1957) (DOE 1993a).

The risk estimated for importing 40 kilograms (88 pounds of plutonium-238 can be scaled to estimate the risk of importing 175 kilograms (5 kilograms per year times 35 years) (385 pounds) of plutonium-238 over the 35-year period covered by this NI PEIS. Approximately 35 shipments of plutonium-238 would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 114,000 kilometers (71,000 miles); and at sea by ships carrying plutonium-238, 298,000 kilometers (161,000 nautical miles).

The transportation impacts analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 12 person-rem; the dose to the public would be 20 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0.0046 latent cancer fatality among transportation workers and 0.0099 latent cancer fatality in the total affected population over the duration of the transportation activities. Latent cancer fatalities associated with radiological releases were estimated by multiplying the occupational (worker) dose by 4.0×10^{-4} latent cancer fatality per person-rem of exposure, and the public accident and accident-free doses by 5.0×10^{-4} latent cancer fatality per person-rem of exposure (ICRP 1991). The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 4.7×10^{-4}.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 0.88 person-rem, resulting in 4.4×10^{-4} latent cancer fatality; and traffic accidents resulting in 0.014 traffic fatality.

4.2.1.2 Maintenance of FFTF in Standby

The environmental impacts associated with maintaining FFTF in standby for 35 years are discussed in the following sections.

4.2.1.2.1 Land Resources

LAND USE. Maintaining FFTF in standby would not change land use in the 400 Area for 35 years because maintenance activities would not require the development of additional land areas. Further, maintenance activities are consistent with the site's industrial nature.

VISUAL RESOURCES. Impacts on visual resources would not change for 35 years because no new construction or modification of existing structures would be required. Since there would be no change in the appearance of FFTF, the current Visual Resource Management Class IV rating for the 400 Area would continue for 35 years.

4.2.1.2.2 Noise

Maintaining FFTF in standby would not involve any new construction, major change in activities, or change in employment. Thus, there would be no change in noise impacts on wildlife around the 400 Area or on people near Hanford and this would be expected to continue for the next 35 years to the extent it is dependent on activities at FFTF.

4.2.1.2.3 Air Quality

Maintaining FFTF in standby for 35 years would not involve any new construction, change in activities, or change in employment. Thus, there would be no change in nonradiological air quality at Hanford. Emissions from maintaining FFTF in standby would be expected to continue for the next 35 years.

4.2.1.2.4 Water Resources

Impact on water resources associated with maintaining FFTF in standby for 35 years would include the continuation of groundwater withdrawals and process and sanitary wastewater discharges associated with Hanford 400 Area facilities. Specifically, groundwater withdrawals by 400 Area facilities (mainly FFTF) would continue to average about 197 million liters (52 million gallons) per year. The discharge of approximately 76 million liters (20 million gallons) per year of FFTF cooling water to the 400 Area process sewer system and the 400 Area Pond (i.e., 4608 B/C percolation ponds) would continue. Also, it is expected that 400 Area sanitary wastewater flows of about 3.8 million liters (1 million gallons) annually could continue to be discharged to Energy Northwest for treatment. However, as groundwater use during standby would not be expected to affect regional groundwater levels and effluents would continue to be discharged to appropriate treatment facilities, the overall impact on water resources at Hanford should be negligible (DOE 2000a:11; Nielsen 1999:38, 39, 41). Further information on current water usage, effluent discharge, and water quality at Hanford is presented in Section 3.4.4.

4.2.1.2.5 Geology and Soils

Maintaining FFTF in standby for 35 years would not involve new construction. Therefore, geologic and soil resources in the 400 Area would not be disturbed. In the *Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement* (*Storage and Disposition PEIS*) (DOE 1996a:4-45), hazards from large-scale geologic conditions at Hanford, such as earthquakes and volcanoes, were evaluated. That analysis was reviewed in the *Surplus Plutonium Disposition Final Environmental Impact Statement* (*Surplus Plutonium Disposition EIS*) (DOE 1999a:4-260). Further review of the data and analyses presented in these referenced documents and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions continue to present a low risk to FFTF. Ground shaking of Modified Mercalli Intensity V to VII (refer to Table 3–3) associated with postulated earthquakes would be expected to primarily affect the

integrity of inadequately designed or nonreinforced structures. Damage to properly or specially designed or upgraded facilities would not be expected. Also, only minimal effects (e.g., ashfall) would be expected from postulated volcanic events in the Cascade Region. The potential for other nontectonic events to affect the facility is also low.

As stated in DOE Order 420.1, DOE requires that nuclear or nonnuclear facilities be designed, constructed, and operated so that the public, the workers, and the environment are protected from the adverse impacts of natural phenomena hazards, including earthquakes. DOE Order 420.1, Section 4.4, as supplemented by DOE Guide 420.1-2, stipulates the natural phenomena hazards mitigation requirements for DOE facilities and specifically provides for the reevaluation and upgrade of existing DOE facilities when there is a significant degradation in the safety basis for the facility. DOE uses the requirements of the latest model building codes and national standards to mitigate the consequences of natural phenomena hazards. Further, the natural phenomena hazards mitigation requirements of DOE Order 420.1 are consistent with the guidance for seismic design and construction contained in the National Earthquake Hazards Reduction Program 1997 provisions (BSSC 1997). In addition, DOE Guide 420.1-2 was recently issued to recognize the consolidation of the three previous U.S. model building codes, including the Uniform Building Code, into the *International Building Code* (ICC 2000). The DOE requirements for seismic engineering have followed the Uniform Building Code, unless the importance of achieving a high level of protection warrants the use of more demanding methods and criteria (DOE Guide 420.1-2). As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1.

4.2.1.2.6 Ecological Resources

Maintaining FFTF in standby for 35 years would not involve new construction or other disturbance to the natural environment. As noted in Section 4.2.1.2.2, there would be no change in noise impacts on wildlife. Impacts on wetlands and aquatic resources (associated with manmade ponds on the site) would not change because water usage and wastewater discharge would not change. Due to the developed nature of the area and because no construction would take place, impacts on threatened and endangered species would not occur. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Consultations have also been initiated with the State of Washington.

4.2.1.2.7 Cultural and Paleontological Resources

Maintaining FFTF in standby for 35 years would not involve new construction and, thus, would not disturb cultural and paleontological resources in the 400 Area. No prehistoric, historic, or paleontological sites have been identified either in the 400 Area or within 2 kilometers (1.2 miles) of the 400 Area. Six buildings in the 400 Area, including two FFTF structures (the Reactor Containment Building and the FFTF Control Building), are eligible for the National Register of Historic Places as contributing properties in the Historic District recommended for mitigation. Maintaining FFTF in standby for 35 years would not affect the status of these structures. No Native American resources are known to occur in the 400 Area. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office. Consultation has also been initiated with interested Native American tribes.

4.2.1.2.8 Socioeconomics

Under the No Action Alternative, FFTF would continue to be maintained in standby for 35 years. Current employment of approximately 300 workers would be continued for the next 35 years. No new employment or in-migration of workers would be required. Thus, there would be no additional impact on the socioeconomic conditions around Hanford.

4.2.1.2.9 Public and Occupational Health and Safety—Normal Standby Activities

Assessments of radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

RADIOLOGICAL IMPACTS. Potential radiological doses to three receptor groups are given in **Table 4–2**: the population within 80 kilometers (50 miles) of FFTF in the year 2020 (approximate midlife of the nuclear infrastructure activities assessed in this NI PEIS), the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

Table 4–2 Radiological Impacts on the Public Around Hanford from Maintaining FFTF in Standby Under All Options of the No Action Alternative

Receptor	Standby
Population within 80 kilometers (50 miles) in the year 2020	
Dose (person-rem)	0.028
35-year latent cancer fatalities	4.9×10^{-4}
Maximally exposed individual	
Annual dose (millirem)	1.3×10^{-4}
35-year latent cancer fatality risk	2.3×10^{-9}
Average exposed individual within 80 kilometers (50 miles)	
Annual dose[a] (millirem)	5.6×10^{-5}
35-year latent cancer fatality risk	9.8×10^{-10}

a. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FFTF in the year 2020 (503,300).

Source: Model results, using the GENII computer code (Napier et al. 1988).

Probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are taken from the *1990 Recommendations of the International Commission on Radiation Protection* (ICRP 1991). A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers. The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

A collective dose of 0.028 person-rem would be incurred by the surrounding population in the year 2020. The corresponding number of latent cancer fatalities in this population from 35 years of maintaining FFTF in standby would be 4.9×10^{-4}. Here, and throughout this document, a latent cancer fatality value of less than one can be related to the statistical probability of a latent cancer fatality. The most probable outcome of a population dose of 0.028 person-rem would be no latent cancer fatalities. However, in a small number of cases, this dose would result in a latent cancer fatality. The lower the number of cases, the less likely is this outcome. This issue is addressed in more detail in Appendix H.

An annual dose of 1.3×10^{-4} millirem is shown for the maximally exposed individual. From 35 years of standby activities, the corresponding risk of a latent cancer fatality to this individual would be 2.3×10^{-9}.

The expected average dose to a worker involved with storage activities while FFTF is maintained in standby and the associated expected dose to the total storage workforce would be 3.5 millirem and 0.69 person-rem, respectively (refer to **Table 4–3**). The associated risk of a latent cancer fatality to the average worker from 35 years of standby activities would be 4.9×10^{-5}, and the estimated number of latent cancer fatalities in the total workforce from 35 years of operations would be 0.0097.

Table 4–3 Radiological Impacts on FFTF Workers from Maintaining FFTF in Standby Under All Options of the No Action Alternative

Receptor—No Action Workers[a]	Standby
Total dose (person-rem per year)	0.69[b]
35-year latent cancer fatalities	0.0097
Average worker dose (millirem per year)	3.5
35-year latent cancer fatality risk	4.9×10^{-5}

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with storage operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 200 workers.
Source: Nielsen 1999.

HAZARDOUS CHEMICAL IMPACTS. No new chemicals would be introduced by maintaining FFTF in standby. Thus, there would be no change in impacts from emissions of hazardous chemicals. Emissions of hazardous air pollutants from maintaining FFTF in standby, would be expected to continue for the next 35 years.

4.2.1.2.10 Public and Occupational Health and Safety—Standby Accidents

In its current standby condition, FFTF is defueled with slightly radioactive sodium circulating through the primary heat transport system. A primary heat transport system sodium spill would be the accident with the highest consequences. A detailed description of the accident analysis is provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of FFTF, and a noninvolved worker at a distance of 640 meters (0.4 miles) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per unit of time (i.e., 1 year or 35 years) for an individual (the maximally exposed offsite individual or a noninvolved worker), and as the increased number of latent cancer fatalities per unit of time (i.e., 1 year or 35 years) in the offsite population.

Consequences to involved workers are addressed Appendix I, Section I.1.7.

Probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are taken from the *1990 Recommendations of the International Commission on Radiological Protection* (ICRP 1991). For low doses or dose rates, a probability coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers, and 5×10^{-4} latent cancer fatality per rem for the public. For high doses received at a high rate, probability coefficients of 8×10^{-4} and 0.001 latent cancer fatality per rem are applied for workers and the public, respectively. These higher probability coefficients apply for doses above 20 rads and dose rates above 10 rads per hour.

Potential consequences and associated risks are presented in **Tables 4–4** and **4–5**, respectively.

Table 4–4 FFTF Standby Accident Consequences Under All Options of the No Action Alternative

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
Primary heat transport system sodium spill	1.34×10^{-7}	6.70×10^{-11}	9.99×10^{-3}	4.99×10^{-6}	1.62×10^{-8}	6.48×10^{-12}

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
Source: Model results, using the MACCS2 computer code (Chanin and Young 1997).

Table 4–5 FFTF Standby Accident Risks Under All Options of the No Action Alternative

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual primary heat transport system sodium spill risk (1×10^{-4})	6.70×10^{-15}	4.99×10^{-10}	6.48×10^{-16}
35-year risk	2.35×10^{-13}	1.75×10^{-8}	2.27×10^{-14}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
Source: Model results, using the MACCS2 computer code (Chanin and Young 1997).

With FFTF in standby for 35 years, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.35×10^{-13} and 2.27×10^{-14}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 1.75×10^{-8}.

The 35-year risks are conservative because they are based on current primary sodium radioactivity levels. The radioisotopes contained in the primary sodium are sodium-22, cesium-137, plutonium-239, and tritium. Examining the current inventories, half-lives, and dose conversion factors of these isotopes, it was determined that currently 99 percent of the dose is attributable to plutonium-239 and sodium-22, with sodium-22 accounting for 78 percent of the total dose. Plutonium-239 has a 24,400-year half-life and would have only decayed 0.1 percent after 35 years. Sodium-22, however, has a 2.6-year half-life and would have decayed over 99.99 percent after 35 years. In year 35, only 21 percent of the original total dose level would remain. The annual risks would decrease each year due mainly to the radioactive decay of sodium-22. Therefore, if the annual risks were recalculated for each subsequent year based on lower activity levels and then summed for the 35-year period, the resulting risks would be lower than those presented.

Maintaining FFTF in standby would not introduce any additional operations that require the use of hazardous chemicals. Thus, there would be no postulated hazardous chemical accidents attributable to maintaining FFTF in standby.

4.2.1.2.11 Public and Occupational Health and Safety—Transportation

There would be no transportation impacts associated with maintaining FFTF in standby.

4.2.1.2.12 Environmental Justice

As discussed in other parts of Section 4.2.1.2, normal and incident-free operations required to maintain FFTF in standby pose no significant risks to the public. For 35 years of normal standby operations, FFTF would be a small contributor to baseline emissions from the Hanford Site. Chemical emissions would not be altered and no transportation impacts are associated with maintenance of FFTF in standby. As discussed in Appendix K,

under the conservative assumption that all food consumed in the potentially affected area during the 35-year operational period would be radioactively contaminated, no credible pattern of food consumption would pose a significant radiological health risk due to ingestion of contaminated food supplies. Radiological risks to the public due to accidents occurring at FFTF while in standby would be essentially zero. Thus, maintaining FFTF in standby would pose no disproportionately high and adverse risks to minority or low-income populations.

4.2.1.2.13 Waste Management

The expected generation rates of wastes at Hanford that would be associated with maintaining FFTF in standby for 35 years are compared with Hanford's treatment, storage, and disposal capacities in **Table 4–6**. The impacts on the Hanford waste management systems, in terms of managing these wastes, are discussed in this section. Radiological and chemical impacts on workers and the public from waste activities are included in the public and occupational health and safety impacts that are given in Sections 4.2.1.2.9 through 4.2.1.2.11.

Table 4–6 Waste Management Impacts of Maintaining FFTF in Standby Under All Options of the No Action Alternative

Waste Type[a]	Estimated Waste Generation for FFTF in Standby (cubic meters per year)	Estimated Waste Generation as a Percent of[b]		
		Onsite Treatment Capacity	Onsite Storage Capacity	Onsite Disposal Capacity
Low-level radioactive waste				
Liquid	<6	(c)	(c)	(c)
Solid	17	NA	NA	0.03
Mixed low-level radioactive waste	<0.5	0.03	0.11	0.13
Hazardous	4[d]	NA	NA	NA
Nonhazardous				
Process wastewater	76,000	(c)	(c)	(c)
Sanitary wastewater	3,800	1.6[e]	NA	NA
Solid	120	NA	NA	NA

a. See definitions in Appendix G.9.
b. The estimated amounts of waste generated annually are compared with the annual site treatment capacities. The estimated total amounts of waste generated over the assumed 35-year operational period are compared with the site storage and disposal capacities.
c. Refer to the text.
d. Represents both liquid and solid hazardous waste.
e. Percent of capacity of the Energy Northwest Sewage Treatment Facility.

Note: To convert from cubic meters per year to cubic yards per year, multiply by 1.308; < means "less than."
Key: NA, not applicable (i.e., the majority of this waste is not routinely treated, stored, or disposed of on site; refer to the text).
Source: DOE 2000a; Nielsen 1999.

In accordance with the Records of Decision for the *Waste Management PEIS* (DOE 1997a), wastes could be treated and disposed of on site at Hanford or at other DOE sites or commercial facilities. Based on the Record of Decision for hazardous waste issued on August 5, 1998 (63 FR 41810), nonwastewater hazardous waste would continue to be treated and disposed of at offsite commercial facilities. Based on the Record of Decision for low-level radioactive waste and mixed low-level radioactive waste issued on February 18, 2000 (65 FR 10061), minimal treatment of low-level radioactive waste will be performed at all sites and, to the extent practicable, onsite disposal of low-level radioactive waste will continue. Hanford and the Nevada Test Site will be made available to all DOE sites for disposal of low-level radioactive waste. Mixed low-level radioactive waste analyzed in the *Waste Management PEIS* will be treated at Hanford, INEEL, ORR, and SRS and will be disposed of at Hanford and the Nevada Test Site.

It is also assumed in this NI PEIS that low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous waste would be treated, stored, and disposed of in accordance with current and developing site practices. No high-level radioactive waste or transuranic waste would be associated with maintaining FFTF in standby.

Solid low-level radioactive waste associated with maintaining FFTF in standby would continue to be compacted, if possible, and packaged in appropriate containers or burial casks, certified, and transferred for disposal in existing onsite facilities.

Six hundred cubic meters (780 cubic yards) of solid low-level radioactive waste would be generated over the 35-year period as a result of maintaining FFTF in standby. This solid low-level radioactive waste represents approximately 0.03 percent of the 1.74-million-cubic-meter (2.28-million-cubic-yard) capacity of the low-level radioactive Burial Grounds. Using the 3,480-cubic-meter-per-hectare (1,842-cubic-yard-per-acre) disposal land usage factor for Hanford published in the *Storage and Disposition PEIS* (DOE 1996a:E-9), 600 cubic meters (780 cubic yards) of waste would require 0.17 hectare (0.42 acre) of disposal space at Hanford. The impacts of managing this low-level radioactive waste at Hanford would be minimal.

Maintaining FFTF in standby would result in 210 cubic meters (275 cubic yards) of liquid low-level radioactive waste over the 35-year period. Liquid low-level radioactive waste associated with maintaining FFTF in standby would continue to be stored in FFTF or the Maintenance and Storage Facility and transported, as necessary, to the 200 Area Effluent Treatment Facility for processing and disposal. This liquid low-level radioactive waste resulting from maintaining FFTF in standby represents a very small amount of waste that can be managed by the 200 Area Liquid Effluent Treatment Facility, which has a capacity of 0.57 cubic meter per minute (0.75 cubic yard per minute).

Mixed low-level radioactive waste would be stabilized, packaged, and stored on site for treatment and disposal in a manner consistent with the Tri-Party Agreement (EPA et al. 1989) for Hanford. Over the 35-year period, it is estimated that less than 18 cubic meters (24 cubic yards) of mixed low-level radioactive waste would be generated as a result of maintaining FFTF in standby. This mixed low-level radioactive waste is expected to be treated at a nearby commercial facility. However, if this waste were treated on site, it is estimated to be less than 0.03 percent of the 1,820-cubic-meter-per-year (2,380-cubic-yard-per-year) capacity of the Waste Receiving and Processing Facility. This waste is also estimated to be less than 0.11 percent of the 16,800-cubic-meter (22,000-cubic-yard) storage capacity of the Central Waste Complex and less than 0.13 percent of the 14,200-cubic-meter (18,600-cubic-yard) planned disposal capacity of the Radioactive Mixed Waste Disposal Facility. Therefore, this waste would only have a minimal impact on the management of mixed low-level radioactive waste at Hanford.

Hazardous wastes generated during maintaining FFTF in standby would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities. The waste load generated during the 35-year period would have only a minimal impact on the Hanford hazardous waste management system.

Nonhazardous solid waste would be packaged and transported in conformance with standard industrial practice. Solid wastes such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent off site for that purpose. The remaining solid sanitary waste would be sent for offsite disposal in a municipal landfill. This waste load would have only a minimal impact on the nonhazardous solid waste management system at Hanford.

Nonhazardous process wastewater, which is composed mainly of blowdown water from the eight FFTF cooling towers and would continue to be discharged into the 400 Area Ponds. This discharge is regulated by State Waste Discharge Permit ST-4501.

Nonhazardous sanitary wastewater would continue to be discharged from the 400 Area, which is connected to the Energy Northwest Treatment System. Nonhazardous sanitary wastewater generated from maintaining FFTF in standby would represent 1.6 percent of the 235,000-cubic-meter-per-year (307,000-cubic-yard-per-year) capacity of the Energy Northwest Sewage Treatment Facility.

The generation rates of wastes at Hanford that are associated with maintaining FFTF in standby (refer to Table 4–6) can be compared with the current total waste generation rates at the site, given in Table 3–26 (Section 3.4.11). The waste generation rates associated with maintaining FFTF in standby is a small fraction of the current total waste generation rates at the site.

4.2.1.2.14 Spent Nuclear Fuel Management

Ongoing surveillance and minimum maintenance would continue while FFTF is in standby, and no irradiated nuclear fuel would be transferred to dry storage (WHC 1994).

The current inventory of spent nuclear fuel at FFTF is approximately 11 metric tons (24,200 pounds) of heavy metal, composed predominantly of mixed plutonium-uranium oxide encapsulated in stainless steel cladding (DOE 1995a). The spent nuclear fuel is stored in the sodium-filled vessels and in the dry cask storage system. Spent nuclear fuel stored at FFTF during standby, would continue under existing conditions. There is no radiological liquid released to the environment from spent nuclear fuel storage. During operation, the airborne releases from FFTF, including spent nuclear fuel storage, resulted in an annual total effective dose equivalent to the public of less than 0.0001 millirem (Nielsen 1999). This dose is negligible compared with EPA's Clean Air Act standard of 10 millirem per year.

4.2.2 No Action Alternative—Option 2

Under Option 2 of the No Action Alternative, the United States would continue to purchase the plutonium-238 from Russia that is needed to fabricate radioisotope power systems for future U.S. space missions. However, to allow for potential future production of plutonium-238, neptunium-237 that could be used in targets would be transported from SRS to a new storage facility. This option evaluates REDC at ORR as that storage facility.

FFTF at Hanford would be maintained in standby as part of this option.

4.2.2.1 Importation of Plutonium-238 from Russia

The environmental impacts associated with importing the plutonium-238 from Russia are given in Section 4.2.1.1.

4.2.2.2 Transportation and Storage

The environmental impacts associated with transporting neptunium-237 oxide from SRS to ORR and storing it in REDC are addressed in the following sections.

4.2.2.2.1 Land Resources

LAND USE. REDC is an existing facility in the 7900 Area of the Oak Ridge National Laboratory (ORNL). The use of this facility for storing neptunium-237 for 35 years would require internal modifications, but no new facilities would be built. Since no additional land would be disturbed and the use of REDC for neptunium-237 storage would be compatible with its present mission, there would be no change in land use at ORR.

VISUAL RESOURCES. All activities associated with storing neptunium-237 would take place over a 35-year period in REDC. Because REDC is an existing facility that would require no external modifications, there would be no change in its appearance. Thus, the current Visual Resource Management Class IV rating for the 7900 Area would continue for 35 years. Since there would be no change in the appearance of REDC or of the 7900 Area, there would be no impact on visual resources.

4.2.2.2.2 Noise

Neptunium-237 storage would generate noise levels similar to those presently associated with REDC operations, as well as other operations in the 7900 Area. Onsite noise impacts would be expected to be minimal, and changes in offsite noise levels would not be noticeable since the nearest site boundary is 2.5 kilometers (1.6 miles) to the southeast. Changes in traffic volume going to and from REDC would be small, and would result in only minor changes to existing onsite and offsite noise levels. There would be no loud noises associated with neptunium-237 storage that would adversely impact wildlife. Noise impacts from this option would be expected to be the same over the next 35 years.

4.2.2.2.3 Air Quality

There would be no additional nonradiological air pollutant emissions associated with the storage of neptunium-237 at REDC over the next 35 years; thus, there would be no change in nonradiological air quality impacts at ORR (Wham 1999a).

The air quality impacts of transportation are presented in Section 4.2.2.2.11.

4.2.2.2.4 Water Resources

There would be no additional impact on water resources associated with the storage of neptunium-237 at REDC over 35 years because there would be no incremental use of surface water or groundwater, and there would be no change in the quantity or quality of effluents discharged to surface water or groundwater (Wham 1999a). Information on current water usage, effluent discharge, and water quality at ORR is presented in Section 3.2.4.

4.2.2.2.5 Geology and Soils

Using REDC for storing neptunium-237 would not involve new construction. Therefore, geologic and soil resources in the 7900 Area of ORNL would not be disturbed. Hazards from large-scale geologic conditions at ORR, such as earthquakes and volcanoes, were previously evaluated in the *Storage and Disposition PEIS* (DOE 1996a:4-260). The analysis determined that these hazards present a low risk to long-term storage facilities. Further review of the data and analyses presented in the referenced document and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions likewise present a low risk to REDC. This is based on the fact that there is no evidence of capable faults on or near ORR and no volcanic hazard exists. Ground shaking of Modified Mercalli Intensity VI (refer to Table 3–3) associated with postulated earthquakes would be expected to primarily affect the integrity of inadequately designed or

nonreinforced structures. Damage to properly or specially designed or upgraded facilities would not be expected. While sinkholes are present in the Knox Group, the 7900 Area is underlain by the Conasauga Group, in which karst features are less well-developed. Thus, sinkholes do not present a geologic hazard to REDC. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.2.2.2.6 Ecological Resources

Because no new construction is planned, direct disturbance to ecological resources, including wetlands, would not occur. As noted in Section 4.2.2.2.2, wildlife would not be adversely affected by noise associated with neptunium-237 storage. There would be no change in impacts on aquatic resources for 35 years because water usage and wastewater discharge would not change from current values (Section 4.2.2.2.4). Due to the developed nature of the area and because no new construction would take place, impacts on threatened and endangered species would not occur. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service. Consultations have also been initiated with the State of Tennessee.

4.2.2.2.7 Cultural and Paleontological Resources

Because no new construction is planned, impacts on cultural and paleontological resources would not occur. One structure on ORNL, the Graphite Reactor, is listed on the National Register of Historic Places as a National Historic Landmark. Additionally, several other structures proposed for listing on the National Register of Historic Places are found on or near ORNL. However, neither the Graphite Reactor nor any of the other structures is in the 7900 Area; thus, the status of cultural resources would not change for 35 years as a result of using REDC for neptunium-237 storage. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office.

4.2.2.2.8 Socioeconomics

The existing storage facilities at ORR would remain operational. The effort associated with this option can be filled from within the currently projected site employment of 3,467. No new employment or in-migration of workers would be required. Thus, there would be no additional impacts on the socioeconomic conditions in the region around ORR.

4.2.2.2.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

RADIOLOGICAL IMPACTS. Upper-bounding radiological doses to three receptor groups over a 35-year period are given in **Table 4–7**: the population within 80 kilometers (50 miles) of REDC in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. For purposes of this evaluation, it is conservatively assumed that the doses from neptunium-237 storage would be 10 percent of the doses from neptunium-237 target fabrication and processing (refer to Section 4.4.1.1.9 and Appendix H). The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

A collective dose of 8.0×10^{-6} person-rem would be incurred by the surrounding population in the year 2020. The corresponding number of latent cancer fatalities in this population from 35 years of storage would be 1.4×10^{-7}. A bounding annual dose of 1.7×10^{-7} millirem is shown for the maximally exposed individual. From 35 years of storage, the corresponding risk of a latent cancer fatality to this individual would be 3.0×10^{-12}.

Table 4–7 Radiological Impacts on the Public Around ORR from Storage in REDC Under Option 2 of the No Action Alternative

Receptor	Storage in REDC[a]
Population within 80 kilometers (50 miles) in the year 2020	
Dose (person-rem)	8.0×10^{-6}
35-year latent cancer fatalities	1.4×10^{-7}
Maximally exposed individual	
Annual dose (millirem)	1.7×10^{-7}
35-year latent cancer fatality risk	3.0×10^{-12}
Average exposed individual within 80 kilometers (50 miles)	
Annual dose[b] (millirem)	7.1×10^{-9}
35-year latent cancer fatality risk	1.2×10^{-13}

a. Because exposure data are not available for neptunium-237 storage exclusively, values are conservatively estimated to be 10 percent of the fabrication and processing component of the total neptunium-237 target fabrication, processing, and storage doses given in Table 4–54 of Section 4.4.1.1.9. These values serve as an upper-bounding representation of the potential impacts that could be incurred from neptunium-237 storage (refer to Appendix H). Realistically, these values would be expected to be virtually zero.

b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of REDC in the year 2020 (1,134,200).

Source: Model results, using the GENII computer code (Napier et al. 1988).

The upper-bounding average dose to a worker involved with neptunium-237 storage operations and the upper-bounding dose to the total storage workforce would be 29 millirem and 2.2 person-rem, respectively (refer to **Table 4–8**). The associated risk of a latent cancer fatality to the average worker from 35 years of storage operations would be 4.1×10^{-4}, and the estimated number of latent cancer fatalities in the total storage workforce from 35 years of operations would be 0.031. The total workforce dose presented in Table 4–8 was assumed to be 10 percent of the value given in *Comparative Review of Isotope Production Projects and Radiochemical Processing Activities at Oak Ridge National Laboratory's Melton Valley 7900 Complex* (LMER 1997). This reduction factor was applied because the values given in that document include dose components associated with all REDC activities required for neptunium-237 processing, and not just the storage of neptunium-237 (refer to Appendix H). The resulting dose still serves as a conservative representation of potential worker impacts associated with neptunium-237 storage.

Table 4–8 Radiological Impacts on ORR Workers from Operational Facilities Under Option 2 of the No Action Alternative

Receptor—No Action Workers[a]	Storage in REDC[b]
Total dose (person-rem per year)	2.2[c]
35-year latent cancer fatalities	0.031
Average worker dose (millirem per year)	29
35-year latent cancer fatality risk	4.1×10^{-4}

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with storage operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Because exposure data are not available for neptunium-237 storage exclusively, values are conservatively estimated to be 10 percent of the total dose from neptunium-237 target fabrication/processing and neptunium-237 storage, given in Section 4.4.1.1.9 (Table 4–55), and serve as an upper-bounding representation of the potential impacts that could be incurred from neptunium-237 storage (refer to Appendix H).
c. Based on an estimated 75 badged workers.

Source: LMER 1997:22; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts would be unchanged from baseline site operations because no new chemicals would be used at REDC (Wham 1999a). Ongoing emissions of hazardous chemicals would be expected to continue for the next 35 years.

4.2.2.2.10 Public and Occupational Health and Safety—Facility Accidents

There would be no consequences from postulated accidents for neptunium-237 storage in REDC. The most severe accident evaluated in this NI PEIS is the beyond-design-basis catastrophic earthquake. Although the building would be expected to collapse, the hot cells would be expected to remain intact, but with cracked walls. In addition, one or more of the shielded viewing windows could be cracked or broken. The neptunium-237 is stored in double steel cans, with both the inner and outer cans sealed. The double cans are stacked in an array of seismically supported steel storage tubes inside the hot cell. The storage tube array would maintain geometry and not be damaged by equipment dislodged in the hot cell during the earthquake. The storage cans would not be stressed to a level that would breach the double containment of the can design. Therefore, no neptunium would be released from the storage cans.

Storage of neptunium-237 at REDC would not require the introduction of hazardous chemicals. Thus, there would be no hazardous chemical accidents associated with the storage of neptunium-237 at REDC.

4.2.2.2.11 Public and Occupational Health and Safety—Transportation

Transportation impacts may be divided into two parts: the impacts of incident-free or routine transportation, and the impacts of transportation accidents. Incident-free transportation and transportation accident impacts are divided into two components: nonradiological and radiological. Incident-free transportation impacts include radiological impacts on the public and the crew from the radiation field that surrounds the package; nonradiological impacts are from vehicular emissions. Nonradiological impacts of potential transportation accidents include traffic accident fatalities. Only as a result of a severe fire and/or a powerful collision, which are of extremely low probability, could a transportation package of the type used to transport radioactive material be so damaged that there could be a release of radioactivity to the environment.

The impact of a specific accident is expressed in terms of probabilistic risk, which is defined as the accident probability (i.e., accident frequency) multiplied by the accident consequences. The overall risk is obtained by summing the individual risks from all reasonably conceivable accidents. The risks for radiological accidents

are expressed as additional latent cancer fatalities, and for nonradiological accidents as additional immediate fatalities. The risks of incident-free effects are expressed in additional latent cancer fatalities.

The first step in the analysis was to determine the incident-free and accident risk factors, on a per-shipment basis, for ground transportation of the various materials. Calculation of risk factors was accomplished by using the HIGHWAY (Johnson et al. 1993) computer code to choose representative routes in accordance with U.S. Department of Transportation (DOT) regulations. This code provides population estimates so that the RADTRAN 5 (Neuhauser and Kanipe 2000) code could be used to determine the radiological risk factors. This analysis is described in Appendix J.

Neptunium-237 would be transported from storage at SRS to REDC at ORR. The neptunium-237 would be shipped in Type B packages. Plutonium-238 would be imported from Russia and shipped to LANL. No other shipments of neptunium-237 or waste are anticipated.

Approximately 133 shipments of radioactive materials would be made by DOE under this option. The total distance traveled on public roads by trucks carrying radioactive materials would be 173,000 kilometers (108,000 miles), and at sea by ships carrying plutonium-238 would be 298,000 kilometers (161,000 nautical miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 12 person-rem; the dose to the public would be 26 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0.0048 latent cancer fatality among transportation workers and 0.013 latent cancer fatality in the total affected population over the duration of the transportation activities. Latent cancer fatalities associated with radiological releases were estimated by multiplying the occupational (worker) dose by 4.0×10^{-4} latent cancer fatality per person-rem of exposure, and the public accident and accident-free doses by 5.0×10^{-4} latent cancer fatality per person-rem of exposure (ICRP 1991). The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 9.7×10^{-4}.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: more than 1 in 10 million per year) would not breach the transportation package. The consequences of more severe accidents that could breach the transportation package and release radioactive material were evaluated and estimated to have probabilities of less than 1 in 10 million per year.

Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 0.88 person-rem, resulting in 4.4×10^{-4} latent cancer fatality; and traffic accidents resulting in 0.014 traffic fatality.

4.2.2.2.12 Environmental Justice

As discussed in other parts of Section 4.2.2.2, neptunium-237 storage operations at REDC would pose no significant health or other environmental risks to the public.

NORMAL OPERATIONS. For 35 years of normal operations, the likelihood of a radiological latent cancer fatality among the population residing within 80 kilometers (50 miles) of REDC would be essentially zero (derived from information in Table 4–7). There would be no significant incremental impact associated with emissions of hazardous chemicals at REDC (Section 4.2.2.2.9). As discussed in Section 4.2.2.2.11, no radiological or nonradiological fatalities would be expected to result from incident-free transportation.

ACCIDENTS. Postulated accidents that would affect neptunium-237 storage were found to have no radiological consequences because the storage containers would not be breached (Section 4.2.2.2.10). Accidents during ground transportation were found to have essentially no radiological consequences because credible transportation accidents would not breach the transportation packages for neptunium-237. As discussed in Section 4.2.2.2.11, a fatal vehicle collision would be unlikely.

The implementation of this option would no pose significant radiological or other environmental risks to the public. Under the conservative assumption that all food consumed in the potentially affected area during the 35-year operational period would be radioactively contaminated, no credible pattern of food consumption would pose a significant radiological health risk due to ingestion of contaminated food supplies (see Appendix K). The transportation of neptunium-237 to ORR and storage at REDC would pose no disproportionately high and adverse risks for minority or low-income populations.

4.2.2.2.13 Waste Management

The only anticipated wastes generated would be from the decontamination of the shipping containers used to transport neptunium-237 from SRS to ORR for storage at REDC. The minor amounts of low-level radioactive waste that would be generated—less than 10 cubic meters (13.1 cubic yards) over a 35-year period (Brunson 1999a)—could be managed under the existing waste management practices discussed in Section 3.2.11. Incremental impacts on the environment would be negligible.

4.2.2.3 Maintenance of FFTF in Standby

The environmental impacts associated with maintaining FFTF in standby for 35 years are addressed in Section 4.2.1.2.

4.2.3 No Action Alternative—Option 3

Under Option 3 of the No Action Alternative, the United States would continue to purchase the plutonium-238 from Russia that is needed to fabricate radioisotope power systems for future U.S. space missions. However, to allow for potential future production of plutonium-238, neptunium-237 that could be used in targets would be transported from SRS to a new storage facility. This option evaluates the Building CPP-651 vault at the Idaho National Engineering and Environmental Laboratory (INEEL) as that storage facility. The CPP–651 vault is within 91 meters (100 yards) of FDPF. This vault has 100 in-ground concrete storage silo positions sealed with 5.1-centimeter (2-inch) stainless steel shielding plugs. The neptunium-237 storage cans would be placed in a rack inside the silo.

FFTF at Hanford would be maintained in standby as part of this option.

4.2.3.1 Importation of Plutonium-238 from Russia

The environmental impacts associated with importing the plutonium-238 from Russia are given in Section 4.2.1.1.

4.2.3.2 Transportation and Storage

The environmental impacts associated with transporting neptunium-237 oxide from SRS to INEEL and storing it in the Building CPP–651 vault are addressed in this section.

4.2.3.2.1 Land Resources

LAND USE. Building CPP–651 is in the Idaho Nuclear Technology and Engineering Center (INTEC) area of INEEL. The use of this facility for storing neptunium-237 for 35 years would require internal modifications of the facility, but no new facilities would be built. Since no additional land would be disturbed and the use of Building CPP–651 for neptunium-237 storage would be compatible with the missions for which it was designed, there would be no change in land use at INEEL.

VISUAL RESOURCES. All activities associated with storing neptunium-237 would take place in Building CPP–651. Because this facility would not require external modifications, there would be no change in its appearance. Thus, the current Visual Resource Management Class IV rating for INTEC would continue for 35 years. Since there would be no change in the appearance of Building CPP–651 or INTEC, there would be no impact on visual resources.

4.2.3.2.2 Noise

Neptunium-237 storage in Building CPP–651 would generate noise levels similar to those presently associated with operations conducted in INTEC. Onsite noise impacts would be expected to be minimal, and changes in offsite noise levels should not be noticeable since the nearest site boundary is 12 kilometers (7.5 miles) to the south. Changes in traffic volume going to and from INTEC would be small and would result in only minor changes to onsite and offsite noise levels. There would be no loud noises associated with neptunium-237 storage that would adversely impact wildlife. Noise impacts from this option would be expected to be the same over the next 35 years.

4.2.3.2.3 Air Quality

There would be no additional nonradiological air pollutant emissions associated with the storage of neptunium-237 at INEEL over the next 35 years; thus, there would be no change in nonradiological air quality impacts.

The air quality impacts of transportation are presented in Section 4.2.3.2.11.

4.2.3.2.4 Water Resources

There would be no additional impact on water resources associated with the storage of neptunium-237 in Building CPP–651 for 35 years because there would be no incremental use of surface water or groundwater, and there would be no change in the quantity or quality of effluents discharged to surface water or groundwater. Information on current water usage, effluent discharge, and water quality at INEEL is presented in Section 3.3.4

4.2.3.2.5 Geology and Soils

Building CPP–651 would be used to store neptunium-237. Because this is an existing facility, there would be no disturbance to either geologic or soil resources at INTEC. Hazards from large-scale geologic conditions at INEEL, such as earthquakes and volcanoes, were previously evaluated in the *Storage and Disposition PEIS* (DOE 1996a:4-148). The analysis determined that these hazards present a low risk to long-term storage facilities. That analysis was reviewed in the *Surplus Plutonium Disposition EIS* (DOE 1999a:4-267-268). Further review of the data and analyses presented in these referenced documents and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions likewise present a low risk to the proposed INTEC facilities. Ground shaking of Modified Mercalli Intensity VI to VII (refer to Table 3–3)

associated with postulated earthquakes would be expected to primarily affect the integrity of inadequately designed or nonreinforced structures. Damage to properly or specially designed or upgraded facilities would not be expected. Also, the likelihood of future volcanic activity during the 35-year storage period is considered low. The potential for other nontectonic events to affect INEEL facilities is also low. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.2.3.2.6 Ecological Resources

Because no new construction is planned, direct disturbance to ecological resources would not occur. As noted in Section 4.2.3.2.2, wildlife would not be affected by noise associated with neptunium-237 storage. There would be no impact on aquatic resources for 35 years because water usage and wastewater discharge would not change from current values (Section 4.2.3.2.4). Due to the developed nature of the area and the fact that no new construction would take place, impacts on threatened and endangered species would not occur. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service. Consultations have also been initiated with the State of Idaho.

4.2.3.2.7 Cultural and Paleontological Resources

Because no new construction is planned, impacts on cultural and paleontological resources at INTEC would not occur. The use of Building CPP–651 to store neptunium-237 for 35 years would not change the status of six historic structures located at INTEC. Also, Native American resources occurring in the vicinity of INTEC would not be impacted by the storage of neptunium-237. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office. Consultation has also been initiated with interested Native American tribes.

4.2.3.2.8 Socioeconomics

The existing storage facilities at INEEL would remain operational. The effort associated with this option can be filled from within the currently projected site employment of 7,993. No new employment or in-migration of workers would be required. Thus, there would be no additional impacts on the socioeconomic conditions in the region around INEEL.

4.2.3.2.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

RADIOLOGICAL IMPACTS. Under this option, INEEL would store neptunium-237 in CPP–651 in the INTEC area. Upper-bounding radiological doses to three receptor groups are given in **Table 4–9**: the population within 80 kilometers (50 miles) of INTEC in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. For purposes of this evaluation, it is conservatively assumed that the doses from neptunium-237 storage would be 10 percent of the doses from neptunium-237 target fabrication and processing (refer to Section 4.4.2.1.9 and Appendix H). The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

Table 4–9 Radiological Impacts on the Public Around INEEL from Operational Facilities Under Option 3 of the No Action Alternative

Receptor	Storage in CPP–651[a]
Population within 80 kilometers (50 miles) in the year 2020	
Dose (person-rem)	3.5×10^{-7}
35-year latent cancer fatalities	6.1×10^{-9}
Maximally exposed individual	
Annual dose (millirem)	2.4×10^{-8}
35-year latent cancer fatality risk	4.2×10^{-13}
Average exposed individual within 80 kilometers (50 miles)	
Annual dose[b] (millirem)	1.9×10^{-9}
35-year latent cancer fatality risk	3.3×10^{-14}

a. Because exposure data are not available for neptunium-237 storage exclusively, values are conservatively estimated to be 10 percent of the fabrication and processing component of the total neptunium-237 target fabrication, processing, and storage doses given in Table 4–65 of Section 4.4.2.1.9. These values serve as an upper-bounding representation of the potential impacts that could be incurred from neptunium-237 storage (refer to Appendix H). Realistically, these values would be expected to be virtually zero.

b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of INTEC in the year 2020 (188,400).

Source: Model results, using the GENII computer code (Napier et al. 1988).

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

A collective dose of 3.5×10^{-7} person-rem would be incurred in the surrounding population in the year 2020. The corresponding number of latent cancer fatalities in this population from 35 years of storage would be 6.1×10^{-9}. A bounding annual dose of 2.4×10^{-8} millirem is shown for the maximally exposed individual. From 35 years of storage, the corresponding risk of a latent cancer fatality to this individual would be 4.2×10^{-13}.

The upper-bounding average dose to a worker involved with neptunium-237 storage operations and the upper-bounding dose to the total storage workforce would be 29 millirem and 2.2 person-rem, respectively (refer to **Table 4–10**). The associated risk of a latent cancer fatality to the average worker from 35 years of storage operations would be 4.1×10^{-4}, and the estimated number of latent cancer fatalities in the total storage workforce from 35 years of operations would be 0.031. The total workforce dose presented in Table 4–10 was assumed to be 10 percent of the value given in *Comparative Review of Isotope Production Projects and Radiochemical Processing Activities at Oak Ridge National Laboratory's Melton Valley 7900 Complex* (LMER 1997). This reduction factor was applied because the values given in that document include dose components associated with all REDC activities, and not just the storage of neptunium-237 (refer to Appendix H). The resulting dose still serves as a conservative representation of potential worker impacts associated with neptunium-237 storage.

Table 4–10 Radiological Impacts on INEEL Workers from Operational Facilities Under Option 3 of the No Action Alternative

Receptor—No Action workers[a]	Storage in CPP–651[b]
Total dose (person-rem per year)	2.2[c]
35-year latent cancer fatalities	0.031
Average worker dose (millirem per year)	29
35-year latent cancer fatality risk	4.1×10^{-4}

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with storage operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Because exposure data are not available for neptunium-237 storage exclusively, values are conservatively estimated to be 10 percent of the total dose from neptunium-237 target fabrication/processing and neptunium-237 storage, given in Section 4.4.2.1.9 (Table 4–66), and serve as an upper-bounding representation of the potential impacts that could be incurred from neptunium-237 storage (refer to Appendix H).
c. Based on an estimated 75 badged workers.

Source: LMER 1997:22; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts at INEEL would be unchanged from baseline site operations because no new chemicals would be emitted to the air at INEEL. Ongoing emissions would be expected to continue for the next 35 years.

4.2.3.2.10 Public and Occupational Health and Safety—Facility Accidents

At INEEL, neptunium-237 would be stored in the Building CPP–651 vault, which is within 91 meters (100 yards) of FDPF. The Building CPP–651 vault has 100 in-ground concrete storage silo positions sealed with 5.1-centimeter (2-inch) stainless steel shielding plugs. The neptunium-237 storage cans would be placed in a rack inside the silo. While the postulated beyond-design-basis earthquake may cause portions of the facility to collapse, none of the storage cans in the in-ground storage silos would be breached. The storage cans would not be stressed to a level that would breach the double containment of the can design.

Storage of neptunium-237 in Building CPP–651 would not require the introduction of hazardous chemicals. Thus, there would be no hazardous chemical accidents associated with the storage of neptunium-237 in Building CPP–651.

4.2.3.2.11 Public and Occupational Health and Safety—Transportation

Neptunium-237 would be transported from storage at SRS to the Building CPP–651 vault at INEEL. The neptunium-237 would be shipped in Type B packages. Plutonium-238 would be imported from Russia and shipped to LANL. No other shipments of neptunium-237 and no shipments of waste are anticipated. The analysis is described in Appendix J.

Approximately 133 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 480,000 kilometers (299,000 miles), and at sea by ships carrying plutonium-238 would be 298,000 kilometers (161,000 nautical miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 15 person-rem; the dose to the public would be 52 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0.0058 latent cancer fatality among transportation workers and 0.026 latent cancer fatality in the total affected population

over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 0.0022.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: more than 1 in 10 million per year) would not breach the transportation package. The consequences of more severe accidents that could breach the transportation package and release radioactive material were evaluated and estimated to have probabilities of less than 1 in 10 million per year.

Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 0.88 person-rem, resulting in 4.4×10^{-4} latent cancer fatality; and traffic accidents resulting in 0.016 traffic fatality.

4.2.3.2.12 Environmental Justice

As discussed in other parts of Section 4.2.3.2, neptunium-237 storage operations would pose no significant health or other environmental risks to the public.

NORMAL OPERATIONS. For 35 years of normal storage operations, the likelihood of a radiological latent cancer fatality among the population residing within 80 kilometers (50 miles) of neptunium storage facilities at INEEL would be essentially zero (derived from information in Table 4–9). There would be no significant incremental impact associated with emissions of hazardous chemicals (Section 4.2.3.2.9). As discussed in Section 4.2.3.2.11, incident-free transportation activities conducted under this option would not be expected to result in fatalities.

ACCIDENTS. Postulated accidents that would affect neptunium-237 storage were found to have no radiological consequences because the storage containers would not be breached (Section 4.2.3.2.10). Accidents during ground transportation were found to have essentially no radiological consequences because credible transportation accidents would not breach the transportation packages for neptunium-237. No fatalities due to vehicle collisions would be expected.

The implementation of this option would pose no significant radiological or other environmental risks to the public. Under the conservative assumption that all food consumed in the potentially affected area during the 35-year operational period would be radioactively contaminated, no credible pattern of food consumption would pose a significant radiological health risk due to ingestion of contaminated food supplies (see Appendix K). The transportation of neptunium-237 to INEEL and storage in Building CPP–651 would pose no disproportionately high and adverse risks for minority or low-income populations.

4.2.3.2.13 Waste Management

The only anticipated wastes associated with this option would be from decontamination of the shipping containers used to transport neptunium-237 from SRS to INEEL for storage. The minor amounts of low-level radioactive waste that would be generated—less than 10 cubic meters (13.1 cubic yards) over a 35-year period (Brunson 1999a)—could be managed under the existing waste management practices discussed in Section 3.3.11. Incremental impacts on the environment would be negligible.

4.2.3.3 Maintenance of FFTF in Standby

The environmental impacts associated with maintaining FFTF in standby for 35 years are addressed in Section 4.2.1.2.

4.2.4 No Action Alternative—Option 4

Under Option 4 of the No Action Alternative, the United States would continue to purchase the plutonium-238 from Russia that is needed to fabricate radioisotope power systems for future U.S. space missions. However, to allow for potential future production of plutonium-238, neptunium-237 that could be used in targets would be transported from SRS to a new storage facility. This option evaluates the Fuels and Materials Examination Facility (FMEF) at Hanford as that storage facility.

FFTF at Hanford would be maintained in standby as part of this option.

4.2.4.1 Importation of Plutonium-238 from Russia

The environmental impacts associated with importing the plutonium-238 from Russia are given in Section 4.2.1.1.

4.2.4.2 Transportation and Storage

The environmental impacts associated with transporting neptunium-237 oxide from SRS to Hanford and storing it at FMEF are addressed in this section.

4.2.4.2.1 Land Resources

LAND USE. FMEF is in the 400 Area of Hanford. The use of this facility for storing neptunium-237 for 35 years would require internal modifications, but no new facilities would be built. Since no additional land would be disturbed and the use of FMEF for neptunium-237 storage would be compatible with the mission for which it was designed, there would be no change in land use at Hanford.

VISUAL RESOURCES. All activities associated with storing neptunium-237 would take place over 35 years in FMEF. Because FMEF would require no external modifications, there would be no change in its appearance. Therefore, the current Visual Resource Management Class IV rating for the 400 Area would continue for 35 years. Since there would be no change in the appearance of FMEF or that of the 400 Area, there would be no impact on visual resources.

4.2.4.2.2 Noise

Neptunium-237 storage would generate noise levels similar to those presently associated with operations in the 400 Area. Onsite noise impacts would be expected to be minimal, and changes in offsite noise levels should not be noticeable since the nearest site boundary is 7 kilometers (4.3 miles) to the east. Changes in traffic volume going to and from FMEF would be small and would result in only minor changes to onsite and offsite noise levels. There would be no loud noises associated with neptunium-237 storage that would adversely impact wildlife. Noise impacts from this option would be expected to be the same over the next 35 years.

4.2.4.2.3 Air Quality

There would be no additional nonradiological air pollutant emissions associated with the storage of neptunium-237 at Hanford over the next 35 years; thus, there would be no change in nonradiological air quality impacts.

The air quality impacts of transportation from SRS to Hanford are presented in Section 4.2.4.2.11.

4.2.4.2.4 Water Resources

There would be no additional impact on water resources associated with the storage of neptunium-237 in FMEF for 35 years because there would be no incremental use of surface water or groundwater, and there would be no change in the quantity or quality of effluents discharged to surface water or groundwater. Information on current water usage, effluent discharge, and water quality at Hanford is presented in Section 3.4.4.

4.2.4.2.5 Geology and Soils

Because the neptunium-237 would be stored in FMEF, an existing facility, there would be no disturbance to either geologic or soil resources in the 400 Area. Hazards from large-scale geologic conditions at Hanford, such as earthquakes and volcanoes, were previously evaluated in the *Storage and Disposition PEIS* (DOE 1996a:4-45). The analysis determined that these hazards present a low risk to long-term storage facilities. That analysis was reviewed in the *Surplus Plutonium Disposition EIS* (DOE 1999a:4-260). Further review of the data and analyses presented in these referenced documents and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions likewise present a low risk to FMEF. Ground shaking of Modified Mercalli Intensity V to VII associated with postulated earthquakes would be expected to primarily affect the integrity of inadequately designed or nonreinforced structures. Damage to properly or specially designed or upgraded facilities would not be expected. Also, only minimal effects (e.g., ashfall) would be expected from postulated volcanic events in the Cascade Region. The potential for other nontectonic events to affect the facility is also low. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.2.4.2.6 Ecological Resources

Because no new construction is planned in the 400 Area, direct disturbance to ecological resources would not occur. As noted in Section 4.2.4.2.2, wildlife would not be affected by noise associated with neptunium-237 storage. Because water usage and wastewater discharge would not change from current values, there would be no change in impacts on aquatic habitat or wetlands associated with the Columbia River for 35 years (Section 4.2.4.2.4). Due to the developed nature of the area and the fact that no new construction would take place, impacts on threatened and endangered species would not occur. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Consultations have also been initiated with the State of Washington.

4.2.4.2.7 Cultural and Paleontological Resources

Because FMEF is an existing facility in the highly disturbed 400 Area and new construction would not be required, there would be no change in the status of cultural and paleontological resources. No prehistoric, historic, or paleontological sites have been identified either in the 400 Area or within 2 kilometers (1.2 miles) of the 400 Area. Six buildings in the 400 Area have been determined to be eligible for listing on the National Register of Historic Places as contributing properties in the Historic District recommended for mitigation. The use of FMEF to store neptunium-237 for 35 years would not affect the eligibility of these structures for the National Register of Historic Places. No Native American resources are known to occur in the 400 Area. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office. Consultation has also been initiated with interested Native American tribes.

4.2.4.2.8 Socioeconomics

The existing storage facilities at Hanford would remain operational. The effort associated with this option can be filled from within the currently projected site employment of 16,005. No new employment or in-migration of workers would be required. Thus, there would be no additional impacts on the socioeconomic conditions in the region around Hanford.

4.2.4.2.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

RADIOLOGICAL IMPACTS. This option involves the storage of neptunium-237 at FMEF. Upper-bounding radiological doses to three receptor groups are given in **Table 4–11**: the population within 80 kilometers (50 miles) of FMEF in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. For purposes of this evaluation, it is conservatively assumed that the doses from neptunium-237 storage would be 10 percent of the doses from neptunium-237 target fabrication and processing (refer to Section 4.4.3.1.9 and Appendix H). The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

Table 4–11 Radiological Impacts on the Public Around Hanford from Operational Facilities Under Option 4 of the No Action Alternative

Receptor	Storage in FMEF[a]
Population within 80 kilometers (50 miles) in the year 2020	
Dose (person-rem)	4.0×10^{-6}
35-year latent cancer fatalities	7.0×10^{-8}
Maximally exposed individual	
Annual dose (millirem)	4.3×10^{-8}
35-year latent cancer fatality risk	7.5×10^{-13}
Average exposed individual within 80 kilometers (50 miles)	
Annual dose[b] (millirem)	8.1×10^{-9}
35-year latent cancer fatality risk	1.4×10^{-13}

a. Because exposure data are not available for neptunium-237 storage exclusively, values are conservatively estimated to be 10 percent of the fabrication and processing component of the total neptunium-237 target fabrication, processing, and storage doses given in Table 4–74 of Section 4.4.3.1.9. These values serve as an upper-bounding representation of the potential impacts that could be incurred from neptunium-237 storage (refer to Appendix H). Realistically, these values would be expected to be virtually zero.

b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FMEF in the year 2020 (494,400).

Source: Model results, using the GENII computer code (Napier et al. 1988).

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

A collective dose of 4.0×10^{-6} person-rem would be incurred in the surrounding population in the year 2020. The corresponding number of latent cancer fatalities in this population from 35 years of storage would be 7.0×10^{-8}. A bounding annual dose of 4.3×10^{-8} millirem is shown for the maximally exposed individual. From 35 years of storage, the corresponding risk of a latent cancer fatality to this individual would be 7.5×10^{-13}.

The upper-bounding average dose to a worker involved with neptunium-237 storage operations and the upper-bounding dose to the total storage workforce would be 29 millirem and 2.2 person-rem, respectively (refer to **Table 4–12**). The associated risk of a latent cancer fatality to the average worker from 35 years of storage operations would be 4.1×10^{-4}, and the estimated number of latent cancer fatalities in the total storage workforce from 35 years of operations would be 0.031. The total workforce dose presented in Table 4–12 was assumed to be 10 percent of the value given in *Comparative Review of Isotope Production Projects and Radiochemical Processing Activities at Oak Ridge National Laboratory's Melton Valley 7900 Complex* (LMER 1997). This reduction factor was applied because the values given in that document include dose components associated with all REDC activities, and not just the storage of neptunium-237 (refer to Appendix H). The resulting dose still serves as a conservative representation of potential worker impacts associated with neptunium-237 storage.

Table 4–12 Radiological Impacts on Hanford Workers from Operational Facilities Under Option 4 of the No Action Alternative

Receptor—No Action Workers[a]	Storage in FMEF[b]
Total dose (person-rem per year)	2.2[c]
35-year latent cancer fatalities	0.031
Average worker dose (millirem per year)	29
35-year latent cancer fatality risk	4.1×10^{-4}

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with storage operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.

b. Because exposure data are not available for neptunium-237 storage exclusively, values are conservatively estimated to be 10 percent of the total dose from neptunium-237 target fabrication/processing and neptunium-237 storage, given in Section 4.4.3.1.9 (Table 4–75), and serve as an upper-bounding representation of the potential impacts that could be incurred from neptunium-237 storage (refer to Appendix H).

c. Based on an estimated 75 badged workers.

Source: LMER 1997:22; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts would be unchanged from baseline site operations because no new chemicals would be emitted to the air at Hanford. Ongoing emissions associated with storage at FMEF would be expected to continue for the next 35 years.

4.2.4.2.10 Public and Occupational Health and Safety—Facility Accidents

There would be no consequences from postulated accidents for neptunium-237 storage in FMEF. The most severe accident evaluated in this NI PEIS is the beyond-design-basis catastrophic earthquake. Although the building would be expected to collapse, the hot cells would be expected to remain intact, but with cracked walls. In addition, one or more of the shielded viewing windows could be cracked or broken. The neptunium-237 is stored in double steel cans, with both the inner and outer cans sealed. The double cans are stacked in an array of seismically supported steel storage tubes inside the hot cell. The storage tube array would maintain geometry and not be damaged by equipment dislodged in the hot cell during the earthquake. The storage cans would not be stressed to a level that would breach the double containment of the can design. Therefore, no neptunium would be released from the storage cans.

Storage of neptunium-237 at FMEF would not require the introduction of hazardous chemicals. Thus, there are no hazardous chemical accidents associated with the storage of neptunium-237 at FMEF.

4.2.4.2.11 Public and Occupational Health and Safety—Transportation

Neptunium-237 would be transported from storage at SRS to FMEF at Hanford. The neptunium-237 would be shipped in Type B packages. Plutonium-238 would be imported from Russia and shipped to LANL. No other shipments of neptunium-237 and no shipments of waste are anticipated.

Approximately 133 shipments of radioactive materials would be made by DOE under this option. The total distance traveled on public roads by trucks carrying radioactive materials would be 548,000 kilometers (342,000 miles), and at sea by ships carrying plutonium-238 would be 298,000 kilometers (161,000 nautical miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 15 person-rem; the dose to the public, 57 person-rem. Accordingly, incident-free transportation of radioactive material would result in 0.0060 latent cancer fatality among transportation workers and 0.029 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this alternative is 0.0023.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million) would not breach the transportation package. The consequences of more severe accidents that could breach the transportation package and release radioactive material were evaluated and estimated to have probabilities of less than 1 in 10 million per year.

Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 0.88 person-rem, resulting in 4.4×10^{-4} latent cancer fatality; and traffic accidents resulting in 0.016 traffic fatality.

4.2.4.2.12 Environmental Justice

As discussed in other parts of Section 4.2.4.2, neptunium-237 storage operations at FMEF would pose no significant health or other environmental risks to the public.

NORMAL OPERATIONS. For 35 years of normal storage operations, the likelihood of a radiological latent cancer fatality among the population residing within 80 kilometers (50 miles) of neptunium storage facilities at Hanford would be essentially zero (derived from information in Table 4–11). There would be no significant incremental impact associated with emissions of hazardous chemicals at Hanford (Section 4.2.4.2.9). No fatalities would be expected from incident-free transportation (Section 4.2.4.2.11).

ACCIDENTS. Postulated accidents that would affect neptunium-237 storage were found to have no radiological consequences because the storage containers would not be breached (Section 4.2.4.2.10). Accidents during ground transportation were found to have essentially no radiological consequences because credible transportation accidents would not breach the transportation packages for neptunium-237. No fatal vehicle collisions would be expected.

The implementation of this option would pose no significant radiological or other environmental risks to the public. Under the conservative assumption that all food consumed in the potentially affected area during the 35-year operational period would be radioactively contaminated, no credible pattern of food consumption would pose a significant radiological health risk due to ingestion of contaminated food supplies (see Appendix K). The transportation of neptunium-237 to Hanford and storage in FMEF would pose no disproportionately high and adverse risks to minority or low-income populations.

4.2.4.2.13 Waste Management

The only anticipated wastes associated with this option would be from decontamination of the shipping containers used to transport neptunium-237 from SRS to Hanford for storage at FMEF. The minor amounts of low-level radioactive waste that would be generated—less than 10 cubic meters (13.1 cubic yards) over a 35-year period (Brunson 1999a)—could be managed under the existing waste management practices discussed in Section 3.4.11. Incremental impacts on the environment would be negligible.

4.2.4.3 Maintenance of FFTF in Standby

The environmental impacts associated with maintaining FFTF in standby for 35 years are addressed in Section 4.2.1.2.

4.3 ALTERNATIVE 1—RESTART FFTF

Under Alternative 1, FFTF at Hanford would be restarted and operated for the 35-year evaluation period. FFTF would be used to irradiate targets for medical and industrial isotopes production, plutonium-238 production, and nuclear research and development irradiation requirements. Ongoing operations at existing facilities as described in Chapter 3, Affected Environment, would continue.

Targets for medical and industrial isotope production would be fabricated in one or more facilities at Hanford. Target material would typically be acquired from ORNL, where enrichment processes are conducted to produce high purity target material suitable for production of medical isotopes. The targets would be irradiated at FFTF and then returned to the fabrication facility for postirradiation processing. From there, the isotope products would be sent directly to commercial pharmaceutical distributors.

Targets for plutonium-238 production would be fabricated in one of three candidate facilities at ORNL, INEEL, or Hanford. The material needed for target fabrication (neptunium-237) would be transported from the fabrication facilities. The nonirradiated targets would be transported and irradiated at FFTF and transported back to the fabricating facilities for postirradiation processing. The separated plutonium-238 would be transported to LANL for fabrication into heat sources for radioisotope power systems.

Under Alternative 1, raw materials, nonirradiated targets, irradiated targets, and processed materials would be transported between the locations selected for raw target material acquisition, material storage, target fabrication, target irradiation, and postirradiation processing and the final destination for the isotopes and the plutonium-238 product or various research and development test sites.

FFTF could produce high-energy neutrons and a large flux level (10^{15} neutron per square centimeters per second) that can be tailored to nearly any desired energy level. FFTF would provide the greatest flexibility for both isotope production and nuclear-based research and development among the baseline configurations for all of the proposed alternatives. Due to its large core size, flux spectrum, demonstrated testing capability, and rated power level, it would be able to concurrently support the projected plutonium-238 needs, production of medical and industrial isotopes (including those isotopes normally produced in particle accelerators), and nuclear research and development related to a broad range of materials, advanced reactors, advanced fuels and waste transmutation.

The six options under this alternative are associated with the type of nuclear fuel to be used for FFTF operations and the specific facilities to be used for target fabrication and processing. The first three options (Options 1 through 3) would involve operating FFTF with a mixed oxide fuel core for the first 21 years and a highly enriched uranium fuel core for the remaining 14 years. The last three options (Options 4 through 6) would involve operating FFTF with a mixed oxide fuel core for the first 6 years and a highly enriched uranium fuel core for the remaining 29 years. FFTF can provide similar irradiation services with either a mixed oxide core or a highly enriched uranium core. The reasons for these options in FFTF core fuel are provided in Section 2.3.1.1.3.

The options involving storage, fabrication, postirradiation processing, and transportation are discussed below.

- **Options 1 and 4.** REDC at ORNL would be used to fabricate and process the neptunium-237 targets required for plutonium-238 production. The neptunium-237 transported from SRS to ORNL would be stored in REDC. The plutonium-238 product would be transported from ORNL to LANL. Hanford's RPL/306–E facilities would be used to fabricate and process targets for medical and industrial isotope production and for research and development, as well as to store the materials needed to fabricate these targets.

- **Options 2 and 5.** FDPF at INEEL would be used to fabricate and process the neptunium-237 targets for plutonium-238 production. The neptunium-237 transported from SRS to INEEL would be stored in FDPF or Building CPP–651 at INEEL. The plutonium-238 product would be transported from INEEL to LANL. Hanford's RPL/306–E facilities would be used to fabricate and process targets for medical and industrial isotope production and for research and development, as well as to store the materials needed to fabricate these targets.

- **Options 3 and 6.** FMEF at Hanford would be used to fabricate and process both neptunium-237 targets for plutonium-238 production and the targets for the production of medical and industrial isotopes. The neptunium-237 transported from SRS to Hanford and the other target materials transported from other offsite facilities to Hanford would be stored in FMEF. The plutonium-238 product would be transported from Hanford to LANL for fabrication into heat sources for radioisotope power systems.

As described in Section 1.2.3, the nuclear research and development initiatives requiring an enhanced DOE nuclear infrastructure fall into three basic categories: materials research, nuclear fuels research, and advanced reactor development.

- Materials research involves irradiating materials in a high-flux field to determine the radiation effect during reactor normal operating conditions or to perform accelerated life-cycle testing. This form of testing would not introduce material into FFTF that would result in additional releases during normal operation or accident conditions.

- Nuclear fuels research involves irradiating test fuel pellets, fuel pins, and fuel assemblies in high-temperature environments expected in future reactor designs. When the test specimens are inserted into FFTF, there would be no significant increase of fissile material in the FFTF core inventory that would result in additional releases during normal operation or accident conditions.

- Advanced reactor development involves test loop experiments under prototypical reactor conditions. When the test loop is operating in the FFTF core, there would be no significant increase of fissile material in the core inventory that would result in additional releases during normal operation or accident conditions.

The environmental impacts associated with implementation of the proposed nuclear research and development missions cannot be distinguished from the impacts of operating FFTF without the nuclear research and development mission.

The baseline operational impacts at ORR, INEEL, and Hanford are presented in Table 4–1. They represent impacts associated with onsite and offsite activities that are foreseeable and documented, but do not include potential NI PEIS impacts. The incremental environmental impacts associated with each of the six options presented in this section can be added to the baseline to provide total site impacts.

4.3.1 Alternative 1 (Restart FFTF)—Option 1

Option 1 involves operating FFTF at Hanford to irradiate all targets and materials associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating REDC at ORR to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and operating facilities in the Hanford 300 Area to fabricate and process the other targets and materials and to process the associated products. This option includes storage in REDC of the neptunium-237 transported to

ORR from SRS and storage in the Hanford 300 Area facilities of the other target materials transported to Hanford from other offsite facilities.

The transportation of the mixed oxide and highly enriched uranium fuel to Hanford for use in FFTF, the transportation of the neptunium-237 to ORR and then to Hanford, the transportation of the other target material to Hanford, and the transportation of the product materials following irradiation and postirradiation processing are also part of this option.

Under Option 1, FFTF would operate with a mixed oxide fuel core for the first 21 years and with a highly enriched uranium fuel core for the next 14 years.

4.3.1.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations and with all transportation activities are assessed in this section.

4.3.1.1.1 Land Resources

LAND USE. FFTF is in the 400 Area of Hanford. For the foreseeable future, land use in the 400 Area is anticipated to be industrial, which is defined to include FFTF operations. The use of the facility for the irradiation services assessed in this NI PEIS would be compatible with the mission for which the facility was originally built. Although internal modifications could be required, no new facilities would be built and thus, there would be no change in land use in the 400 Area.

REDC at ORR would be used for neptunium-237 storage, target fabrication, and processing. REDC is an existing operating facility in the 7900 Area of ORNL, and use of this facility would require internal modifications, but no new facilities would be built. Because no additional land would be disturbed and the use of REDC for neptunium-237 storage, target fabrication, and processing would be compatible with its present mission, there would be no change in land use at ORR.

The Radiochemical Processing Laboratory (RPL) and Building 306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and nuclear research and development missions. These buildings are existing structures that would require only internal modifications. Because no additional land would be disturbed and target fabrication and processing would be compatible with their present mission, there would be no impact on land use at Hanford.

VISUAL RESOURCES. The use of FFTF would not require any external modifications that would alter the appearance of the facility. Thus, the current Visual Resource Management Class IV rating for the 400 Area would not change. Since there would be no change in the appearance of FFTF or that of the 400 Area, there would be no additional impact on visual resources.

All activities associated with neptunium-237 storage, target fabrication, and processing would take place in REDC at ORR. Because REDC is an existing facility that would require no external modifications, there would be no change in its appearance. Therefore, the current Visual Resource Management Class IV rating for the 7900 Area would not change, and there would be no impact on visual resources.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and nuclear research and development missions. These existing structures would require no external modifications. Because the appearance of these buildings would

remain unchanged, the current Visual Resource Management Class IV rating for the 300 Area would not change; thus, there would be no impact on visual resources.

4.3.1.1.2 Noise

No new construction would be required at FFTF under Option 1. Noise sources from FFTF operations would be similar to those during standby. Therefore, the change in noise levels from operation activities would be expected to be small. FFTF operations would not be expected to result in any change in noise impacts on wildlife around the 400 Area, and offsite noise impacts would also be minor because the nearest site boundary is 7 kilometers (4.3 miles) to the east. Operations would be expected to result in a minimal change in noise impacts on people near Hanford as a result of changes in employee and truck traffic levels.

REDC at ORR would be used for neptunium-237 target-material storage, target fabrication, and processing. Interior modifications of these facilities in the 7900 Area of ORNL would be expected to result in little change in noise impacts on wildlife around this area. REDC operations would not be expected to result in any change in noise impacts on wildlife around the 7900 Area, and offsite noise impacts would be small because the nearest site boundary is 2.5 kilometers (1.6 miles) to the southeast. Operations would be expected to result in minimal change in noise impacts on people near ORR as a result of changes in employee and truck traffic levels.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and nuclear research and development missions. Interior modifications of these facilities would be expected to result in little change in noise impacts on wildlife around this area and people near Hanford. Operation of these facilities for target fabrication and processing would not be expected to result in any change in noise impacts on wildlife around the 300 Area and people near Hanford. Operations would be expected to result in minimal change in noise impacts on people near Hanford as a result of changes in employee and truck traffic levels.

4.3.1.1.3 Air Quality

There are no planned FFTF outdoor construction activities associated with the restart of FFTF. No airborne constituents are currently measured or have been required to be monitored during previous reactor operations (Nielsen 2000). Several air pollutant sources are operating at FFTF, including the gas turbine emergency generator, the diesel-driven fire pump, and the oil-fired preheaters. They would continue to operate at the existing frequency. The emergency diesel generators are not currently operated or tested. The restart of FFTF would require the emergency diesel generators to be tested approximately 30 minutes each month to ensure operability (Nielsen 2000). Criteria pollutants were modeled and compared with the most stringent standards for the Hanford area. The concentrations are based on a dispersion-modeling screening analysis conducted with maximum expected emission rates and a set of worst-case meteorological conditions. Only those air pollutants expected to be emitted that have ambient air quality standards are presented in the table.

The concentrations at Hanford from FFTF attributable to this option are presented in **Table 4–13.** The concentrations were determined to be small and would be below the applicable ambient standards even when ambient monitored values and contributions from other site activities were included.

Table 4–13 Incremental Hanford Concentrations Associated with Alternative 1 (Restart FFTF)—Option 1

Pollutant	Averaging Time	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (micrograms per cubic meter)
Carbon monoxide	8 hours	10,000[b]	52.1
	1 hour	40,000[b]	74.4
Nitrogen dioxide	Annual	100[b]	0.0118
PM_{10}	Annual	50[c]	0.000839
	24 hours	150[c]	9.84
Sulfur dioxide	Annual	50[d]	0.00785
	24 hours	260[d]	9.11
	3 hours	1,300[d]	20.5
	1 hour	660[d]	22.8

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} (particulate matter with an aerodynamic diameter less than or equal to 10 micrometers) standard is attained when the expected number of days with a 24-hour average concentration above the standard is much less than 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.
b. Federal and state standard.
c. Federal standard currently under litigation.
d. State standard.

Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995); additional data from Nielsen 2000.

The concentrations at Hanford attributable to this option are compared with the Prevention of Significant Deterioration Class II increments for sulfur dioxide and nitrogen dioxide in **Table 4–14**.

Table 4–14 PSD Class II Increments Compared to Hanford Concentrations Associated with FFTF Under Alternative 1 (Restart FFTF)—Option 1

Pollutant	Averaging Time	Allowable PSD Increment (micrograms per cubic meter)	Modeled Increment (micrograms per cubic meter)
Nitrogen dioxide	Annual	25	0.0118
Sulfur dioxide	Annual	20	0.00785
	24 hours	91	9.11
	3 hours	512	20.5

Key: PSD, Prevention of Significant Deterioration.
Source: Modeled PSD increments are based on the SCREEN 3 computer code (EPA 1995).

The air pollutant concentrations at ORR attributable to this option at REDC are presented in **Table 4–15**. The concentrations are based on a dispersion-modeling screening analysis conducted with maximum expected emission rates and a set of worst-case meteorological conditions. Only those air pollutants expected to be emitted that have ambient air quality standards are presented in the table.

Table 4–15 Incremental ORR Concentrations[a] Associated with Alternative 1 (Restart FFTF)—Option 1

Pollutant	Averaging Time	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (micrograms per cubic meter)
Nitrogen dioxide	Annual	100	1.99×10^{-4}
Sulfur dioxide	Annual	80	0.04
	24 hours	365	0.31
	3 hours	1,300	0.70

a. For comparison with ambient air quality standards.
Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995).

There are no Prevention of Significant Deterioration increment-consuming sources at ORR; therefore, a Prevention of Significant Deterioration increment consumption analysis was not conducted. Health effects from hazardous chemicals associated with this option are addressed in Section 4.3.1.1.9.

The change in ambient concentrations of these pollutants would be minimal compared to the baseline. Concentrations off site would be expected to stay well below the ambient standards even when ambient monitored values and the contribution from other site activities were included.

The air quality impacts of transportation are presented in Section 4.3.1.1.11.

4.3.1.1.4 Water Resources

For the restart of FFTF, an existing facility, there would be no construction-related impacts on water bodies, floodplains, or on surface water or groundwater quality.

During current standby operations, annual average groundwater withdrawal by 400 Area facilities is about 197 million liters (52 million gallons). Should FFTF be restarted, FFTF operations would increase water use by about 61 million liters (16 million gallons) to a total annual withdrawal of approximately 257 million liters (68 million gallons) (Nielsen 1999:38, 41). In addition to higher process cooling demands at FFTF from cooling tower operation, this increase reflects additional staffing and associated potable and sanitary water demands in the 400 Area (DOE 2000a:11; Nielsen 1999:38, 41). This volume of 257 million liters (68 million gallons) per year is approximately 65 percent of the 400 Area groundwater production capacity of about 398 million liters (105.1 million gallons) per year (DOE 1999a:4-262). However, no impact on regional groundwater levels would be expected from increased withdrawals (Nielsen 1999:38). Resumption of groundwater withdrawals could potentially affect the direction of groundwater flow in the unconfined aquifer system on a localized basis. Surface water would not be used for operation of the 400 Area facilities; thus, there would be no impact on the availability of surface water from the Columbia River.

Additional staffing required to support the restart of FFTF would also increase annual sanitary wastewater generation in the 400 Area by approximately 1.9 million liters (500,000 gallons) over standby to about 5.7 million liters (1.5 million gallons) per year during operations (DOE 2000a:11). Sanitary wastewater from the 400 Area is conveyed to the Energy Northwest treatment system (Nielsen 1999:39). The Energy Northwest treatment system has a treatment capacity of approximately 235 million liters (62 million gallons) per year with sufficient excess capacity to accommodate increased flow from the 400 Area (DOE 1999a:4-41).

There are no radiological liquid effluent pathways to the environment from FFTF. Process (nonradioactive) wastewater from 400 Area facilities is discharged to the 400 Area process sewer system and ultimately to the 400 Area Pond (i.e., 4608 B/C percolation ponds). These discharges are regulated under State Waste Discharge Permit No. ST-4501. This system is further described in Section 3.4.4.1.2. Process wastewater

discharges from FFTF would increase from about 76 million liters (20 million gallons) annually during standby to approximately 98 million liters (26 million gallons) per year during operations. Increased process wastewater volume would mainly consist of cooling tower blowdown from FFTF's eight cooling towers. However, chemical usage required to control scaling and biofouling of the cooling water systems would not increase (DOE 2000a: 11; Nielsen 1999:38). Therefore, as the chemical quality of the process wastewater would not change, no impact on groundwater quality would be expected.

Small quantities of liquid, low-level radioactive waste would be generated during operations associated with washing residual sodium from reactor components in FFTF's Interim Examination and Maintenance Cell and decontamination activities at the 400 Area Maintenance and Storage Facility. Approximately 6,000 liters (1,600 gallons) of liquid, low-level radioactive waste would be generated annually, which would be collected and transported to the 200 Area Effluent Treatment Facility for treatment and disposal (DOE 2000a:7; Nielsen 1999:39, 41).

Waste management aspects of this alternative and their effects are further discussed in Section 4.3.1.1.13.

REDC in the 7900 Area of ORNL would be used for neptunium-237 storage, target fabrication, and processing in support of plutonium-238 production with proposed activities similar to the current mission of REDC. As existing facilities would be used, there would be no construction-related impacts on water bodies, floodplains, or on surface water or groundwater quality. In addition, no measurable increase in water use is anticipated to support target fabrication for plutonium-238 production. The only measurable increase would be an additional 23,000 liters (6,100 gallons) per year of process wastewater associated with target processing (Wham 1999c). Any change in the quantity or quality of process and sanitary wastewater discharges would be small compared to that of other activities (Section 3.2.4.1.2), with no radiological liquid effluent discharge to the environment under normal operations (Wham 1999a; LMER 1997). Specifically, the anticipated additional 23,000 liters (6,100 gallons) of process wastewater generated per year would be negligible relative to the total volume of process wastewater generated and treated at ORNL, approximately 2.08 million liters (550,000 gallons) per day. Overall, no measurable impact on water resources at ORR is expected.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and nuclear research and development missions. However, radiological activities would be confined to RPL, with Building 306–E providing support to activities not involving radioactive materials (DOE 2000a:C-1). As existing facilities would be used requiring no external modifications, there would be no construction-related impacts on water bodies, floodplains, or on surface water or groundwater quality. Little or no measurable increase in water use is anticipated to support target fabrication and processing for medical, industrial, and research and development isotope production, with no radiological liquid effluent discharge to the environment under normal operations (DOE 1997b:4-28, 4-29). Also, changes in the quantity or quality of process and sanitary wastewater discharges would be negligible compared to that of other RPL activities, with the only projected increase resulting from equipment washing of nonradiological target materials (DOE 1997b:4-30). Process wastewater discharge from washing activities at RPL is projected to increase by about 16,000 liters (4,200 gallons) per year from a current annual average of approximately 3.6 million liters (950,000 gallons) (DOE 2000a:C-3). This is an increase of less than 1 percent. Thus, impacts on water resources at Hanford are expected to be negligible overall.

Waste management aspects of this option and their effects are further discussed in Section 4.3.1.1.13.

4.3.1.1.5 Geology and Soils

Since no new construction is planned under the proposed restart of FFTF, there would be no disturbance to either geologic or soil resources in the 400 Area of Hanford. As discussed in Section 4.2.1.2.5, hazards from large-scale geologic conditions at Hanford, such as earthquakes and volcanoes, were previously evaluated in the *Storage and Disposition PEIS* (DOE 1996a:4-45). The analysis determined that these hazards present a low risk to properly or specially designed or upgraded facilities. That analysis was reviewed in the *Surplus Plutonium Disposition EIS* (DOE 1999a:4-260). Further review of the data and analyses presented in these referenced documents and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions likewise present a low risk to proposed FFTF operations. This is based on the relatively low seismic risk of the area to such specially designed facilities and the expected minimal effects from postulated volcanic events in the Cascade Region.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and nuclear research and development missions. Because existing structures would be used, there would be no disturbance to geologic or soil resources in the 300 Area. Hazards from large-scale geologic conditions at Hanford were previously evaluated as discussed above for FFTF and determined to present a low risk to existing facilities. For the reasons previously described, the large-scale geologic conditions likewise present a low risk to the subject 300 Area facilities. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

Because the existing REDC facility would be used for neptunium-237 storage, target fabrication, and processing, geologic and soil resources in the 7900 Area of ORR would not be disturbed. Hazards from large-scale geologic conditions at ORR, such as earthquakes and volcanoes, were previously analyzed as discussed in Section 4.2.2.2.5 and determined to present a relatively low risk to REDC.

4.3.1.1.6 Ecological Resources

Terrestrial resources would not be adversely affected by the restart of FFTF because it is in the highly disturbed and fenced 400 Area and no new construction is planned. Further, as noted in Section 4.3.1.1.2, there would be no change in noise impacts on wildlife. Because additional water usage and wastewater discharge would be small fractions of current values and discharge chemistry would not be expected to change, there would be no change in impacts on aquatic habitat or wetlands associated with the Columbia River (Section 4.3.1.1.4). Due to the developed nature of the area and the fact that no new construction would take place, impacts on threatened and endangered species would not occur. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Consultations have also been initiated with the State of Washington.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and nuclear research and development missions. Because use of these buildings would not involve any new construction, direct disturbance to ecological resources would not occur. As noted in Section 4.3.1.1.1, wildlife would not be adversely affected by noise associated with target fabrication and processing activities. Because water usage and wastewater discharge would be small fractions of current values and discharge chemistry would not be expected to change, there would be no change in impacts on aquatic habitat or wetlands associated with the Columbia River (Section 4.3.1.1.4). Due to the developed nature of the area and the fact that no new construction would take place, impacts on threatened and endangered species would not occur. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Consultations have also been initiated with the State of Tennessee.

The existing REDC at ORR would be used for neptunium-237 storage, target fabrication, and processing. No new construction would take place; thus, direct disturbance to ecological resources, including wetlands, would not occur. As noted in Section 4.3.1.1.2, there would be no change in noise impacts on wildlife. Because there are no wetlands in or directly adjacent to the 7900 Area, this resource would not be affected. There would be no change in impacts on aquatic resources because no additional water would be withdrawn from or discharged to site surface waters and discharge chemistry would not be expected to change (Section 4.3.1.1.4). Threatened and endangered species would not be impacted because an existing facility in the developed area would be used. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service. Consultations have also been initiated with the State of Tennessee.

4.3.1.1.7 Cultural and Paleontological Resources

Because FFTF is in the highly disturbed 400 Area and new construction would not be required, no direct impacts on cultural and paleontological resources would be expected. No prehistoric, historic, or paleontological sites have been identified either in the 400 Area or within 2 kilometers (1.2 miles) of the 400 Area. Six buildings in the 400 Area, including two FFTF structures (the Reactor Containment Building and FFTF Control Building), have been determined to be eligible for the National Register of Historic Places as contributing properties in the Historic District recommended for mitigation. The restart of FFTF would be consistent with the purpose for which the reactor was built and would not affect the status of the aforementioned structures. No Native American resources are known to occur in the 400 Area. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office. Consultation has also been initiated with interested Native American tribes.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and nuclear research and development missions. Although a number of archaeological sites have been located at least partially within the 300 Area, none would be disturbed because new construction would not be required. Additionally, both buildings have been determined eligible for the National Register of Historic Places as contributing properties within the Historic District recommended for mitigation (Section 3.4.7.2.2); however, they would not be substantially altered by use for target fabrication and processing, and thus, their status would not change. Areas near the 300 Area that are of importance to Native Americans would not be affected by the proposed action. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office. Consultation has also been initiated with interested Native American tribes.

Neptunium-237 storage, target fabrication, and processing would take place at the existing REDC facility, which is in the 7900 Area of ORNL. Because no new construction would take place, direct impacts on cultural and paleontological resources would not occur. One structure within ORNL, the Graphite Reactor, is listed on the National Register of Historic Places as a National Historic Landmark. Additionally, several other structures proposed for listing on the National Register of Historic Places are found within or near ORNL. However, neither the Graphite Reactor nor any of the other structures is in the 7900 Area and, thus, their status would not change by the use of REDC for target fabrication and processing. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office.

4.3.1.1.8 Socioeconomics

Operating FFTF and target fabrication and processing of all other targets at Hanford 300 Area facilities would require about 56 additional workers to operate these facilities (DOE 1997b, Hoyt et al. 1999). This level of employment would generate about 142 indirect jobs in the region around Hanford. The potential total

employment increase of 198 direct and indirect jobs in the Hanford region represents less than a 0.1 percent increase in the projected regional economic area workforce. It would have no noticeable impact on the regional economic area.

Additional employment resulting from this option would not have any noticeable impact on community services in the Hanford region of influence. Assuming that 91 percent of the new employment associated with this option would reside in Hanford's region of influence (Section 3.4.8), 198 total jobs could increase the region's population by approximately 334 persons. This increase, in conjunction with normal population growth forecasted by the State of Washington, would not have any noticeable impact on the availability of housing and/or the price of housing in the region of influence. Given the current population-to-student ratio in the region of influence, this would likely result in an increase of about 69 students, requiring local school districts to slightly increase the number of classrooms to accommodate them.

Community services in the region of influence would be expected to change to accommodate the population growth as follows: four new teachers would be needed to maintain the current student-to-teacher ratio of 17.4:1; one new police officer would be needed to maintain the current officer-to-population ratio of 1.5:1000; and one new firefighter would need to be added to maintain the current firefighter-to-population ratio of 3.4:1000. Thus, an additional six positions would have to be created to maintain community services at current levels. Hospitals in the region of influence would not experience any change from the 2.1 beds per 1,000 persons currently available. Additionally, the average school enrollment would not change. None of these projected changes should have a major impact on the level of community services currently offered in the region of influence.

Target fabrication and processing of neptunium-237 targets at ORR would require about 41 additional workers to operate these facilities (Wham et al. 1998). This level of employment would generate approximately 105 indirect jobs in the region around Oak Ridge. The potential total employment increase of 146 direct and indirect jobs represents less than 0.1 percent of the projected regional economic area workforce. It would have no noticeable impact on the regional economic area.

Additional employment resulting from this option would not have any noticeable impact on community services in the ORR region of influence. Assuming that 89.9 percent of the new employment associated with this option would reside in ORR's region of influence (Section 3.2.8), 146 total new jobs could increase the region's population by approximately 250 persons. This increase, in conjunction with normal population growth forecasted by the State of Tennessee, would have no noticeable effect on the availability of housing and/or the price of housing in the region of influence. The public would experience little or no change in the level of community services currently offered in the region of influence.

4.3.1.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup, processing, and operations are given in **Table 4–16** for FFTF and RPL at Hanford and REDC at ORR: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding

population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

To represent a bounding annual dose scenario at Hanford, it is assumed that a full-year's isotopic release would occur from target processing at RPL concurrently with a full-year's release from FFTF operations at 400 MW; the impacts presented in Table 4–16 assume a full-year's release resulting from FFTF and RPL preoperational testing and startup activities. To represent a bounding annual dose scenario at ORR, it is assumed that a full year's release would occur from neptunium-237 target processing at REDC.

Table 4–16 Incremental Radiological Impacts on the Public Around ORR and Hanford from Operational Facilities Under Alternative 1 (Restart FFTF)—Option 1

Receptor	ORR REDC Processing[a]	Hanford FFTF Preoper. Activities[b]	Hanford RPL Preoper. Activities[b]	Hanford FFTF Operations	Hanford RPL Target Processing[a]	Hanford Operations and Processing Total[c]
Population within 80 kilometers (50 miles) in the year 2020						
Dose (person-rem)	8.8×10^{-5}	0.028	1.0[d]	0.044	0.21	0.25
1-year latent cancer fatalities	–	1.4×10^{-5}	5.0×10^{-4}	–	–	–
35-year latent cancer fatalities	1.5×10^{-6}	–	–	7.7×10^{-4}	0.0037	0.0045
Maximally exposed individual						
Annual dose (millirem)	1.9×10^{-6}	1.3×10^{-4}	0.043[c]	4.0×10^{-4}	0.0050	0.0054
1-year latent cancer fatality risk	–	6.5×10^{-11}	2.2×10^{-8}	–	–	–
35-year latent cancer fatality risk	3.3×10^{-11}	–	–	7.0×10^{-9}	8.8×10^{-8}	9.5×10^{-8}
Average exposed individual within 80 kilometers (50 miles)						
Annual dose[e] (millirem)	7.8×10^{-8}	5.6×10^{-5}	2.0×10^{-3} [c]	8.7×10^{-5}	4.2×10^{-4}	5.1×10^{-4}
1-year latent cancer fatality risk	–	2.8×10^{-11}	1.0×10^{-9}	–	–	–
35-year latent cancer fatality risk	1.4×10^{-12}	–	–	1.5×10^{-9}	7.3×10^{-9}	8.8×10^{-9}

a. Target storage, processing, and fabrication activities are performed at the facility. Impacts are for all facility target activities and are dominated by processing activity impacts.
b. For conservatism as well as consistency with other radiological impacts evaluated in this NI PEIS, these values were assessed for the year 2020 even though these activities would commence prior to that year.
c. Represents upper-bounding values.
d. Annual emissions during preoperational activities were assumed to be the same as the 1998 releases for RPL (BWHC 1999a). The majority of this dose is due to tritium releases.
e. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of the facilities in the year 2020 (about 505,000 for Hanford and 1,134,200 for ORR).

Source: Model results, using the GENII computer code (Napier et al. 1988).

As a result of annual operations, the bounding projected total incremental population dose in the year 2020 for the populations surrounding Hanford and ORR would be 0.25 person-rem. The corresponding number of latent cancer fatalities in these populations from 35 years of operations would be 0.0045. The bounding total

incremental dose to the maximally exposed member of the public from annual operations at Hanford would be 0.0054 millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 9.5×10^{-8}. The incremental dose to the maximally exposed member of the public from annual operations at ORR would be 1.9×10^{-6} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 3.3×10^{-11}.

Incremental doses to involved workers from normal operations are given in **Table 4–17**; these workers are defined as those directly associated with all process and operational activities. The incremental annual average dose to REDC workers would be 290 millirem; the incremental annual average dose to FFTF workers (during startup) would be 3.5 millirem; the incremental annual average dose to FFTF workers (during operations) would be 6.6 millirem; the incremental annual average dose to RPL workers (during startup) would be 81 millirem; and the incremental annual average dose for RPL workers (during processing) is estimated to be approximately 160 millirem. The incremental annual dose received by the total site workforce for each of these facilities (at the different phases) would be approximately 22, 0.69, 1.3, 3.2, and 4.8 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers are included in Table 4–17. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–17 Incremental Radiological Impacts on Involved REDC, FFTF, and RPL Workers Under Alternative 1 (Restart FFTF)—Option 1

Receptor—Involved Workers[a]	ORR REDC Processing[b]	Hanford FFTF Preoper. Activities	Hanford RPL Preoper. Activities	Hanford FFTF Operations	Hanford RPL Target Processing[b]	Hanford Operations & Processing Total
Total dose (person-rem per year)	22[c]	0.69[d]	3.2[e]	1.3[d]	4.8[f]	6.1
1-year latent cancer fatalities	–	2.8×10^{-4}	0.0013	–	–	–
35-year latent cancer fatalities	0.31	–	–	0.018	0.067	0.085
Average worker dose (millirem per year)	290	3.5	81	6.6	160	NA
1-year latent cancer fatality risk	–	1.4×10^{-6}	3.2×10^{-5}	–	–	–
35-year latent cancer fatality risk	0.0041	–	–	9.2×10^{-5}	0.0022	NA

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Target storage, processing, and fabrication activities are performed at this facility. Impacts, dominated by processing activities, include impacts from all facility target activities.
c. Based on an estimated 75 badged workers.
d. Based on an estimated 200 badged workers.
e. Based on an estimated 40 badged workers.
f. Based on an estimated 30 badged workers.
Key: NA, not applicable.
Source: BWHC 1999; LMER 1997:22; Nielsen 1999; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. No new hazardous chemical impacts would be expected at RPL/306–E in the 300 Area of Hanford. The quantities of chemicals used for target fabrication and processing would change little from ongoing operations in the 300 Area, and emissions and air quality impacts would be expected to be unchanged.

FFTF restart would require emergency diesel generators to be tested. Hazardous chemical impacts are summarized in **Table 4–18**.

Table 4–18 Incremental Hazardous Chemical Impacts Associated with FFTF Emergency Diesel Generators at Hanford Under Alternative 1 (Restart FFTF)—Option 1

Chemical	Modeled Annual Increment (micrograms per cubic meter)	Reference Concentration (micrograms per cubic meter)	Unit Cancer Risk (risk per micrograms per cubic meter)	Hazard Quotient	Cancer Risk
Benzene	2.5×10^{-6}	NA	7.8×10^{-6}	NA	1.96×10^{-11}
Toluene	1.10×10^{-6}	400	NA	2.90×10^{-9}	NA
Propylene	6.92×10^{-6}	NA	3.7×10^{-6}	NA	2.56×10^{-11}
Formaldehyde	3.17×10^{-6}	NA	0.000013	NA	4.12×10^{-11}
Acetaldehyde	2.06×10^{-6}	NA	2.2×10^{-6}	NA	4.53×10^{-12}

Key: NA, not applicable (the chemical is not a known carcinogen or it is a carcinogen and only unit cancer risk will apply).
Source: EPA, 1999; model results, using the Screen 3 computer model (EPA 1995).

At ORR, both carcinogenic and noncarcinogenic health effects from exposure to hazardous chemicals were evaluated. It was assumed that under normal operating conditions, the primary exposure pathway for members of the public would be from air emissions released through the 7911 stack. Emissions of chemicals were estimated based on anticipated chemical usage. A worst-case dispersion-modeling screening analysis was performed to estimate annual concentrations for each chemical, based on their emission rates.

The annual concentration for each noncarcinogenic chemical was divided by the corresponding inhalation reference concentration to estimate the Hazard Quotient for each chemical. The Hazard Quotients were summed to give the Hazard Index from all noncarcinogenic chemicals associated with this option. A Hazard Index of less than one indicates that adverse health effects from non-cancer-causing agents are not expected. For carcinogens, the annual concentration was multiplied by the unit cancer risk to estimate the increased cancer risk from that chemical. Hazardous chemical health effects are summarized in **Table 4–19**.

Table 4–19 Incremental Hazardous Chemical Impacts on the Public Around ORR Under Alternative 1 (Restart FFTF)—Option 1

Chemical	Modeled Annual Increment (milligrams per cubic meter)	Reference Concentration Inhalation (milligrams per cubic meter)	Unit Cancer Risk (risk per milligrams per cubic meter)	Hazard Quotient	Cancer Risk
Diethyl benzene	3.37×10^{-5}	1	0.0078	3.37×10^{-5}	2.63×10^{-7}
Methanol	1.23×10^{-6}	1.75	NA	7.03×10^{-7}	NA
Nitric acid	1.53×10^{-6}	0.1225	NA	1.25×10^{-5}	NA
Tributyl phosphate	6.34×10^{-5}	0.01	NA	0.00634	NA
			Hazard Index =	0.00639	

Note: For diethyl benzene, the reference concentration for ethyl benzene and the unit cancer risk for benzene were used to estimate Hazard Quotient and cancer risk because no information was available for diethyl benzene. For tributyl phosphate, the reference concentration for phosphoric acid was used to estimate the Hazard Quotient because no information was available for tributyl phosphate. Propylene oxide cancer unit was used for propylene.
Key: NA, not applicable (the chemical is not a known carcinogen or it is a carcinogen and only unit cancer risk will apply).
Source: DOE 1996a; EPA 1999; model results, using the SCREEN 3 computer code (EPA 1995).

4.3.1.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with FFTF target irradiation, REDC neptunium-237 target processing, and RPL medical, industrial, research and development isotope processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 mile) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are presented in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–20** and **4–21**, respectively.

FFTF would operate for 21 years with a mixed oxide core followed by 14 years with a highly enriched uranium core. As shown in Table 4–20, the hypothetical core disruptive accident would result in the largest radiological consequences among FFTF accidents. In order to provide a conservative estimate of FFTF accident risks, the accident frequency of 1×10^{-6} was selected for the hypothetical core disruptive accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.24×10^{-8} and 1.69×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00129.

For 35 years of REDC neptunium-237 target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 5.71×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.157.

For 35 years of RPL medical, industrial, and research and development target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 4.51×10^{-4} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.377

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 4.51×10^{-4} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.535.

Table 4–20 FFTF, REDC, and RPL Accident Consequences Under Alternative 1 (Restart FFTF)—Option 1

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
FFTF accidents						
Design-basis-accident primary sodium spill (MOX)	0.00113	5.65×10^{-7}	78.6	0.0393	0.00313	1.25×10^{-6}
Design-basis-accident primary sodium spill (HEU)	8.63×10^{-4}	4.32×10^{-7}	72.6	0.0363	0.00181	7.24×10^{-7}
Hypothetical core disruptive accident (MOX)	0.679	3.40×10^{-4}	6.68×10^{4}	33.4	0.679	2.72×10^{-4}
Hypothetical core disruptive accident (HEU)	0.481	2.41×10^{-4}	6.16×10^{4}	30.8	0.375	1.50×10^{-4}
BLTC driver fuel-handling accident (MOX)	0.00383	1.92×10^{-6}	1,280	0.639	0.357	1.43×10^{-4}
BLTC driver fuel-handling accident (HEU)	0.00384	1.92×10^{-6}	1,230	0.617	0.340	1.36×10^{-4}
BLTC neptunium-237 target-handling accident	2.61×10^{-4}	1.31×10^{-7}	25.8	0.0129	0.0279	1.12×10^{-5}
BLTC isotope target-handling accident	1.22×10^{-4}	6.10×10^{-8}	2.74	0.00137	0.0143	5.72×10^{-6}
REDC accidents						
Ion exchange explosion during neptunium-237 target fabrication	6.13×10^{-9}	3.06×10^{-12}	8.58×10^{-5}	4.29×10^{-8}	5.60×10^{-10}	2.24×10^{-13}
Target dissolver tank failure during plutonium-238 separation	1.76×10^{-7}	8.79×10^{-11}	0.00196	9.82×10^{-7}	1.69×10^{-8}	6.74×10^{-12}
Ion exchange explosion during plutonium-238 separation	4.68×10^{-4}	2.34×10^{-7}	5.23	0.00261	4.49×10^{-5}	1.79×10^{-8}
Plutonium-238 processing facility beyond-design-basis earthquake	163	0.163	8.91×10^{5}	445	1,310	1.00[c]
RPL accidents						
Medical and industrial isotopes localized solvent fire	0.0135	6.74×10^{-6}	77.8	0.0389	0.0047	1.88×10^{-6}
Medical and industrial isotopes unlikely seismic event	1.52	7.60×10^{-4}	1,350	0.675	1.50	6.00×10^{-4}
Medical and industrial isotopes glovebox explosion	50.0	0.050	4.60×10^{4}	23.0	49.0	0.0392

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–21 FFTF, REDC, and RPL Accident Risks Under Alternative 1 (Restart FFTF)—Option 1

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Hypothetical core disruptive accident (MOX) (1×10^{-6})	3.40×10^{-10}	3.34×10^{-5}	2.72×10^{-10}
Hypothetical core disruptive accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-6})	1.92×10^{-12}	6.39×10^{-7}	1.43×10^{-10}
BLTC driver fuel-handling accident (HEU) (1×10^{-6})	1.92×10^{-12}	6.17×10^{-7}	1.36×10^{-10}
BLTC neptunium-237 target-handling accident (1×10^{-6})	1.31×10^{-13}	1.29×10^{-8}	1.12×10^{-11}
BLTC isotope target-handling accident (1×10^{-6})	6.10×10^{-14}	1.37×10^{-9}	5.72×10^{-12}
35-year FFTF risk	1.24×10^{-8}	0.00129	1.69×10^{-8}
Annual REDC risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	3.06×10^{-14}	4.29×10^{-10}	2.24×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	8.79×10^{-13}	9.82×10^{-9}	6.74×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	2.34×10^{-9}	2.61×10^{-5}	1.79×10^{-10}
Plutonium-238 processing facility beyond-design-basis earthquake (1×10^{-5})	1.63×10^{-6}	0.00445	1.00×10^{-5}[c]
35-year REDC risk	5.71×10^{-5}	0.157	3.50×10^{-4}
Annual RPL risks			
Medical and industrial isotopes localized solvent fire (0.044)	2.99×10^{-7}	0.00173	8.35×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	7.60×10^{-6}	0.00675	6.00×10^{-6}
Medical and industrial isotopes glovebox explosion (1×10^{-4})	5.00×10^{-6}	0.00230	3.92×10^{-6}
35-year RPL risk	4.51×10^{-4}	0.377	3.50×10^{-4}
35-year Option risk	4.51×10^{-4}	0.535	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

The irradiation of medical, industrial, research and development, and neptunium-237 targets at FFTF would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of medical, industrial, research and development, or neptunium-237 targets at FFTF.

Processing associated with the plutonium-238 production program at REDC, including storage of neptunium-237 and plutonium-238, neptunium-237 target fabrication, postirradiation processing to extract plutonium-238 and to recycle the unconverted neptunium-237 into new targets, does not require the introduction of hazardous chemicals that are not in current use in the facility. The quantities of in-process hazardous chemicals for the plutonium-238 production program are bounded by the quantities of the material currently stored in the facility. The impacts of in-process hazardous chemical accidents associated with the plutonium-238 production are bounded by the impacts of hazardous chemical accidents for existing storage facilities at REDC.

Processing associated with the medical, industrial, and research and development isotope production program at RPL, including target fabrication and postirradiation processing, would not require the introduction of hazardous chemicals that are not in current use in the facility. The quantities of in-process hazardous chemicals for the medical and industrial isotope production program are bounded by the quantities of the material currently stored in the facility. The impacts of in-process hazardous chemical accidents associated with the medical and industrial isotope production are bounded by the impacts of hazardous chemical accidents for existing storage facilities at RPL.

4.3.1.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the REDC target fabrication facility at ORR. DOE would transport the unirradiated neptunium-237 targets from REDC to FFTF. Following irradiation in FFTF, the targets would be returned to REDC for processing. After this processing, the plutonium-238 product would be shipped to LANL. FFTF would receive highly enriched uranium fuel from a U.S. fuel fabrication facility and mixed oxide fuel from Europe via an east coast port. Additionally, medical and industrial isotopes would be shipped from FFTF to a local airport, and from there to locations throughout the country.

Approximately 38,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 8.0 million kilometers (5.0 million miles); at sea by ships carrying mixed oxide fuel, 96,000 kilometers (52,000 nautical miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

The transportation impact analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 31 person-rem; the dose to the public, 303 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.013 latent cancer fatality among transportation workers and 0.15 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.03. About half of the crew risk, about 2 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to REDC with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying

neptunium-237 (unirradiated) or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting in 0.19 traffic fatality. Nearly all of the radiological and traffic accident risk would result from shipping medical and industrial isotopes.

IMPACTS OF MARINE TRANSPORTATION. The potential impacts of marine transport of mixed oxide fuel on the global commons (i.e., portions of the ocean not within the territorial boundary of any nation) were evaluated in accordance with Executive Order 12114 (44 FR 1957). Following a hypothetical severe accident, radioactive particles dispersed over the ocean would not be in large enough amounts to have a measurable impact on the environment. The risks of accidents approaching and docking at the port have been estimated to be less than 1×10^{-9} person-rem, resulting in less than 1×10^{-12} latent cancer fatality. The radiological doses associated with incident-free transportation, which include the exposure of the ship's crew to low levels of radiation during transport and handling of the packages, have been estimated to be approximately 0.03 person-rem for a route to an east coast port and 0.06 person-rem for a route to a west coast port. These doses would result in 1.2×10^{-5} and 2.4×10^{-5} latent cancer fatalities, respectively.

4.3.1.1.12 Environmental Justice

NORMAL OPERATIONS. Expected latent cancer fatalities among the population residing within 80 kilometers (50 miles) of REDC at ORR and FFTF and RPL at Hanford would be less than 0.005 for 35 years of normal operations (Table 4–16). As shown in Tables 4–18 and 4–19, the release of hazardous chemicals at Hanford and ORR would pose no significant risk of cancer or toxic effects among the public. As discussed in Sections K.5.2 and K.5.3, the expected latent cancer fatalities that would result from the ingestion of food that could be radiologically contaminated due to normal operations would be approximately 0.002 at Hanford and essentially zero at ORR. No credible pattern of food consumption by persons residing in potentially affected areas would result in significant health risks due to radiological contamination of food supplies near Hanford or ORR. As discussed in Section 4.3.1.1.11, incident-free transportation would not be expected to result in fatalities.

ACCIDENTS. Expected latent cancer fatalities among populations at risk due to radiological accidents listed in Table 4–20 would be approximately 0.5. In the event a radiological accident were to occur at REDC and winds were from the southwest, the predominantly minority population of the Scarboro Community adjacent to the northern boundary of ORR would lie in the path of highest potential radiological exposure (see Figure K–6). If the winds were from the west, the predominantly minority populations in Knoxville, Tennessee, would lie in the path of exposure. Because the accidents that could occur under the implementation of this option would not be expected to result in significant offsite exposures to any exposed offsite individual or populations, neither situation would result in a disproportionately high and adverse risk to any group or individuals within the population. If a radiological accident were to occur at FFTF or the 300 Area at Hanford and northeasterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Yakama Indian Reservation (see Figure K–11). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the population or maximally exposed individual residing within the boundary of the Yakama Indian Reservation.

The number of expected latent cancer fatalities resulting from transportation accidents with radiological emissions was found to be approximately 0.5. As discussed in Appendix J, this risk is driven by accidents that could occur during air transportation of medical and industrial isotopes and the conservative assumptions used

in the analysis of such accidents. Such accidents could occur anywhere along the flight paths and would not place any identifiable group within the general population at disproportionate risk. As discussed in Section 4.3.2.1.11 and Appendix J, expected fatalities due to a fatal traffic collision would be approximately 0.2.

In summary, normal operations and accidents that could result from the implementation of this option would pose no significant radiological or nonradiological risks to the public, and implementation would pose no disproportionately high and adverse risks to any group within the population.

4.3.1.1.13 Waste Management

The expected generation rates of wastes at Hanford that would be associated with the operation of FTFF for irradiating targets and RPL/306–E for processing and fabricating target materials for the research and development support and medical and industrial isotope production are compared with Hanford's treatment, storage, and disposal capacities in **Table 4–22**. The expected generation rates of waste at ORR that would be associated with the operation of REDC to fabricate and process the neptunium-237 targets for plutonium-238 production are compared with ORR's treatment, storage, and disposal capacities in **Table 4–23**.

The impacts on the Hanford and ORR waste management systems in terms of managing these additional wastes are discussed in this section. Currently, it is DOE's intent that waste generated from the restart and operation of FFTF be managed independent of the existing Hanford site waste management infrastructure by using commercially available facilities for all waste treatment and disposal activities. DOE has developed a draft *Waste Minimization and Management Plan for FFTF* to incorporate pollution prevention and waste minimization practices in its consideration of the future of FFTF (DOE 2000a). If a decision were made to restart FFTF, this plan would be used to ensure that optimum opportunities are provided for characterizing potential waste streams, identifying source reduction and recycling strategies, evaluating disposition options, developing sustainable designs, and implementing effective management strategies. This plan identifies DOE's preferred options for management, treatment, and/or disposition of all waste streams related to the restart and operation of FFTF. These preferred options primarily use commercial waste handling and disposal facilities. Although it is DOE's intent to use commercial waste handling and disposal facilities, the Hanford waste management infrastructure is analyzed in this NI PEIS as a reasonable alternative for the management of wastes resulting from FFTF restart and operation in case commercial disposal is not practicable at the time of restart and operation. Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.3.2.1.9 through 4.3.2.1.11.

Canisters used to transport neptunium-237 to the site would constitute a very small additional amount of solid low-level radioactive waste—less than 10 cubic meters (13.1 cubic yards) over the 35-year operational period, even if no credit is taken for volume reduction by compaction (Brunson 1999a). The annual generation of this waste would fall within the range of accuracy of the generation rate of solid low-level radioactive waste given in Table 4–23, and its management need not be addressed separately.

In accordance with the Records of Decision for the *Waste Management PEIS* (DOE 1997a), wastes could be treated and disposed of on site at Hanford or at other DOE sites or commercial facilities. Based on the Record of Decision for transuranic waste issued on January 20, 1998 (63 FR 3629), transuranic waste would be certified on site and eventually shipped to a suitable geologic repository for disposal. Based on the Record of Decision for hazardous waste issued on August 5, 1998 (63 FR 41810), nonwastewater hazardous waste would continue to be treated and disposed of at offsite commercial facilities. Based on the Record of Decision for low-level radioactive waste and mixed low-level radioactive waste issued on February 18, 2000 (65 FR 10061), minimal treatment of low-level radioactive waste will be performed at all sites and, to the

extent practicable, onsite disposal of low-level radioactive waste will continue. Hanford and the Nevada Test Site will be made available to all DOE sites for disposal of low-level radioactive waste. Mixed low-level radioactive waste analyzed in the *Waste Management PEIS* (DOE 1997a) will be treated at Hanford, INEEL, ORR, and SRS and will be disposed of at Hanford and the Nevada Test Site.

Table 4–22 Incremental Waste Management Impacts of Operating FFTF and RPL/306–E at Hanford Under Alternative 1 (Restart FFTF)—Option 1

Waste Type[a]	Estimated Waste Generation for FFTF Operation (cubic meters per year)	Estmimated Additional Waste Generation for FFTF[b] (cubic meters per year)	Estimated Additional Waste Generation for RPL/306–E (cubic meters per year)	Estimated Additional Waste Generation (both FFTF and RPL/306–E) as a Percent of[c]		
				Onsite Treatment Capacity	Onsite Storage Capacity	Onsite Disposal Capacity
Transuranic	0	0	0	0	0	0
Low-level radioactive waste						
Liquid	<6	0	0	0	0	0
Solid	80	63	20	NA	NA	0.17
Mixed low-level radioactive	<0.5	0	4	0.22	0.83	0.98
Hazardous	4	0	<1	NA	NA	NA
Nonhazardous						
Process wastewater	98,000	22,000	16	(d)	(d)	(d)
Sanitary wastewater	5,700	1,900	0	0.81[e]	NA	NA
Solid	250	0	20	NA	NA	NA

a. See definitions in Appendix G.9.
b. These estimates represent the increase in waste generated as a result of restart and operation of FFTF (i.e., operation minus standby waste generation estimates provided in the No Action Alternative, Table 4–6).
c. The estimated additional amounts of waste generated annually are compared with the annual site treatment capacities. The estimated total amounts of additional waste generated over the assumed 35-year operational period are compared with the site storage and disposal capacities.
d. Refer to the text.
e. Percent of capacity of the Energy Northwest Sewage Treatment Facility.

Note: To convert from cubic meters per year to cubic yards per year, multiply by 1.308; < means "less than."

Key: NA, not applicable (i.e., the majority of this waste is not routinely treated, stored, or disposed of on site; refer to the text in this section).

Source: DOE 2000a; Nielsen 1999.

Table 4–23 Incremental Waste Management Impacts of Operating REDC at ORR Under Alternative 1 (Restart FFTF)—Option 1

Waste Type[a]	Estimated Additional Waste Generation (cubic meters per year)	Estimated Additional Waste Generation as a Percent of[b]		
		Onsite Treatment Capacity	Onsite Storage Capacity	Onsite Disposal Capacity
Transuranic[c]				
Contact handled	7	NA[d]	11	NA[d]
Remotely handled	4	NA[d]	6.4	NA[d]
Low-level radioactive				
Liquid	25	0.13	24[e]	46
Solid	35	NA[f]	2.6[g]	NA[h]
Mixed low-level radioactive				
Liquid	NA[i]	NA[i]	NA[i]	NA[i]
Solid	<5	<2.2[j]	<0.57[k]	NA[h]
Hazardous	6,500 kilograms	NA[l]	NA[l]	NA[l]
Nonhazardous				
Liquid	23	0.0017	NA[m]	NA[m]
Solid	148	NA[n]	NA[n]	0.42

a. See definitions in Appendix G.9.
b. The estimated additional amounts of waste generated annually are compared with the annual site treatment capacities. The estimated total amounts of additional waste generated over the assumed 35-year operational period are compared with the site storage and disposal capacities.
c. The transuranic waste, as given in this table, is in the form of a solid.
d. The current plans of the Oak Ridge Operations Office are to pursue privatization of the treatment and disposal of contact- and remotely handled transuranic waste at ORNL. A draft environmental impact statement has been issued by the Oak Ridge Operations Office for these actions.
e. Liquid low-level radioactive waste is processed through an evaporator for volume reduction. The evaporator bottoms are stored as a concentrated solution.
f. The solid low-level radioactive waste would not be treated on site.
g. Refer to the text for a discussion of potential limitations of the onsite storage capacity for solid low-level radioactive waste and the probable solution.
h. It is anticipated that solid low-level radioactive waste and solid mixed low-level radioactive waste would be disposed of at an off site facility.
i. Reported as low-level radioactive waste.
j. In the short-term, the Toxic Substances Control Act Incinerator would be used for the treatment of solid mixed low-level radioactive waste. If this facility is shut down, the site's management and integration contractor would identify other options for treatment of this waste.
k. Refer to the text for a discussion of potential limitations of the onsite storage capacity for solid mixed low-level radioactive waste and the probable solution.
l. Although there is some treatment and storage capacity for hazardous waste, this waste would be shipped off site to permitted commercial facilities.
m. The nonhazardous liquid waste would be discharged to a permitted outfall or otherwise disposed of off site after onsite treatment.
n. Solid nonhazardous waste would be taken to the Oak Ridge Y–12 landfill for disposal.

Note: To convert from cubic meters per year to cubic yards per year, multiply by 1.308; to convert from kilograms to pounds, multiply by 2.20; < means "less than."
Key: NA, not applicable.
Source: Brunson 1999b; Wham 1999c, 1999d, 1999e.

It is also assumed in this NI PEIS that transuranic waste, low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous waste would be treated, stored, and disposed of in accordance with current and developing site practices. No high-level radioactive waste would be associated with irradiating targets in FFTF, with target fabrication and processing in RPL/306–E, or with neptunium-237 fabrication and processing in REDC. No transuranic waste would be associated with irradiating targets in FFTF, and no transuranic waste would be associated with the target fabrication and processing in RPL/306–E.

Solid low-level radioactive waste associated with target irradiation at FFTF and fabrication and processing in RPL/306–E would be packaged in appropriate containers or burial casks, certified, and transferred for additional treatment and disposal in existing onsite facilities. Liquid low-level radioactive waste associated with target irradiation at FFTF and fabrication and processing in RPL/306–E would be transported to the 200 Area Effluent Treatment Facility for processing and ultimate disposal.

An additional 2,200 cubic meters (2,900 cubic yards) of solid low-level radioactive waste would be generated over the 35-year operational period as a result of target irradiation at FFTF as compared to the current standby mode for FFTF. Target fabrication and processing at RPL/306–E would generate about 700 cubic meters (920 cubic yards) of solid low-level radioactive waste over the 35-year operational period. The total amount of additional solid low-level radioactive waste resulting from operations at FFTF and RPL/306–E represents approximately 0.17 percent of the 1.74 million-cubic meter (2.28 million-cubic yard) capacity of the low-level radioactive Burial Grounds. Using the 3,480-cubic-meter-per-hectare (1,842-cubic-yard-per-acre) disposal land usage factor for Hanford published in the *Storage and Disposition PEIS* (DOE 1996a:E-9), 2,900 cubic meters (3,800 cubic yards) of waste would require 0.83 hectares (2.1 acres) of disposal space at Hanford. The impacts of managing this additional low-level radioactive waste at Hanford would be minimal.

There would be no increase in liquid low-level radioactive waste generation as a result of target irradiation at FFTF as compared to the current standby mode for FFTF, nor for target fabrication and processing at the RPL/306–E.

Mixed low-level radioactive waste would be stabilized, packaged, and stored on site for treatment and disposal in a manner consistent with the Tri-Party Agreement (EPA et al. 1989) for Hanford. Over the 35-year operational period, no additional mixed low-level radioactive waste would be generated as a result of target irradiation at FFTF as compared to the current standby mode. Mixed low-level radioactive waste generated at RPL/306–E associated with target fabrication and processing is estimated over the 35-year operation period to be about 140 cubic meters (180 cubic yards). This mixed low-level radioactive waste is expected to be treated at a nearby commercial facility. However, if this waste were treated on site, it is estimated to be about 0.22 percent of the 1,820-meter-per-year (2,380-cubic-yard- per-year) capacity of the Waste Receiving and Processing Facility. This additional waste is also estimated to be about 0.83 percent of the 16,800-cubic-meter (22,000-cubic-yard) storage capacity of the Central Waste Complex and about 0.98 percent of the 14,200-cubic-meter (18,600-cubic-yard) planned disposal capacity of the Radioactive Mixed Waste Disposal Facility. Therefore, this additional waste would only have a minimal impact on the management of mixed low-level radioactive waste at Hanford.

Hazardous wastes generated during operation would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities. The additional waste load generated during the 35-year operational period would have only a minimal impact on the Hanford hazardous waste management system.

Nonhazardous solid waste would be packaged and transported in conformance with standard industrial practice. Solid wastes such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent off site for that purpose. The remaining solid sanitary waste would be sent for offsite disposal. This additional waste load would have only a minimal impact on the nonhazardous solid waste management system at Hanford.

Nonhazardous sanitary wastewater from FFTF operations would be discharged to the 400 Area sanitary sewer system, which connects to the Energy Northwest Sewage Treatment Facility. Nonhazardous sanitary wastewater generated at FFTF would represent about 0.81 percent of the 235,000-cubic-meter-per-year (307,000-cubic-yard-per-year) capacity of the Energy Northwest Sewage Treatment Facility.

Nonhazardous process wastewater from FFTF would be discharged into the 400 Area Ponds. This discharge is regulated by State Waste Discharge Permit ST-4501. Nonhazardous process wastewater generated from target fabrication and processing in RPL/306–E would be discharged to the 300 Area Treated Effluent Disposal Facility.

The generation rates of wastes at Hanford that would be associated with this option (refer to Table 4–22), can be compared with the current waste generation rates at the site, given in Table 3–27 (Section 3.4.11). The waste generation rates would be much smaller than the current waste generation rates at the site.

The current plans of DOE's Oak Ridge Operations Office are to pursue privatization of the treatment of ORNL's transuranic waste. This includes the transuranic waste that would be associated with neptunium-237 target fabrication and processing at REDC. Plans and analysis of the privatization of a transuranic waste treatment facility are progressing. A draft environmental impact statement has been issued by the Oak Ridge Operations Office (*Environmental Impact Statement for Treating Transuranic/Alpha Low-Level Waste at Oak Ridge National Laboratory* [DOE/EIS-0305, DOE 2000b]). Attempts to reduce the transuranic waste volume either through processing or minimization also are being undertaken. All transuranic waste would eventually be disposed of in a suitable geologic repository after meeting the repository's waste acceptance criteria. This waste would be considered nondefense transuranic waste and, therefore, under current legislation, could not be disposed of at the Waste Isolation Pilot Plant (WIPP). Because this transuranic waste has no current disposition path, DOE Headquarters' approval, as required by DOE Order 435.1, would be necessary before a decision were made to generate this waste. A total of 385 cubic meters (504 cubic yards) of contact- and remotely handled transuranic waste would be generated from neptunium-237 target fabrication and processing over the 35-year operational period. If onsite storage were used to manage this additional transuranic waste, it would represent approximately 18 percent of the available 2,169-cubic-meter (2,837-cubic-yard) storage capacity in facilities 7572, 7574, 7826, 7827, 7878, 7879, and 7883.

Low-level radioactive waste at ORR would be treated, packaged, certified, and accumulated before transfer for additional treatment and disposal at onsite and offsite facilities. Annual liquid low-level radioactive waste generation (including mixed low-level radioactive waste—refer to Table 4–22) that would be associated with neptunium-237 target fabrication and processing in REDC is estimated to be 0.13 percent of the 19,908-cubic-meter-per-year (26,040-cubic-yard-per-year) site treatment capacity. If all the liquid low-level radioactive waste generated over the 35-year operational period were stored on site, the amount would represent 24 percent of the 3,646-cubic-meter (4,769-cubic-yard) storage capacity at ORR, and 46 percent of the estimated onsite disposal capacity of 1,894 cubic meters (2,477 cubic yards) of tank storage for liquid low-level radioactive waste from the Liquid Low-Level Waste Evaporator Facility Building 2531. Solid low-level radioactive waste would not be treated on site. If all the solid low-level radioactive waste generated over the 35-year operational period were stored on site, the amount would represent 2.6 percent of the 47,000-cubic-meter (61,500-cubic-yard) storage capacity at ORR. If account is taken of the existing inventory of solid low-level radioactive waste (41,000 cubic meters [53,600 cubic yards]) and of its present generation rate (7,000 cubic meters [9,160 cubic yards] per year), sufficient storage capacity probably would not be available. However, this should be considered only an interim situation. Arrangements are being made that would allow the solid low-level radioactive waste to be treated and disposed of off site at another DOE site or at a commercial facility, thereby eliminating any onsite storage problems, including the storage capacity limitations at ORR. A draft *Environmental Assessment for Transportation of Low-Level Radioactive Waste from the Oak Ridge Reservation to Off-Site Treatment and Disposal Facilities* (DOE/EA-1315, DOE 2000c) has been issued by the Oak Ridge Operations Office.

The management of the additional low-level radioactive waste from 35 years of operating REDC to fabricate and process neptunium-237 targets would not have a major impact on ORR's ability to manage low-level radioactive waste.

Mixed low-level radioactive waste associated with neptunium-237 target fabrication and processing at ORR would be stabilized, packaged, and stored on site for treatment and disposal in a manner consistent with the site treatment plan. Liquid mixed low-level radioactive waste is reported as low-level radioactive waste; the generation and management of this waste are covered under the low-level radioactive waste discussion above. Solid mixed low-level radioactive waste generation is estimated to be less than 2.2 percent of the 227-cubic-meter-per-year (297-cubic-yard-per-year) site treatment capacity. If all the solid mixed low-level radioactive waste generated over the 35-year operational period were stored on site, the amount would represent less than 0.57 percent of the 30,780-cubic-meter (40,260-cubic-yard) storage capacity at ORR. However, if account is taken of the existing inventory of solid mixed low-level radioactive waste (24,964 cubic meters [32,700 cubic yards]) and of its present generation rate (801 cubic meters [1,050 cubic yards] per year), part or all of the storage capacity may not be available. As is the case for the solid low-level radioactive waste, arrangements are being made that would allow the solid mixed low-level radioactive waste to be disposed of off site at another DOE site or at a commercial facility, thereby eliminating any onsite storage problems, including the storage capacity limitations at ORR. A draft environmental assessment for transportation of mixed low-level radioactive waste from the ORR to offsite treatment or disposal facilities is under development by the Oak Ridge Operations Office.

Managing the small additional quantities of mixed waste that would be generated at ORR would not impact ORR's management of this type of waste.

At ORR, hazardous waste associated with the fabrication and processing of neptunium-237 targets at REDC would be packaged in DOT-approved containers, and shipped off site to permitted commercial recycling, treatment, and disposal facilities. The additional waste load generated during the operational period would only have a minimal impact on ORR's management of hazardous waste.

Nonhazardous solid waste associated with neptunium-237 target fabrication and processing in REDC would be packaged in conformance with standard industrial practices and disposed of in the onsite landfills. If all the nonhazardous solid waste generated over the 35-year operational period were disposed of in Industrial Landfills V and VI, only 0.42 percent of the 1,219,000-cubic-meter (1,594,000-cubic-yard) total capacity of these landfills would be needed. Nonhazardous liquid waste would be processed, as necessary, in the wastewater treatment facilities before discharge to an outfall or other offsite disposition facility. The additional solid and liquid waste loads would only have a minimal impact on nonhazardous waste management at ORR.

The generation rates of waste at ORR that would be associated with this option (Table 4–23), can be compared with the current waste generation rates at the site, given in Table 3–8 (Section 3.2.11). The waste generation rates associated with plutonium-238 production would be much smaller than the current waste generation rates at the site.

4.3.1.1.14 Spent Nuclear Fuel Management

Data on spent nuclear fuel generation and storage under all options of Alternative 1 are presented in **Table 4–24**.

Table 4–24 Data for Spent Nuclear Fuel Generation and Storage Under All Options of Alternative 1 (Restart FFTF)

Data Parameter	At FFTF
Operating duration (years)	35
Operating power level (megawatts)	100
Existing spent nuclear fuel inventory (metric tons of heavy metal)	11[a]
Method of storage	Sodium-cooled vessels and dry storage casks
Number of spent nuclear fuel assemblies generated annually	About 12 to 15 (i.e., 2 casks per year)
Spent nuclear fuel generated in 35 years (metric tons of heavy metal)	16

a. The total spent nuclear fuel inventory at Hanford is 2,133 metric tons of heavy metal.
Note: To convert from metric tons to pounds, multiply by 2,200.
Source: DOE 2000a.

The operation of FFTF would generate about 0.46 metric ton heavy metal (1,008 pounds) of spent nuclear fuel per year. For the 35-year proposed mission at 100 megawatts, this would equate to a total of 16 metric tons of heavy metal (35,200 pounds) of spent nuclear fuel, which is less than 1 weight-percent of the total spent nuclear fuel inventory presently stored at Hanford.

The currently authorized storage modes for the FFTF spent nuclear fuel include two sodium-filled storage vessels within the facility and the interim storage area located at the northeast corner of the FFTF site which now is capable of accommodating spent nuclear fuel in 49 aboveground dry storage casks. It is projected that these storage modes will provide enough capacity at the reactor site for 35 years of reactor operation. This projection is based on the assumption that the nonfuel irradiated components are disposed of and do not remain in storage (Section 4.3.1.1.13 addresses waste). If it is conservatively assumed that this hardware remains in storage, the number of spaces available for spent nuclear fuel storage would be reduced. With this worst-case assumption, it is projected that the current storage modes would support 24 years of reactor operation. Since the operation of FFTF would result in the generation of 12 to 15 spent nuclear fuel assemblies per year and each dry storage cask is capable of storing 7 assemblies, the additional storage capacity for years 25 through 35 of reactor operation could be provided by loading 2 additional dry storage casks per year.

Upon cessation of reactor operation, or earlier, the spent nuclear fuel would be packaged in acceptable containers and shipped to a geologic repository for disposal. Refer to Section 4.6.1.3.14 for further information on the geologic repository.

CONSTRUCTION IMPACTS. The interim storage area is currently authorized for spent nuclear fuel storage in 49 dry storage casks. Prior to standby, 30 dry storage casks were procured, 18 of which are storing spent nuclear fuel and 12 of which are currently empty. It is anticipated that with additional cask procurement, the interim storage area, as currently authorized, would provide enough capacity for 35 years of reactor operation. As such, no construction impacts associated with expanding the dry cask storage capability of the interim storage area would be incurred.

However, based on the worst case assumption that all the irradiated nonfuel hardware would remain in storage, it is possible that the interim storage area would need to accommodate 20 additional dry storage casks. The construction impact of providing an additional concrete storage pad north of the existing concrete pad would be minimal.

OPERATIONAL IMPACTS. Operation of the sodium-filled storage vessels and the dry storage casks would not result in significant releases of radionuclides to the environment. The airborne radionuclides emitted from overall FFTF operations have always been at levels practically indistinguishable from natural background radiation. During the last year of reactor operations (1992), the overall radionuclide releases from the entire FFTF complex resulted in a total effective dose equivalent to the public of less than 0.0001 millirem (DOE 2000a). This dose is well below EPA's Clean Air Act standard of 10 millirem per year that is cited in DOE Order 5400.5. Any dose contribution from the storage vessels would be expected to be only a small fraction of the overall dose. No radionuclide releases from the dry cask storage system would occur because the spent nuclear fuel is contained in a sealed confinement.

Although no radionuclides are expected to be released from the dry storage cask, the cask would be a source of direct and skyline-scattered radiation that would penetrate the thick concrete shielding of the cask. The direct radiation is from neutron and gamma sources emitted from the spent nuclear fuel, with the greatest contribution coming from the gamma source. Based on the operating experience of the Independent Spent Fuel Storage Installation (ISFSI) facilities, (BGE 1989; CPL 1986; Duke 1988; VEPCO 1985), the direct radiation dose to an individual 100 meters from the cask was calculated to be in the range of 0.01 to 0.1 millirem per hour. This direct radiation would have an onsite effect only on workers; the radiation dose is greatly reduced to insignificant levels beyond the site boundary. The whole body dose to an offsite individual (at about or more than 1,000 meters [0.62 mile] from the site) for these ISFSIs is normally less than 1 millirem per year.

The operation of the dry storage system would generate a small quantity of decay heat, which is removed by natural air convection and would not have any effect on the offsite environment.

There would be no liquid releases to the environment associated with spent nuclear fuel management. The environmental impacts associated with the dry spent nuclear fuel storage system are summarized in **Table 4–25**.

Table 4–25 Environmental Impact of Dry Spent Nuclear Fuel Storage System Under All Options of Alternative 1 (Restart FFTF)

Environmental Parameter	Environmental Impact
Radiological impacts (normal operation)	Dose of less than 0.1 millirem per year, well below EPA's Clean Air Act standard of 10 millirem per year
Effect of decay heat on the site	Equivalent to 210 light bulbs (100 watts each); no offsite effect
Facility water use	Small
Liquid and solid radwaste generated	Small; no discharges to the environment
Chemical and biocide generated	Minimal (if any)
Effect of sanitary waste discharges	Minimal
Noise and traffic impacts	Minimal
Effect of maintenance of the electrical system	Minimal
Effect on ecology	Minimal
Socioeconomics	Small; fewer than five additional people would be employed

Source: BGE 1989; CPL 1986; Duke 1988; VEPCO 1985.

4.3.2 Alternative 1 (Restart FFTF)—Option 2

Option 2 involves operating FFTF at Hanford to irradiate all targets and materials associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating FDPF at INEEL to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and operating facilities in the Hanford 300 Area to fabricate and process the other targets and materials and

to process the associated products. This option includes storage in Building CPP–651 or FDPF of the neptunium-237 transported from SRS to INEEL and storage in RPL/306–E of the other target materials transported to Hanford from other offsite facilities.

The transportation of the mixed oxide and highly enriched uranium fuel to Hanford for use in FFTF, the transportation of the neptunium-237 to INEEL and then to Hanford, the transportation of the other target material to Hanford, and the transportation of the product materials following irradiation and postirradiation processing are also part of this option.

Under Option 2, FFTF would operate with a mixed oxide fuel core for the first 21 years and with a highly enriched uranium fuel core for the next 14 years.

4.3.2.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations and with all transportation activities are assessed in this section.

4.3.2.1.1 Land Resources

LAND USE. The restart of FFTF would not result in impacts on land use at Hanford for the reasons described in Section 4.3.1.1.1.

Building CPP–651 and/or FDPF, which are both in the INTEC area of INEEL, would be used for neptunium-237 storage, and FDPF for target fabrication and processing. The use of either facility would require internal modifications, but no new facilities would be built. Because additional land would not be disturbed and the use of Building CPP–651 and/or FDPF would be compatible with the missions for which they were designed, there would be no change in land use at INEEL.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on land use at Hanford for the reasons described in Section 4.3.1.1.1.

VISUAL RESOURCES. The restart of FFTF would not result in impacts on visual resources at Hanford for the reasons described in Section 4.3.1.1.1.

All activities associated with neptunium-237 storage, target fabrication, and processing would take place in Building CPP–651 and/or FDPF. Because neither facility would require external modification, there would be no change in appearance. Therefore, the current Visual Resource Management Class IV rating for INTEC would not change. Because there would be no change in the appearance of either of these facilities or the INTEC area, there would be no impact on visual resources.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on visual resources at Hanford for the reasons described in Section 4.3.1.1.1.

4.3.2.1.2 Noise

For the restart of FFTF, the change in noise impacts from construction and operation would be expected to be small as described in Section 4.3.1.1.2.

Building CPP–651 and/or FDPF, both in the INTEC area of INEEL, would be used for neptunium-237 target-material storage, and FDPF for target fabrication and processing. Interior modifications of these facilities in the INTEC area of INEEL would be expected to result in little change in noise impacts on wildlife around this area. The operation of these facilities would not be expected to result in any change in noise impacts on wildlife around the INTEC area and offsite noise impacts would be small because the nearest site boundary is 12 kilometers (7.5 miles) to the south. Operation would be expected to result in minimal change in noise impacts on people near the INEEL as a result of changes in employee and truck traffic levels.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and nuclear research and development missions. Interior modifications of these facilities and operation would be expected to result in little change in noise impacts on wildlife around this area and people near Hanford as described in Section 4.3.1.1.2.

4.3.2.1.3 Air Quality

Under this option, air quality impacts due to the restart of FFTF would be the same as under Option 1 (Section 4.3.1.1.3). Air quality impacts from target fabrication and processing in the Hanford 300 Area facility would be the same as under Option 1 (Section 4.3.1.1.3).

The concentrations at INEEL attributable to FDPF operations under this option are presented in **Table 4–26**. The concentrations are based on a dispersion-modeling screening analysis conducted with maximum expected emission rates and a set of worst-case meteorological conditions. Only those air pollutants expected to be emitted that have ambient air quality standards are presented in the table. The change in concentrations of these pollutants would be small and would be below applicable ambient standards even when ambient monitored values and the contribution from other site activities were included.

Table 4–26 Incremental INEEL Concentrations[a] Associated with Alternative 1 (Restart FFTF)—Option 2

Pollutant	Averaging Time	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (micrograms per cubic meter)
Criteria pollutants			
Nitrogen dioxide	Annual	100	3.66×10^{-4}
Sulfur dioxide	Annual 24 hours 3 hours	80 365 1,300	0.024 0.19 0.43
Toxic air pollutants			
Methanol	24 hours	13,000	0.0048
Nitric acid	24 hours	250	0.0097
Paraffin hydrocarbons	24 hours	100	0.44
Tributyl phosphate	24 hours	110	0.025

a. For comparison with ambient air quality standards.
Note: Toxic air pollutant standards apply to new or modified sources only.
Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995).

The concentrations at INEEL attributed to this option are compared with the Prevention of Significant Deterioration Class II increments for nitrogen dioxide and sulfur dioxide in **Table 4–27**.

Table 4–27 PSD Class II Increments Compared to INEEL Concentrations Associated with Alternative 1 (Restart FFTF)—Option 2

Pollutant	Averaging Time	Allowable PSD Increment (micrograms per cubic meter)	Modeled Increment (micrograms per cubic meter)
Nitrogen dioxide	Annual	25	3.66×10^{-4}
Sulfur dioxide	Annual	20	0.024
	24 hours	91	0.19
	3 hours	512	0.43

Key: PSD, Prevention of Significant Deterioration.
Source: Modeled PSD increments are based on the SCREEN 3 computer code (EPA 1995).

Health impacts from FDPF chemical releases are discussed in Section 4.3.2.1.9.

The air quality impacts of transportation are presented in Section 4.3.2.1.11.

4.3.2.1.4 Water Resources

Impacts on water resources at Hanford associated with the restart of FFTF would be substantially the same as those described in Section 4.3.1.1.4.

Building CPP–651 and/or FDPF, which are both located within the INTEC area of INEEL, would be used for neptunium-237 storage with target fabrication and processing in support of plutonium-238 production conducted in FDPF. As existing facilities would be used, there would be no construction-related impacts on water bodies, floodplains, or on surface water or groundwater quality. In addition, no measurable increase in water use is anticipated to support target fabrication for plutonium-238 production (Moor 1999). The only measurable increase would be an additional 23,000 liters (6,100 gallons) per year of process wastewater associated with target processing in FDPF (Kirkham 1999; Wham 1999c). There would be no radiological liquid effluent discharge to the environment under normal operations, and no measurable impact on water resources at INEEL would be expected.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and nuclear research and development missions. As a result, it is expected that impacts on water resources at Hanford would be negligible as previously described in Section 4.3.1.1.4.

Waste management aspects of this option and their effects are further discussed in Section 4.3.2.1.13.

4.3.2.1.5 Geology and Soils

The restart of FFTF would not be expected to result in impacts on geologic and soil resources at Hanford, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.1.2.5 and 4.3.1.1.5.

Because existing facilities (i.e., Building CPP–651 and/or FDPF) would be used, there would be no disturbance to either geologic or soil resources at INTEC. Hazards from large-scale geologic conditions, such as earthquakes and volcanoes, were previously evaluated as discussed in Section 4.2.3.2.5. The analysis determined that these hazards present a low risk for neptunium-237 storage in INTEC facilities. Likewise, large-scale geologic conditions do not present a substantial risk to use of the proposed facilities for neptunium-237 storage, target fabrication, and processing.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not be expected to result in impacts on geologic resources at Hanford, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.1.2.5 and 4.3.1.1.5. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.3.2.1.6 Ecological Resources

The restart of FFTF would not be expected to result in impacts on ecological resources at Hanford for the reasons described in Section 4.3.1.1.6.

Because no new construction is planned, the use of Building CPP–651 and/or FDPF at INEEL would not result in direct disturbance to ecological resources. As noted in Section 4.3.2.1.2, there would be little change in noise impacts on wildlife. Because additional water usage and wastewater discharge would be small fractions of current values, and discharge chemistry would not be expected to change, there would be no impact on aquatic resources (Section 4.3.2.1.4). Due to the developed nature of the area and the fact that no new construction would take place, impacts on threatened and endangered species would not occur. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service. Consultations have also been initiated with the state.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on ecological resources at Hanford for the reasons described in Section 4.3.1.1.6.

4.3.2.1.7 Cultural and Paleontological Resources

The restart of FFTF would not result in impacts on cultural resources at Hanford for the reasons described in Section 4.3.1.1.7.

No new construction is planned; therefore, direct impacts on cultural and paleontological resources at INTEC would not occur. The use of Building CPP–651 and/or FDPF to store neptunium-237 or FDPF to fabricate and process neptunium-237 targets would not change the status of six historic structures located at INTEC. Also, Native American resources occurring in the vicinity of INTEC would not be impacted. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office. Consultation has also been initiated with interested Native American tribes.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on cultural resources at Hanford for the reasons described in Section 4.3.1.1.7.

4.3.2.1.8 Socioeconomics

The socioeconomic impacts associated with restarting and operating FFTF to irradiate all targets, and operating RPL/306–E to fabricate and process all other targets are addressed in Section 4.3.1.1.8.

Target fabrication and processing of neptunium-237 targets at INEEL would require approximately 24 additional workers (Hill et al. 1999). This level of employment could generate 64 indirect jobs in the region around INEEL. The potential total employment increase of 88 direct and indirect jobs in the INEEL region represents less than 0.1 percent of the projected regional economic area workforce. It would have no noticeable impact on the regional economic area.

Additional employment resulting from this option would not have any noticeable impact on community services in the INEEL region of influence. Assuming 94 percent of the new employment associated with this alternative would reside in INEEL's region of influence (Section 3.3.8), 88 total new jobs could increase the region's population by approximately 161 persons. This increase in conjunction with normal population growth forecasted by the State of Idaho would not have any noticeable effect on the availability of housing and/or the price of housing in the region of influence. The public would experience little or no change in the level of community services currently offered in the region of influence.

4.3.2.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup, processing, and operations are given in **Table 4–28** for FFTF and RPL at Hanford and FDPF at INEEL: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

To represent a bounding annual dose scenario at Hanford, it is assumed that a full-year's isotopic release would occur from target processing at RPL concurrently with a full-year's release from FFTF operations at 400 megawatts; the impacts presented in Table 4–28 also assume a full-year's release resulting from FFTF and RPL preoperational testing and startup activities. To represent a bounding annual dose scenario at INEEL, it is assumed that a full year's release would occur from neptunium-237 target processing at FDPF.

As a result of annual operations, the bounding projected total incremental population dose in the year 2020 for the populations surrounding Hanford and INEEL would be 0.25 person-rem. The corresponding number of latent cancer fatalities in these populations from 35 years of operations would be 0.0045. The bounding total incremental dose to the maximally exposed member of the public from annual operations at Hanford would be 0.0054 millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 9.5×10^{-8}. The incremental dose to the maximally exposed member of the public from annual operations at FDPF would be 2.6×10^{-7} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 4.6×10^{-12}.

Table 4–28 Incremental Radiological Impacts on the Public Around INEEL and Hanford from Operational Facilities Under Alternative 1 (Restart FFTF)—Option 2

Receptor	INEEL FDPF Processing[a]	Hanford Preoperational Activities[b]		Hanford FFTF Operations	Hanford RPL Target Processing[a]	Hanford Operations and Processing Total[c]
		FFTF	RPL			
Population within 80 kilometers (50 miles) in the year 2020						
Dose (person-rem)	3.9×10^{-6}	0.028	1.0[d]	0.044	0.21	0.25
1-year latent cancer fatalities	–	1.4×10^{-5}	5.0×10^{-4}	–	–	–
35-year latent cancer fatalities	6.8×10^{-8}	–	–	7.7×10^{-4}	0.0037	0.0045
Maximally exposed individual						
Annual dose (millirem)	2.6×10^{-7}	1.3×10^{-4}	0.043[c]	4.0×10^{-4}	0.0050	0.0054
1-year latent cancer fatality risk	–	6.5×10^{-11}	2.2×10^{-8}	–	–	–
35-year latent cancer fatality risk	4.6×10^{-12}	–	–	7.0×10^{-9}	8.8×10^{-8}	9.5×10^{-8}
Average exposed individual within 80 kilometers (50 miles)						
Annual dose[e] (millirem)	2.1×10^{-8}	5.6×10^{-5}	0.0020[c]	8.7×10^{-5}	4.2×10^{-4}	5.1×10^{-4}
1-year latent cancer fatality risk	–	2.8×10^{-11}	1.0×10^{-9}	–	–	–
35-year latent cancer fatality risk	3.7×10^{-13}	–	–	1.5×10^{-9}	7.3×10^{-9}	8.8×10^{-9}

a. Target storage, processing, and fabrication activities are performed at the facility. Impacts are for all facility target activities and are dominated by processing activity impacts.
b. For conservatism as well as consistency with other radiological impacts evaluated in this NI PEIS, these values were assessed for the year 2020 even though these activities would commence prior to that year.
c. Represents upper-bounding values.
d. Annual emissions during preoperational activities were assumed to be the same as the 1998 releases for RPL (BWHC 1999). The majority of this dose is due to tritium releases.
e. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of the facilities in the year 2020 (about 505,000 for Hanford and 188,400 for INEEL).

Source: Model results, using the GENII computer code (Napier et al. 1988).

Incremental doses to involved workers from normal operations are given in **Table 4–29**; these workers are defined as those directly associated with all process and operational activities. The incremental annual average dose to FDPF workers would be 290 millirem; the incremental annual average dose to FFTF workers (during startup) would be 3.5 millirem; the incremental annual average dose to FFTF workers (during operations) would be 6.6 millirem; the incremental annual average dose to RPL workers (during startup) would be 81 millirem; and the incremental annual average dose for RPL workers (during processing) would be approximately 160 millirem. The incremental annual dose received by the total workforce for each of these facilities (at the different phases) would be approximately 22, 0.69, 1.3, 3.2, and 4.8 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers are included in Table 4–29. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–29 Incremental Radiological Impacts on Involved FDPF, FFTF, and RPL Workers Under Alternative 1 (Restart FFTF)—Option 2

Receptor—Involved Workers[a]	INEEL FDPF Processing[b]	Hanford Preoperational Activities		Hanford		
		FFTF	RPL	FFTF Operations	RPL Target Processing[b]	Operations and Processing Total
Total dose (person-rem per year)	22[c]	0.69[d]	3.2[e]	1.3[d]	4.8[f]	6.1
1-year latent cancer fatalities	–	2.8×10^{-4}	0.0013	–	–	–
35-year latent cancer fatalities	0.31	–	–	0.018	0.067	0.085
Average worker dose (millirem per year)	290	3.5	81	6.6	160	NA
1-year latent cancer fatality risk	–	1.4×10^{-6}	3.2×10^{-5}	–	–	–
35-year latent cancer fatality risk	0.0041	–	–	9.2×10^{-5}	0.0022	NA

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Target storage, processing, and fabrication activities are performed at this facility. Impacts, dominated by processing activities, include impacts from all facility target activities.
c. Based on an estimated 75 badged workers.
d. Based on an estimated 200 badged workers.
e. Based on an estimated 40 badged workers.
f. Based on an estimated 30 badged workers.

Key: NA, not applicable.
Source: BWHC 1999; LMER 1997:22; Mecham 1999; Nielsen 1999; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts associated with FFTF restart and target fabrication and processing in the 300 Area at Hanford were determined to be the same as for Option 1 (Section 4.3.1.1.9). Hazardous chemical impacts associated with processing in FDPF at INEEL are presented in **Table 4–30** and show little effect from air pollutant releases associated with this option.

Table 4–30 Incremental Hazardous Chemical Impacts on the Public Around INEEL Under Alternative 1 (Restart FFTF)—Option 2

Chemical	Modeled Annual Increment (micrograms per cubic meter)	RfC (micrograms per cubic meter)	Unit Cancer Risk (risk per micrograms per cubic meter)	Hazard Quotient	Cancer Risk
Diethyl benzene	0.0165	1,000	7.80×10^{-6}	1.65×10^{-5}	1.29×10^{-7}
Methanol	0.000602	1,750	NA	3.44×10^{-7}	NA
Nitric acid	0.00121	122.5	NA	9.86×10^{-6}	NA
Tributyl phosphate	0.031	10	NA	0.0031	NA
			Hazard Index =	0.0031	

Note: For diethyl benzene, the reference concentration for ethyl benzene and the unit cancer risk for benzene were used. For tributyl phosphate, the reference concentration for phosphoric acid was used to estimate the Hazard Quotient because no information was available for tributyl phosphate.
Key: NA, not applicable (the chemical is not a known carcinogen); RfC, Reference Concentration.
Source: DOE 1996a; EPA 1999; model results, using the SCREEN 3 computer code (EPA 1995).

4.3.2.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with FFTF target irradiation, FDPF neptunium-237 target processing, and RPL medical and industrial target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 mile) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are presented in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–31** and **4–32**, respectively.

FFTF would operate for 21 years with a mixed oxide core followed by 14 years with a highly enriched uranium core. As shown in Table 4–31, the hypothetical core disruptive accident would result in the largest radiological consequences among FFTF accidents. In order to provide a conservative estimate of FFTF accident risks, the accident frequency of 1×10^{-6} was selected for the hypothetical core disruptive accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.24×10^{-8} and 1.69×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00129.

For 35 years of FDPF neptunium-237 target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 1.49×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0287.

Table 4–31 FFTF, RPL, and FDPF Accident Consequences Under Alternative 1 (Restart FFTF)—Option 2

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
FFTF accidents						
Design-basis-accident primary sodium spill (MOX)	0.00113	5.65×10^{-7}	78.6	0.0393	0.00313	1.25×10^{-6}
Design-basis-accident primary sodium spill (HEU)	8.63×10^{-4}	4.32×10^{-7}	72.6	0.0363	0.00181	7.24×10^{-7}
Hypothetical core disruptive accident (MOX)	0.679	3.40×10^{-4}	6.68×10^{4}	33.4	0.679	2.72×10^{-4}
Hypothetical core disruptive accident (HEU)	0.481	2.41×10^{-4}	6.16×10^{4}	30.8	0.375	1.50×10^{-4}
BLTC driver fuel-handling accident (MOX)	0.00383	1.92×10^{-6}	1,280	0.639	0.357	1.43×10^{-4}
BLTC driver fuel-handling accident (HEU)	0.00384	1.92×10^{-6}	1,230	0.617	0.340	1.36×10^{-4}
BLTC neptunium-237 target-handling accident	2.61×10^{-4}	1.31×10^{-7}	25.8	0.0129	0.0279	1.12×10^{-5}
BLTC isotope target-handling accident	1.22×10^{-4}	6.10×10^{-8}	2.74	0.00137	0.0143	5.72×10^{-6}
FDPF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.01×10^{-9}	1.01×10^{-12}	2.49×10^{-5}	1.24×10^{-8}	7.26×10^{-9}	2.91×10^{-12}
Target dissolver tank failure during plutonium-238 separation	6.11×10^{-8}	3.05×10^{-11}	5.65×10^{-4}	2.82×10^{-7}	2.17×10^{-7}	8.69×10^{-11}
Ion exchange explosion during plutonium-238 separation	1.63×10^{-5}	8.13×10^{-9}	0.150	7.51×10^{-5}	5.79×10^{-5}	2.31×10^{-8}
Plutonium-238 processing facility beyond-design-basis earthquake	42.5	0.0425	1.64×10^{5}	82.0	1,200	1.0[c]
RPL accidents						
Medical and industrial isotopes localized solvent fire	0.0135	6.74×10^{-6}	77.8	0.0389	0.0047	1.88×10^{-6}
Medical and industrial isotopes unlikely seismic event	1.52	7.60×10^{-4}	1,350	0.675	1.50	6.00×10^{-4}
Medical and industrial isotopes glovebox explosion	50.0	0.050	4.60×10^{4}	23.0	49.0	0.0392

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–32 FFTF, RPL, and FDPF Accident Risks Under Alternative 1 (Restart FFTF)—Option 2

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Hypothetical core disruptive accident (MOX) (1×10^{-6})	3.40×10^{-10}	3.34×10^{-5}	2.72×10^{-10}
Hypothetical core disruptive accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-6})	1.92×10^{-12}	6.39×10^{-7}	1.43×10^{-10}
BLTC driver fuel-handling accident (HEU) (1×10^{-6})	1.92×10^{-12}	6.17×10^{-7}	1.36×10^{-10}
BLTC neptunium-237 target-handling accident (1×10^{-6})	1.31×10^{-13}	1.29×10^{-8}	1.12×10^{-11}
BLTC isotope target-handling accident (1×10^{-6})	6.10×10^{-14}	1.37×10^{-9}	5.72×10^{-12}
35-year FFTF risk	1.24×10^{-8}	0.00129	1.69×10^{-8}
Annual FDPF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	1.24×10^{-10}	2.91×10^{-14}
Target dissolver tank failure during plutonium-238 separation (0.01)	3.05×10^{-13}	2.82×10^{-9}	8.69×10^{-13}
Ion exchange explosion during plutonium-238 separation (0.01)	8.13×10^{-11}	7.51×10^{-7}	2.31×10^{-10}
Plutonium-238 processing facility beyond-design-basis earthquake (1×10^{-5})	4.25×10^{-7}	8.20×10^{-4}	1.00×10^{-5}[c]
35-year FDPF risk	1.49×10^{-5}	0.0287	3.50×10^{-4}
Annual RPL risks			
Medical and industrial isotopes localized solvent fire (0.044)	2.99×10^{-7}	0.00173	8.35×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	7.60×10^{-6}	0.00675	6.00×10^{-6}
Medical and industrial isotopes glovebox explosion (1×10^{-4})	5.00×10^{-6}	0.00230	3.92×10^{-6}
35-year RPL risk	4.51×10^{-4}	0.377	3.50×10^{-4}
35-year Option risk	4.51×10^{-4}	0.407	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years of RPL medical, industrial, and research and development target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 4.51×10^{-4} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.377.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 4.51×10^{-4} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.407.

The irradiation of medical, industrial, research and development, and neptunium-237 targets at FFTF would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of medical, industrial, or neptunium-237 targets at FFTF.

No chemical processing activities are currently performed at FDPF and no chemicals are stored in this facility. Processing activities in support of plutonium-238 production would require the introduction of hazardous chemicals, specifically nitric acid and nitric oxide. Potential health impacts from accidental releases of nitric acid were assessed by comparing estimated airborne concentrations of the chemicals to Emergency Response Planning Guidelines (ERPG) developed by the American Industrial Hygiene Association. The ERPG-1 value (0.5 part per million) is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour, resulting in only mild, transient, and reversible adverse health effects. The ERPG-2 value (10 parts per million) is protective of irreversible or serious health effects or impairment of an individual's ability to take protective action. The ERPG-3 value (25 parts per million) is indicative of potentially life threatening health effects.

The maximum distances, in meters, needed to reach the ERPG values for nitric acid releases at FDPF for Stability Classes D and F are shown in **Table 4–33.** Two separate atmospheric conditions were evaluated, Stability Classes D and F. Stability Class D represents average meteorological conditions while Stability Class F represents worst-case meteorological conditions. The number of involved and noninvolved workers potentially exposed would vary with a number of factors, such as the time of day and whether they are sheltered within buildings at the time of release. Individuals at the nearest access road (5,800 meters [3.6 miles]) and at the nearest site boundary (13,952 meters [8.7 miles]) from FDPF would be exposed to levels well below ERPG-1.

Table 4–33 ERPG Distances for Nitric Acid Releases at FDPF

Evaluation Parameter	Stability Class D (meters)	Stability Class F (meters)
ERPG-3	375	450
ERPG-2	500	600
ERPG-1	2,000	3,000

Note: To convert from meters to miles, multiply by 6.22×10^{-4}.
Key: ERPG, Emergency Response Planning Guideline.

There are no ERPG values for nitric oxide. For nitric oxide accidents, the level of concern has been estimated by using one-tenth of the "Immediately Dangerous to Life and Health" level published by the National Institute for Occupational Safety and Health. The Immediately Dangerous to Life and Health value for nitric oxide is 100 parts per million. The level of concern value used for this PEIS is 10 parts per million. The level of concern is defined as the concentration of an extremely hazardous substance in air above which there may be serious irreversible health effects as a result of a single exposure for a relatively short period of time.

For FDPF, the maximum distances needed to reach the level of concern for nitric oxide releases for Stability Classes D and F are 500 and 2,000 meters (1,640 and 6,560 feet), respectively. The number of involved and noninvolved workers potentially exposed would vary with a number of factors such as the time of day and whether they are sheltered within buildings at the time of release. Individuals at the nearest access road (5,800 meters [3.6 miles]) and at the nearest site boundary (13,952 meters [8.7 miles]) from FDPF would be exposed to levels well below the level of concern for nitric oxide.

Potential health impacts from the accidental release of the hazardous chemicals were assessed for offsite individuals who are members of the public located at the nearest site boundary and onsite individuals who are members of the public located at the nearest point of public access onsite.

The impacts associated with the accidental release of nitric acid and nitric oxide at FDPF are presented in **Table 4–34**.

Table 4–34 FDPF Hazardous Chemical Accident Impacts Under Alternative 1 (Restart FFTF)—Option 2

Receptor	Evaluation Parameter	Nitric Acid		Nitric Oxide	
		Stability Class D	Stability Class F	Stability Class D	Stability Class F
Onsite individual	Parts per million Level of concern Potential health effects	0.05 < ERPG-1 None	0.15 ERPG-1 Mild, transient	0.09 < LOC None	0.87 < LOC None
Offsite individual	Parts per million Level of concern Potential health effects	<<0.05 < ERPG-1 None	<<0.15 ERPG-1 Mild, transient	<<0.09 < LOC None	<<0.87 < LOC None

Key: ERPG, Emergency Response Planning Guideline; LOC, level of concern.
Note: < means "less than"; << means "much less than."
Source: Model results.

Processing associated with the medical, industrial, and research and development isotope production program at RPL, including target fabrication and postirradiation processing, would not require the introduction of hazardous chemicals that are not in current use in the facility. The quantities of in-process hazardous chemicals for the medical and industrial isotope production program are bounded by the quantities of the material currently stored in the facility. The impacts of in-process hazardous chemical accidents associated with the medical, industrial, and research and development isotope production are bounded by the impacts of hazardous chemical accidents for existing storage facilities at RPL.

4.3.2.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the FDPF target fabrication facility at INEEL. DOE would transport the unirradiated neptunium-237 targets from FDPF to FFTF. Following irradiation in FFTF, the targets would be returned to FDPF for processing. After this processing, the plutonium-238 product would be shipped to LANL. FFTF would receive highly enriched uranium fuel from a U.S. fuel fabrication facility and mixed oxide fuel from Europe via an east coast port. Additionally, medical and industrial isotopes would be shipped from FFTF to a local airport, and from there to locations throughout the country.

Approximately 38,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 6.5 million kilometers (4.0 million miles); at sea by ships carrying mixed oxide fuel, 96,000 kilometers (52,000 nautical miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

The transportation impacts analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 23 person-rem; the dose to the public, 113 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.009 latent cancer fatality among transportation workers and 0.056 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.025. About half of the crew risk, about

7 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FDPF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting in 0.13 traffic fatality. Nearly all of the radiological and traffic accident risk would result from shipping medical and industrial isotopes.

IMPACTS OF MARINE TRANSPORTATION. The potential impacts of marine transport of mixed oxide fuel on the global commons (i.e., portions of the ocean not within the territorial boundary of any nation) were evaluated in accordance with Executive Order 12114 (44 FR 1957). Following a hypothetical severe accident, radioactive particles dispersed over the ocean would not be in large enough amounts to have a measurable impact on the environment. The risks of accidents approaching and docking at the port have been estimated to be less than 1×10^{-9} person-rem, resulting in less than 1×10^{-12} latent cancer fatality. The radiological doses associated with incident-free transportation, which include the exposure of the ship's crew to low levels of radiation during transport and handling of the packages, have been estimated to be approximately 0.03 person-rem for a route to an east coast port and 0.06 person-rem for a route to a west coast port. These doses would result in 1.2×10^{-5} and 2.4×10^{-5} latent cancer fatalities, respectively.

4.3.2.1.12 Environmental Justice

NORMAL OPERATIONS. Expected latent cancer fatalities among the populations residing within 80 kilometers (50 miles) of FDPF at INEEL and FFTF and RPL at Hanford would be less than 0.005 for 35 years of normal operations (Table 4–28). As shown in Table 4–30, the release of hazardous chemicals at INEEL would pose no significant risk of cancer or toxic effects among the public. As discussed in Sections K.5.1 and K.5.3, the expected latent cancer fatalities that would result from the ingestion of food that could be radiologically contaminated due to normal operations would be approximately 0.002 at Hanford and essentially zero at INEEL. No credible pattern of food consumption by persons residing in potentially affected areas would result in significant health risks due to radiological contamination of food supplies near Hanford or INEEL. As shown in Section 4.3.2.1.11, incident-free transportation would not be expected to result in fatalities.

ACCIDENTS. Expected latent cancer fatalities among populations at risk due to radiological accidents listed in Table 4–32 would be approximately 0.5. In the event a radiological accident were to occur at FDPF and northwesterly winds prevailed at the time of the accident, radiological contamination would be directed toward the Fort Hall Indian Reservation (see Figure K–2). If a radiological accident were to occur at FFTF or the 300 Area at Hanford and northeasterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Yakama Indian Reservation (see Figure K–11). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the populations or a maximally exposed individuals residing within the boundaries of the Fort Hall Indian Reservation or Yakama Indian Reservation.

The number of expected latent cancer fatalities resulting from transportation accidents with radiological emissions was found to be approximately 0.5. As discussed in Appendix J, this risk is driven by accidents that could occur from air transportation of medical and industrial isotopes and the conservative assumptions used in the analysis of such accidents. Such accidents could occur anywhere along the flight paths and would not place any identifiable group within the general population at disproportionate risk. As discussed in Section 4.3.2.1.11 and Appendix J, expected fatalities due to a traffic collision would be approximately 0.14.

In summary, normal operations and accidents that could result from the implementation of this option would pose no significant radiological or nonradiological risks to the public, and implementation would pose no disproportionately high and adverse risks to any group within the population.

4.3.2.1.13 Waste Management

The impacts of managing wastes associated with irradiating targets in FFTF and processing and fabricating target materials for the research and development support and medical and industrial isotope production in RPL/306–E are assumed to be the same as for Option 1 (Section 4.3.1.1.13). This is because the same amount of plutonium-238 production, medical and industrial isotope production, and nuclear research and development support would be accomplished annually. As discussed in that section, the impacts on Hanford's waste management systems would be minimal.

The expected generation rates of wastes that would be associated with the operation of FDPF to fabricate and process neptunium-237 targets are compared with INEEL's treatment, storage and disposal capacities in **Table 4–35**. The impacts on the INEEL waste management systems, in terms of managing the additional wastes, are discussed in this section. Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.3.2.1.9 through 4.3.2.1.11.

Canisters used to transport neptunium-237 to the site would constitute a very small additional amount of solid low-level radioactive—less than 10 cubic meters (13.1 cubic yards) over the 35-year operational period, even if no credit is taken for volume reduction by compaction (Brunson 1999a). The annual generation of this waste would fall within the range of accuracy of the generation rate of solid low-level radioactive waste given in Table 4–35, and its management need not be addressed separately.

In accordance with the Records of Decision for the *Waste Management PEIS* (DOE 1997a), wastes could be treated and disposed of on site at INEEL or at other DOE sites or commercial facilities. Based on the Record of Decision for transuranic waste issued on January 20, 1998 (63 FR 3629), transuranic waste would be certified on site and eventually shipped to a suitable geologic repository for disposal. Based on the Record of Decision for hazardous waste issued on August 5, 1998 (63 FR 41810), nonwastewater hazardous waste would continue to be treated and disposed of at offsite commercial facilities. Based on the Record of Decision for low-level radioactive waste and mixed low-level radioactive waste issued on February 18, 2000 (65 FR 10061), minimal treatment of low-level radioactive waste will be performed at all sites and, to the extent practicable, onsite disposal of low-level radioactive waste will continue. Hanford and the Nevada Test Site will be made available to all DOE sites for disposal of low-level radioactive waste. Mixed low-level radioactive waste analyzed in the *Waste Management PEIS* will be treated at Hanford, INEEL, ORR, and SRS and will be disposed of at Hanford and the Nevada Test Site.

It is also assumed in this NI PEIS that low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous waste would be treated, stored, and disposed of in accordance with current and developing site practices. No high-level radioactive waste would be associated with neptunium-237 target fabrication or processing in FDPF.

Two management approaches are being considered for the transuranic waste associated with neptunium-237 fabrication and processing in FDPF: (1) its management as transuranic waste or (2) its management as high-level radioactive waste.

Table 4–35 Incremental Waste Management Impacts of Operating FDPF at INEEL Under Alternative 1 (Restart FFTF)—Option 2

Waste Type[a]	Estimated Additional Waste Generation (cubic meters per year)	Estimated Additional Waste Generation as a Percent of[b]		
		Onsite Treatment Capacity	Onsite Storage Capacity	Onsite Disposal Capacity
Transuranic waste[c]	7	0.11 (0.054)	0.14 (3.5)	NA
Low-level radioactive				
Liquid[d]	30	0.23	(e)	(e)
Solid	35	0.071	0.69	0.093
Mixed low-level radioactive				
Liquid	(d)	(d)	(d)	(d)
Solid	<5	<0.077	<0.099	NA
Hazardous	6,500 kilograms	NA	2.4	NA
Nonhazardous				
Liquid	23	NA	NA	0.14[f]
Solid	148	NA	NA	0.31

a. See definitions in Appendix G.9.
b. Estimated additional annual waste generation is compared with annual site treatment and disposal capacities. Additional waste generation over the assumed 35-year operational period is compared with site storage capacities.
c. Includes mixed transuranic waste. The transuranic waste, as given in the table, is in the form of a solid. FDPF operations are not expected to generate remotely handled transuranic waste; only contact-handled transuranic waste is anticipated. Refer to the text for a discussion of the two transuranic waste management approaches; this is the reason for the two entries in the table for the onsite treatment and storage capacities of this type waste.
d. Mixed liquid low-level radioactive waste is included under liquid low-level radioactive waste because these wastes are processed together.
e. Refer to the text. The impact on the waste management system would be small.
f. Percent of capacity of the two INTEC percolation ponds.

Note: To convert from cubic meters per year to cubic yards per year, multiply by 1.308; to convert from kilograms to pounds, multiply by 2.20; < means "less than."

Key: INTEC, Idaho Nuclear Technology and Engineering Center; NA, not applicable (i.e., the majority of this waste is not routinely treated, or is not routinely stored, or is not routinely disposed of on site; refer to the text).

Source: Brunson 1999b; DOE 1999a; Kirkham 1999; Wham 1999d.

Under the first approach, transuranic waste associated with neptunium-237 fabrication and processing would be treated, packaged, and stored on site pending the availability of a suitable geologic repository. This waste would be considered nondefense transuranic waste and, therefore, under current legislation, could not be disposed of at WIPP. Because this waste has no current disposition path, DOE Headquarters' approval, as required by DOE Order 435.1, would be necessary before a decision were made to generate this waste. Drum-gas testing, real-time radiography, and loading the transuranic waste package transporter for shipment to the repository would occur at the planned Advanced Mixed Waste Treatment Project at INEEL.

The generation of the transuranic waste is estimated to represent 0.11 percent of the 6,500-cubic-meter-per-year (8,500-cubic-yard-per-year) planned capacity of the Advanced Mixed Waste Treatment Project. A total of 245 cubic meters (320 cubic yards) of transuranic waste would be generated over the 35-year operational period. If all this additional transuranic waste were stored on site, it would represent 0.14 percent of the 177,300-cubic-meter (231,900-cubic-yard) storage capacity available at the Radioactive Waste Management Complex. Assuming the waste were stored in 208-liter (55-gallon) drums that could be stacked two high, and

allowing a 50 percent factor for aisle space, a storage area of 0.044 hectare (0.11 acre) would be required. The impacts of managing the additional quantities of transuranic waste at INEEL under this approach would be minimal.

Because INEEL does not currently generate transuranic waste, a second approach is being considered for the management of transuranic waste associated with neptunium-237 fabrication and processing. Under the second approach, the transuranic waste would be managed as high-level radioactive waste, for ultimate disposal in a geologic repository. (Although it may be managed as if it were high-level radioactive waste, the transuranic waste would not be designated as high-level radioactive waste.) The amount of this transuranic waste would represent an extremely small fraction of the sodium-bearing waste that is also being managed as high-level radioactive waste at INEEL. The generation of this transuranic waste would represent only 0.054 percent of the processing capacity of the INTEC Process Equipment Waste Evaporator (13,000 cubic meters [17,000 cubic yards] per year). The transuranic waste generated over the 35-year operational period would represent 3.5 percent of the storage capacity of the INTEC Calcine Bin Sets (6,950 cubic meters [9,090 cubic yards]). The impacts of managing the additional quantities of transuranic waste as high-level radioactive waste at INEEL would be minimal.

At INEEL, low-level radioactive waste from neptunium-237 fabrication and processing would be packaged, certified, and accumulated at FDPF before transfer for additional treatment and disposal in existing onsite facilities. Annual liquid low-level radioactive waste generation, including mixed liquid low-level radioactive waste that would be associated with neptunium-237 target fabrication and processing in FDPF, is estimated to be 0.23 percent of the 13,000-cubic-meter-per-year (17,000-cubic-yard-per-year) capacity of the INTEC Process Equipment Waste evaporator. The condensate from this evaporator would be processed by the Liquid Effluent Treatment and Disposal System evaporator and released to the main stack as steam. The concentrated waste from both evaporators would be grouted for final disposition.

The annual amount of solid low-level radioactive waste that would be generated at FDPF as the result of neptunium-237 target fabrication and processing is estimated to represent 0.071 percent of the 49,610-cubic-meter-per-year (64,890-cubic-yard-per-year) treatment capacity of the Waste Experimental Reduction Facility and 0.093 percent of the 37,700-cubic-meter-per-year (49,300-cubic-yard-per-year) disposal capacity of the Radioactive Waste Management Complex. A total of 1,225 cubic meters (1,602 cubic yards) of solid low-level radioactive waste would be generated over the 35-year operational period. This would represent 0.69 percent of the 177,300-cubic-meter (231,900-cubic-yard) storage capacity of the Radioactive Waste Management Complex. Using the 6,264-cubic-meter-per-hectare (3,316-cubic-yard-per-acre) disposal land usage factor for INEEL published in the *Storage and Disposition PEIS* (DOE 1996a:E-9), 1,225 cubic meters (1,602 cubic yards) of waste would require 0.20 hectares (0.48 acres) of disposal space at INEEL. At some future time, low-level radioactive waste would be disposed of off site. The impacts of managing the additional low-level radioactive waste at INEEL would be minimal.

At INEEL, mixed solid low-level radioactive waste would be stabilized, packaged, and stored on site for treatment and disposal in a manner consistent with the site treatment plan. Mixed low-level radioactive waste is currently treated on site with some waste shipped to Envirocare of Utah for disposal. The additional mixed solid low-level radioactive waste that would be generated at FDPF is estimated to be less than 0.077 percent of the 6,500-cubic-meter-per-year (8,500-cubic-yard-per-year) planned capacity of the Advanced Mixed Waste Treatment Project. Over the 35-year operational period, the amount of this waste generated would represent less than 0.099 percent of the 177,300-cubic-meter (231,900-cubic-yard) storage capacity of the Radioactive Waste Management Complex. Therefore, the management of this additional waste at INEEL would have only a minimal impact on the management of mixed low-level radioactive waste at INEEL.

Hazardous wastes generated during the operation of FDPF would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities. Hazardous waste generated from 35 years of operating FDPF to fabricate and process the neptunium-237 targets is estimated to represent about 2.4 percent of the 9,600-cubic-meter (12,560-cubic-yard) capacity of the hazardous waste storage buildings (including staging). Management of these additional hazardous wastes at INEEL would have only a minimal impact on the hazardous waste management system.

Nonhazardous solid waste would be packaged and transported in conformance with standard industrial practice. Solid wastes such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent off site for that purpose. The remaining solid sanitary waste would be sent to the onsite landfill. This additional waste load would have only a minimal impact on the nonhazardous solid waste management system at INEEL. The annual amount of nonhazardous solid waste that would be generated is estimated to represent 0.31 percent of the 48,000-cubic-meter-per-year (63,000-cubic-yard-per-year) capacity of the Central Facilities Area Landfill Complex.

At INEEL, nonhazardous industrial wastewater generated by FDPF would be discharged to the INTEC service waste system, which then discharges to the two INTEC percolation ponds. Nonhazardous liquid waste generated as the result of neptunium-237 target fabrication and processing is estimated to be 0.14 percent of the 16,700-cubic-meter-per-year (21,800-cubic-yard-per-year) capacity of the INTEC percolation ponds. Therefore, management of nonhazardous liquid waste at INEEL would have only a minimal impact on the management system.

The generation rates of waste at INEEL that would be associated with this option (Table 4–35) can be compared with the current waste generation rates at the site, given in Table 3–18 (Section 3.3.11). Except for transuranic waste, which currently is not being generated at INEEL, the waste generation rates associated with plutonium-238 production would be much smaller than the current waste generation rates at the site.

4.3.2.1.14 Spent Nuclear Fuel Management

Impacts associated with spent nuclear fuel management would be the same as for Option 1, and are given in Section 4.3.1.1.14.

4.3.3 Alternative 1 (Restart FFTF)—Option 3

Option 3 involves operating FFTF at Hanford to irradiate all targets and materials associated with plutonium-238 production, medical and industrial isotope production, and research and development, and also operating FMEF at Hanford to fabricate and process these targets and materials and the associated irradiated products. This option includes storage in FMEF of the neptunium-237 transported to Hanford from SRS and of the other target materials transported to Hanford from other offsite facilities.

The transportation of the mixed oxide and highly enriched uranium fuel to Hanford for use in FFTF, the transportation of the neptunium-237 and other target material to Hanford, and the transportation of the product materials following postirradiation processing are also part of this option.

Under Option 3, FFTF would operate with a mixed oxide fuel core for the first 21 years and with a highly enriched uranium fuel core for the next 14 years.

4.3.3.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations and with all transportation activities are assessed in this section.

4.3.3.1.1 Land Resources

LAND USE. The restart of FFTF would not result in impacts on land use at Hanford for the reasons described in Section 4.3.1.1.1.

FMEF, which is in the 400 Area of Hanford, would be used for target material storage, target fabrication, and processing. The use of this facility would require the construction of a new 76-meter (250-foot) stack. Because the stack would be placed on previously disturbed land, and use of FMEF would be compatible with the mission for which it was designed, land use impacts in the 400 Area would be minimal.

VISUAL RESOURCES. The restart of FFTF would not result in impacts on visual resources at Hanford for the reasons described in Section 4.3.1.1.1.

The use of FMEF for target material storage, target fabrication, and processing would involve the construction of a 76-meter (250-foot) stack. While the stack would be visible from surrounding areas, it would not change the overall appearance of the 400 Area or its Visual Resource Management Class IV rating. Thus, impacts on visual resources would be minimal.

4.3.3.1.2 Noise

The change in noise impacts from FFTF restart and operation would be expected to be small as described in Section 4.3.1.1.2.

FMEF would be used for target material storage, target fabrication, and processing. A new 76-meter (250-foot) stack would be required for neptunium-237 target processing at FMEF. Activities associated with construction of a new stack would be typical of small construction projects and would result in some temporary increase in noise. Noise sources associated with this construction would not be expected to be loud impulsive sources and would not be expected to result in disturbance of wildlife around the 400 Area. FMEF operations would not be expected to result in any change in noise impacts on wildlife around the 400 Area, and offsite noise impacts would also be minor because the nearest site boundary is 7 kilometers (4.3 miles) to the east. Operations would be expected to result in minimal change in noise impacts on people near Hanford as a result of changes in employee and truck traffic levels.

4.3.3.1.3 Air Quality

The restart of FFTF under this option would have the same air quality impacts as under Option 1 (Section 4.3.1.1.3).

There would be no change in air quality impacts from target processing at the Hanford 300 Area. Emissions of target material would be minimal due to efficient filtration and measures taken to prevent losses of expensive target material. Fugitive dust from employee and truck traffic could increase slightly.

The concentrations at Hanford from FFTF and FMEF attributable to this option are presented in **Table 4–36**. Changes in concentrations were determined to be small and would be below the applicable ambient standards

even when ambient monitored values and the contributions from the other site activities were included. Hazardous chemical impacts are addressed in Section 4.3.3.1.9.

Table 4–36 Incremental Hanford Concentrations Associated with Alternative 1 (Restart FFTF)—Option 3

Pollutant	Averaging Time	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (micrograms per cubic meter)	
			FFTF	FMEF
Criteria pollutants				
Carbon monoxide	8 hours 1 hour	10,000[b] 40,000[b]	52.1 74.4	0 0
Nitrogen dioxide	Annual	100[b]	0.0118	4.43×10^{-5}
PM_{10}	Annual 24 hours	50[c] 150[c]	0.00084 9.84	0 0
Sulfur dioxide	Annual 24 hours 3 hours 1 hour	50[d] 260[d] 1,300[d] 660[d]	0.00785 9.11 20.5 22.8	0.0087 0.069 0.16 0.17
Toxic air pollutants				
Methanol	24 hours	870	0	0.0018
Nitric acid	24 hours	17	0	0.0022
Paraffin hydrocarbons	24 hours	7	0	0.16
Tributyl phosphate	24 hours	7.3	0	0.090

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} (particulate matter with an aerodynamic diameter less than or equal to 10 micrometers) standard is attained when the expected number of days with a 24-hour average concentration above the standard is much less than 1. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.
b. Federal and state standard.
c. Federal standard currently under litigation.
d. State standard.

Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995); additional data from Nielsen 2000.

The concentrations at Hanford attributable to this option are compared with the Prevention of Significant Deterioration Class II increments for sulfur dioxide and nitrogen dioxide in **Table 4–37**.

The air quality impacts of transportation are presented in Section 4.3.3.1.11.

Table 4–37 PSD Class II Increments Compared to Hanford Concentrations Associated with FMEF Under Alternative 1 (Restart FFTF)—Option 3

Pollutant	Averaging Time	Allowable PSD Increment (micrograms per cubic meter)	Modeled Increment (micrograms per cubic meter)
Nitrogen dioxide	Annual	25	0.0118
Sulfur dioxide	Annual 24 hours 3 hours	20 91 512	0.0166 9.17 20.6

Key: PSD, Prevention of Significant Deterioration.

Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995).

4.3.3.1.4 Water Resources

The restart of FFTF for isotope production and the use of FMEF for target material storage, target fabrication, and processing, both existing facilities located in the Hanford 400 Area, would not have any construction-related impacts on water bodies, floodplains, or on surface water or groundwater quality.

Operational impacts on water resources associated with the restart of FFTF would be substantially the same as those discussed in Section 4.3.1.1.4, with only a small incremental impact associated with FMEF operations. Annual average groundwater withdrawal during standby by 400 Area facilities is about 197 million liters (52 million gallons) (Section 4.3.1.1.4). The restart of FFTF combined with the use of FMEF would increase annual water use to approximately 276 million liters (73 million gallons). This includes some 15 million liters (4 million gallons) per year to support FMEF cooling needs and approximately 3.8 million liters (1 million gallons) per year for increased sanitary and potable water needs (Chapin 2000). This volume of 276 million liters (73 million gallons) per year is approximately 69 percent of the 400 Area groundwater production capacity of about 398 million liters (105.1 million gallons) per year (DOE 1999a:4-262).

Additional staffing required to support both the restart of FFTF and use of FMEF would also increase annual sanitary wastewater generation in the 400 Area by a total of 5.7 million liters (1.5 million gallons) over standby to about 9.5 million liters (2.5 million gallons) per year during operation. FMEF alone would contribute 3.8 million liters (1 million gallons) annually to this increase (Chapin 2000). Nevertheless, the Energy Northwest treatment system has sufficient excess capacity to accommodate this increased flow from the 400 Area (Section 4.3.1.1.4).

Process (nonradioactive) wastewater discharge from the 400 Area (mainly FFTF and FMEF) would increase by a total of approximately 38 million liters (10 million gallons) over standby to about 114 million liters (30 million gallons) per year as a result of FFTF and FMEF operations. FMEF would contribute about 15 million liters (4 million gallons) annually based on a conservative estimate of cooling water discharges and blowdown from FMEF's three cooling towers (currently inactive) (Chapin 2000); Nielsen 1999:38). This additional volume includes approximately 38,000 liters (10,000 gallons) per year of process wastewater resulting from target fabrication and processing activities (Chapin 2000). This wastewater would be discharged 400 Area process sewer system and ultimately to the 400 Area Pond, with no impact on groundwater quality expected for the same reasons cited in Sections 4.3.1.1.4.

Waste management aspects of this alternative and their effects are further discussed in Section 4.3.3.1.13.

4.3.3.1.5 Geology and Soils

The restart of FFTF would not be expected to result in impacts on geologic and soil resources at Hanford, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.1.2.5 and 4.3.1.1.5.

FMEF would be used for target material storage, target fabrication, and processing. Additionally, a new 76-meter (250-foot) stack would be constructed (Nielsen 1999:24). Because FMEF is an existing facility and the stack would be located on previously disturbed land, impacts on geologic resources and soils would be negligible. As referenced above, and in Section 4.2.4.2.5, hazards from large-scale geologic conditions at Hanford were previously evaluated and were reviewed in this NI PEIS and found to present a low risk to FMEF. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.3.3.1.6 Ecological Resources

The restart of FFTF would not be expected to result in impacts on ecological resources at Hanford for the reasons described in Section 4.3.1.1.6.

FMEF, an existing facility, would be used for target material storage, target fabrication, and processing. Impacts on ecological resources resulting from the use of FMEF would not occur for the same reasons noted above for FFTF, which is also in the 400 Area. While a new 76-meter (250-foot) stack would be built, it would be placed on previously disturbed land in the 400 Area; thus, no natural terrestrial habitat would be lost.

4.3.3.1.7 Cultural and Paleontological Resources

The restart of FFTF would not be expected to result in impacts on cultural resources at Hanford for the reasons described in Section 4.3.1.1.7.

Target material storage, target fabrication, and processing would take place at FMEF in the 400 Area. Impacts on cultural resources resulting from the use of FMEF would not occur for the same reasons noted above for FFTF, which is also in the 400 Area. Although a new 76-meter (250-foot) stack would be built, it would be placed on previously disturbed land in the 400 Area; thus, impacts on cultural and paleontological resources would not be expected.

4.3.3.1.8 Socioeconomics

The irradiation of all isotopes at FFTF, and the fabrication and processing of all targets at FMEF would annually require about 130 additional workers at Hanford (Hoyt et al. 1999; DOE 1997b). This level of employment would generate about 329 indirect jobs in the region around Hanford. The potential total employment increase of 459 direct and indirect jobs in the Hanford region represents an approximate 0.1 percent increase in the projected regional economic area workforce. It would have no noticeable impact on the regional economic area.

Additional employment resulting from this option would not have any noticeable impact on community services in the Hanford region of influence. Assuming that 91 percent of the new employment would reside in Hanford's region of influence (refer to Section 3.4.8), 459 total jobs could increase the region's population by approximately 775 persons. This increase, in conjunction with the normal population growth forecasted by the State of Washington, would not have any noticeable impact on the availability of housing and/or the price of housing in the region of influence. Given the current population-to-student ratio in the region of influence, this would likely result in an increase of about 160 students, requiring local school districts to slightly increase the number of classrooms to accommodate them.

Community services in the region of influence would be expected to change to accommodate the population growth as follows: 10 new teachers would be needed to maintain the current student-to-teacher ratio of 16:1; 1 new police officer would need to be added to maintain the current officer-to-population ratio of 1.5:100; 3 new firefighters would need to be added to maintain the current firefighter-to-population ratio of 3.4:1000; and 1 new doctor would be added to maintain the current physician-to-population ratio of 1.4:1000. Thus, an additional 15 positions would have to be created to maintain community services at current levels. Hospitals in the region of influence would not experience any change from the 2.1 beds per 1,000 persons currently available. Moreover, average school enrollment would increase to 92.8 percent from the current 92.5 percent unless additional classrooms were built. None of these projected changes should have a major impact on the level of community services currently offered in the region of influence.

4.3.3.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup, processing, and operations are given in **Table 4–38**: the population within 80 kilometers (50 miles) of FFTF and FMEF in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

To represent a bounding annual dose scenario, it is assumed that a full-year's isotopic release would occur from target processing at FMEF concurrently with a full-year's release from FFTF operations at 400 MW. The impacts presented in Table 4–38 assume a full-year's release resulting from FFTF preoperational testing and startup activities. As a result of annual operations, the bounding projected total incremental population dose in the year 2020 would be 0.13 person-rem. The corresponding number of latent cancer fatalities in the population surrounding Hanford from 35 years of operations would be 2.3×10^{-3}. The bounding total incremental dose to the maximally exposed member of the public from annual operations of FFTF and FMEF would be 7.0×10^{-4} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 1.2×10^{-8}.

Incremental doses to involved workers from normal operations are given in **Table 4–39**; these workers are defined as those directly associated with all process and operational activities. The incremental annual average dose to FFTF workers during startup would be 3.5 millirem; the incremental annual average dose during operations, 6.6 millirem. For FMEF workers, the incremental annual average dose is estimated to be approximately 250 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be approximately 0.69, 1.3, and 27 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers are included in Table 4–39. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

HAZARDOUS CHEMICAL IMPACTS. At FMEF, both carcinogenic and noncarcinogenic health effects from exposure to hazardous chemicals were evaluated and are presented in **Table 4–40**. It was assumed that under normal operating conditions, the primary exposure pathway for members of the public would be from airborne emissions released through the new 76-meter (250-foot) stack. Emissions of chemicals were estimated based on anticipated chemical usage. A worst-case dispersion-modeling screening analysis was performed to estimate annual concentrations for each chemical.

The annual concentration of each noncarcinogenic chemical was divided by the corresponding inhalation reference concentration to estimate the Hazard Quotient for each of the noncarcinogenic chemicals associated with this option. The Hazard Quotients were then summed to determine the Hazard Index. A Hazard Index of less than one indicates that adverse health effects from non-cancer-causing agents are not expected. For

carcinogens, the annual concentration was multiplied by the unit cancer risk to estimate the increased cancer risk from that chemical.

Table 4–38 Incremental Radiological Impacts on the Public Around Hanford from Operational Facilities Under Alternative 1 (Restart FFTF)—Option 3

Receptor	FFTF Preoperational Activities[a]	FFTF Operations	FMEF Target Processing[b]	Operations and Processing Total[c]
Population within 80 kilometers (50 miles) in the year 2020				
Dose (person-rem)	0.028	0.044	0.085	0.13
1-year latent cancer fatalities	1.4×10^{-5}	–	–	–
35-year latent cancer fatalities	–	7.7×10^{-4}	0.0015	0.0023
Maximally exposed individual				
Annual dose (millirem)	1.3×10^{-4}	4.0×10^{-4}	3.0×10^{-4}	7.0×10^{-4}
1-year latent cancer fatality risk	6.5×10^{-11}	–	–	–
35-year latent cancer fatality risk	–	7.0×10^{-9}	5.3×10^{-9}	1.2×10^{-8}
Average exposed individual within 80 kilometers (50 miles)				
Annual dose[d] (millirem)	5.6×10^{-5}	8.7×10^{-5}	1.7×10^{-4}	2.6×10^{-4}
1-year latent cancer fatality risk	2.8×10^{-11}	–	–	–
35-year latent cancer fatality risk	–	1.5×10^{-9}	3.0×10^{-9}	4.5×10^{-9}

a. For conservatism as well as consistency with other radiological impacts evaluated in this NI PEIS, these values were assessed for the year 2020 even though these activities would commence prior to that year.
b. Target storage, processing, and fabrication activities are performed at the facility. Impacts are for all facility target activities and are dominated by processing activity impacts.
c. Represents upper-bounding values.
d. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FFTF and FMEF in the year 2020 (about 500,000).

Source: Model results, using the GENII computer code (Napier et al. 1988).

Table 4–39 Incremental Radiological Impacts on Involved FFTF and FMEF Workers Under Alternative 1 (Restart FFTF)—Option 3

Receptor—Involved Workers[a]	FFTF Preoperational Activities	FFTF Operations	FMEF Target Processing[b]	Operations and Processing Total
Total dose (person-rem per year)	0.69[c]	1.3[c]	27[d]	28
1-year latent cancer fatalities	2.8×10^{-4}	–	–	–
35-year latent cancer fatalities	–	0.018	0.38	0.40
Average worker dose (millirem per year)	3.5	6.6	250	NA
1-year latent cancer fatality risk	1.4×10^{-6}	–	–	–
35-year latent cancer fatality risk	–	9.2×10^{-5}	0.0035	NA

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Doses are based on a weighted average from historical data associated with plutonium processing and other radiochemical processing. Target storage, processing, and fabrication activities are performed at this facility. Impacts, dominated by processing activities, include impacts from all facility target activities.
c. Based on an estimated 200 badged workers.
d. Based on an estimated 105 badged workers.

Key: NA, not applicable.

Source: BWHC 1999; LMER 1997:22; Mecham 1999; Nielsen 1999; Wham 1999b.

Table 4–40 Incremental Hazardous Chemical Impacts on the Public at Hanford Under Alternative 1 (Restart FFTF)—Option 3

Chemical	Modeled Annual Increment (micrograms per cubic meter)	Reference Concentration (micrograms per cubic meter)	Unit Cancer Risk (risk per micrograms per cubic meter)	Hazard Quotient	Cancer Risk
FFTF emergency diesel generators					
Benzene	2.5×10^{-6}	NA	7.8×10^{-6}	NA	1.96×10^{-11}
Toluene	1.10×10^{-6}	400	NA	2.90×10^{-9}	NA
Propylene	6.92×10^{-6}	NA	3.7×10^{-6}	NA	2.56×10^{-11}
Formaldehyde	3.17×10^{-6}	NA	0.000013	NA	4.12×10^{-11}
Acetaldehyde	2.06×10^{-6}	NA	2.2×10^{-6}	NA	4.53×10^{-12}
FMEF					
Nitric acid	2.73×10^{-4}	122.5	NA	2.22×10^{-6}	NA
Diethyl benzene	0.00601	1000	7.8×10^{-6}	6.01×10^{-6}	4.69×10^{-8}
Methanol	2.19×10^{-4}	1750	NA	1.25×10^{-7}	NA
Tributyl phosphate	0.0113	10	NA	0.00113	NA
			Hazard Index =	0.00114	

Note: For diethyl benzene, the reference concentration for ethyl benzene and the unit cancer risk for benzene were used. For tributyl phosphate, the reference concentration for phosphoric acid was used to estimate the Hazard Quotient because no information was available for tributyl phosphate. The propylene oxide unit cancer risk factor was used for propylene.
Key: NA, not applicable (the chemical is not a known carcinogen or it is a carcinogen and only unit risk will apply).
Source: DOE 1996a; EPA 1999; model results, using the SCREEN 3 computer code (EPA 1995).

4.3.3.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with FFTF target irradiation and FMEF target fabrication and processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 mile) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are presented in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–41** and **4–42**, respectively.

FFTF would operate for 21 years with a mixed oxide core followed by 14 years with a highly enriched uranium (HEU) core. As shown in Table 4–41, the hypothetical core disruptive accident would result in the largest

Table 4–41 FFTF and FMEF Accident Consequences Under Alternative 1 (Restart FFTF)—Option 3

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
FFTF accidents						
Design-basis-accident primary sodium spill (MOX)	0.00113	5.65×10^{-7}	78.6	0.0393	0.00313	1.25×10^{-6}
Design-basis-accident primary sodium spill (HEU)	8.63×10^{-4}	4.32×10^{-7}	72.6	0.0363	0.00181	7.24×10^{-7}
Hypothetical core disruptive accident (MOX)	0.679	3.40×10^{-4}	6.68×10^{4}	33.4	0.679	2.72×10^{-4}
Hypothetical core disruptive accident (HEU)	0.481	2.41×10^{-4}	6.16×10^{4}	30.8	0.375	1.50×10^{-4}
BLTC driver fuel-handling accident (MOX)	0.00383	1.92×10^{-6}	1,280	0.639	0.357	1.43×10^{-4}
BLTC driver fuel-handling accident (HEU)	0.00384	1.92×10^{-6}	1,230	0.617	0.340	1.36×10^{-4}
BLTC neptunium-237 target-handling accident	2.61×10^{-4}	1.31×10^{-7}	25.8	0.0129	0.0279	1.12×10^{-5}
BLTC isotope target-handling accident	1.22×10^{-4}	6.10×10^{-8}	2.74	0.00137	0.0143	5.72×10^{-6}
FMEF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.02×10^{-9}	1.01×10^{-12}	7.26×10^{-5}	3.63×10^{-8}	6.65×10^{-10}	2.66×10^{-13}
Target dissolver tank failure during plutonium-238 separation	4.64×10^{-8}	2.32×10^{-11}	0.00169	8.47×10^{-7}	1.95×10^{-8}	7.81×10^{-12}
Ion exchange explosion during plutonium-238 separation	1.24×10^{-5}	6.18×10^{-9}	0.451	2.25×10^{-4}	5.20×10^{-6}	2.08×10^{-9}
Medical and industrial isotopes localized solvent fire	0.00276	1.38×10^{-6}	56.2	0.0281	9.51×10^{-5}	3.80×10^{-8}
Medical and industrial isotopes glovebox explosion	1.00	5.00×10^{-4}	2.95×10^{4}	14.8	24.0	0.0192
Processing facility beyond-design-basis earthquake	16.5	0.00825	6.42×10^{5}	321	922	1.00[c]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

radiological consequences among FFTF accidents. In order to provide a conservative estimate of FFTF accident risks, the accident frequency of 1×10^{-6} was selected for the hypothetical core disruptive accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.24×10^{-8} and 1.69×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00129.

Table 4–42 FFTF and FMEF Accident Risks Under Alternative 1 (Restart FFTF)—Option 3

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Hypothetical core disruptive accident (MOX) (1×10^{-6})	3.40×10^{-10}	3.34×10^{-5}	2.72×10^{-10}
Hypothetical core disruptive accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-6})	1.92×10^{-12}	6.39×10^{-7}	1.43×10^{-10}
BLTC driver fuel-handling accident (HEU) (1×10^{-6})	1.92×10^{-12}	6.17×10^{-7}	1.36×10^{-10}
BLTC neptunium-237 target-handling accident (1×10^{-6})	1.31×10^{-13}	1.29×10^{-8}	1.12×10^{-11}
BLTC isotope target-handling accident (1×10^{-6})	6.10×10^{-14}	1.37×10^{-9}	5.72×10^{-12}
35-year FFTF risk	1.24×10^{-8}	0.00129	1.69×10^{-8}
Annual FMEF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	3.63×10^{-10}	2.66×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	2.32×10^{-13}	8.47×10^{-9}	7.81×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	6.18×10^{-11}	2.25×10^{-6}	2.08×10^{-11}
Medical and industrial isotopes localized solvent fire (0.044)	6.13×10^{-8}	0.00125	1.69×10^{-9}
Medical and industrial isotopes glovebox explosion (1×10^{-4})	5.00×10^{-8}	0.00148	1.92×10^{-6}
Processing facility beyond-design-basis earthquake (1×10^{-5})	8.25×10^{-8}	0.00321	1.00×10^{-5}[c]
35-year FMEF risk	6.79×10^{-6}	0.208	4.17×10^{-4}
35-year Option risk	6.80×10^{-6}	0.209	4.17×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years of FMEF target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 6.79×10^{-6} and 4.17×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.208.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 6.80×10^{-6} and 4.17×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.209.

The irradiation of medical, industrial, research and development, and neptunium-237 targets at FFTF would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of medical, industrial, or neptunium-237 targets at FFTF.

No chemical processing activities are currently performed at FMEF and no chemicals are stored in this facility. Processing activities in support of medical, industrial, research and development isotope and plutonium-238 production would require the introduction of hazardous chemicals, specifically nitric acid and nitric oxide. Potential health impacts from accidental releases of nitric acid were assessed by comparing estimated airborne concentrations of the chemicals to Emergency Response Planning Guidelines (ERPG) developed by the American Industrial Hygiene Association. The ERPG-1 value (0.5 parts per million) is the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour, resulting in only mild, transient, and reversible adverse health effects. The ERPG-2 value (10 parts per million) is protective of irreversible or serious health effects or impairment of an individual's ability to take protective action. The ERPG-3 value (25 parts per million) is indicative of potentially life threatening health effects.

The maximum distances, in meters, needed to reach the ERPG values for nitric acid releases at the FMEF for Stability Classes D and F are shown in **Table 4–43**. Two separate atmospheric conditions were evaluated, Stability Classes D and F. Stability Class D represents average meteorological conditions while Stability Class F represents worst-case meteorological conditions. The number of involved and noninvolved workers potentially exposed would vary with a number of factors such as the time of day and whether they are sheltered within buildings at the time of release. Individuals at the nearest access road (7,100 meters [4.4 miles]) and at the nearest site boundary (7,210 meters [4.5 miles]) from FMEF would be exposed to levels well below ERPG-1.

Table 4–43 ERPG Distances for Nitric Acid Releases at FMEF

Evaluation Parameter	Stability Class D (meters)	Stability Class F (meters)
ERPG-3	375	450
ERPG-2	500	600
ERPG-1	2,000	3,000

Note: To convert from meters to miles, multiply by 6.22×10^{-4}.
Key: ERPG, Emergency Response Planning Guideline.

There are no ERPG values for nitric oxide. For nitric oxide accidents, the level of concern has been estimated by using one-tenth of the "Immediately Dangerous to Life and Health" level published by the National Institute for Occupational Safety and Health. The Immediately Dangerous to Life and Health value for nitric oxide is 100 parts per million. The level of concern value used for this NI PEIS is 10 parts per million. The level of concern is defined as the concentration of an extremely hazardous substance in air above which there may be serious irreversible health effects as a result of a single exposure for a relatively short period of time.

For FMEF, the maximum distances needed to reach the level of concern for nitric oxide releases for Stability Classes D and F are 500 and 1,900 meters (1,640 and 6,560 feet), respectively. The number of involved and noninvolved workers potentially exposed would vary with a number of factors such as the time of day and whether they are sheltered within buildings at the time of release. Individuals at the nearest access road (7,100 meters [4.4 miles]) and at the nearest site boundary (7,210 meters [4.5 miles]) from FMEF would be exposed to levels well below the level of concern for nitric oxide.

Potential health impacts from the accidental release of the hazardous chemicals were assessed for offsite individuals who are members of the public located at the nearest site boundary and onsite individuals who are members of the public located at the nearest point of public access onsite.

The impacts associated with the accidental release of nitric acid and nitric oxide at FMEF are presented in **Table 4–44**.

Table 4–44 FMEF Hazardous Chemical Accident Impacts Under Alternative 1 (Restart FFTF)—Option 3

Receptor	Evaluation Parameter	Nitric Acid		Nitric Oxide	
		Stability Class D	Stability Class F	Stability Class D	Stability Class F
Onsite individual	Parts per million Level of concern Potential health effects	0.03 < ERPG-1 None	0.1 ERPG-1 Mild, transient	0.09 < LOC None	0.55 < LOC None
Offsite individual	Parts per million Level of concern Potential health effects	0.03 < ERPG-1 None	0.1 ERPG-1 Mild, transient	0.09 < LOC None	0.53 < LOC None

Key: ERPG, Emergency Response Planning Guideline; LOC, level of concern.
Note: < means "less than."
Source: Model results.

4.3.3.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the FMEF target fabrication facility at Hanford. DOE would transport the unirradiated neptunium-237 targets from FMEF to FFTF. Following irradiation in FFTF, the targets would be returned to FMEF for processing. After this processing, the plutonium-238 product would be shipped to LANL. FFTF would receive highly enriched uranium fuel from a U.S. fuel fabrication facility and mixed oxide fuel from Europe via an east coast port. Additionally, medical and industrial isotopes would be shipped from FFTF to a local airport, and from there to locations throughout the country.

Approximately 38,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 5.9 million kilometers (3.7 million miles); at sea by ships carrying mixed oxide fuel, 96,000 kilometers (52,000 nautical miles); and in the air by aircraft carrying medical isotopes, 23 million kilometers (14 million miles).

The transportation impact analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 21 person-rem; the dose to the public, 47 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0083 latent cancer fatality among transportation workers and 0.024 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.024. About half of the crew risk, about 16 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of mixed oxide fuel to FFTF with a severity Category V accident in a suburban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.40 person-rem to the public with an associated 2.0×10^{-4} latent cancer fatality, and 3.3 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.7×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237

(unirradiated), irradiated targets or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting in 0.12 traffic fatality. Nearly all of the radiological and traffic accident risk would result from shipping medical and industrial isotopes.

IMPACTS OF MARINE TRANSPORTATION. The potential impacts of marine transport of mixed oxide fuel on the global commons (i.e., portions of the ocean not within the territorial boundary of any nation) were evaluated in accordance with Executive Order 12114 (44 FR 1957). Following a hypothetical severe accident, radioactive particles dispersed over the ocean would not be in large enough amounts to have a measurable impact on the environment. The risks of accidents approaching and docking at the port have been estimated to be less than 1×10^{-9} person-rem, resulting in less than 1×10^{-12} latent cancer fatalities. The radiological doses associated with incident-free transportation, which include the exposure of the ship's crew to low levels of radiation during transport and handling of the packages, have been estimated to be approximately 0.03 person-rem for a route to an east coast port and 0.06 person-rem for a route to a west coast port. These doses would result in 1.2×10^{-5} and 2.4×10^{-5} latent cancer fatalities, respectively.

4.3.3.1.12 Environmental Justice

NORMAL OPERATIONS. Expected latent cancer fatalities among the population residing within 80 kilometers (50 miles) of FFTF and FMEF would be less than 0.003 for 35 years of normal operations (Table 4–38). As shown in Table 4–40, the release of hazardous chemicals at FFTF and FMEF would pose no significant risk of cancer or toxic effects among the public. As discussed in Section K.5.3, the expected latent cancer fatalities that would result from the ingestion of food that could be radiologically contaminated due to normal operations at FFTF and FMEF would be approximately 0.001. No credible pattern of food consumption by persons residing in potentially affected areas would result in significant health risks due to radiological contamination of food supplies near Hanford. As discussed in Section 4.3.1.1.11, incident-free transportation would not be expected to result in fatalities.

ACCIDENTS. Expected latent cancer fatalities among the populations at risk due to radiological accidents listed in Table 4–42 would be approximately 0.2. If a radiological accident were to occur at FFTF or the 300 Area at Hanford and northeasterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Yakama Indian Reservation (see Figure K–11). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the population or maximally exposed individual residing within the boundary of the Yakama Indian Reservation.

The number of expected latent cancer fatalities resulting from transportation accidents with radiological emissions was found to be approximately 0.5. As discussed in Appendix J, this risk is driven by accidents that could occur during the air transportation of medical and industrial isotopes and the conservative assumptions used in the analysis of such accidents. Such accidents could occur anywhere along the flight paths and would not place any identifiable group within the general population at disproportionate risk. As discussed in Section 4.3.3.1.11 and Appendix J, expected fatalities due to a traffic collision would be approximately 0.1.

In summary, normal operations and accidents that could result from the implementation of this option would pose no significant radiological or nonradiological risks to the public, and implementation would pose no disproportionately high and adverse risks to any group within the population.

4.3.3.1.13 Waste Management

The expected generation rates of wastes at Hanford that would be associated with the operation of FFTF for irradiating targets and with the operation of FMEF for target fabrication and processing are compared with Hanford's treatment, storage, and disposal capacities in **Table 4–45**. The impacts on the Hanford waste management systems, in terms of managing these additional wastes, are discussed in this section. Currently, it is DOE's intent that waste generated from the restart and operation of FFTF be managed independent of the existing Hanford site waste management infrastructure by using commercially available facilities for all waste treatment and disposal activities. DOE has developed a draft *Waste Minimization and Management Plan for FFTF* to incorporate pollution prevention and waste minimization practices in its consideration of the future of FFTF (DOE 2000a). If a decision were made to restart FFTF, this plan would be used to ensure that optimum opportunities are provided for characterizing potential waste streams, identifying source reduction and recycling strategies, evaluating disposition options, developing sustainable designs, and implementing effective management strategies. This plan identifies DOE's preferred options for management, treatment, and/or disposition of all waste streams related to the restart and operation of FFTF. These preferred options primarily use commercial waste handling and disposal facilities. Although it is DOE's intent to use commercial waste handling and disposal facilities, the Hanford waste management infrastructure is analyzed in this NI PEIS as a reasonable alternative for the management of wastes resulting from FFTF restart and operation in case commercial disposal is not practicable at the time of restart and operation. Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.3.3.1.9 through 4.3.3.1.11.

Table 4–45 Incremental Waste Management Impacts of Operating FFTF and FMEF at Hanford Under Alternative 1 (Restart FFTF)—Option 3

Waste Type[a]	Estimated Waste Generation for FFTF Operation (cubic meters per year)	Estimated Additional Waste Generation for FFTF[b] (cubic meters per year)	Estimated Additional Waste Generation for FMEF (cubic meters per year)	Estimated Additional Waste Generation (both FFTF and FMEF) as a Percent of[c]		
				Onsite Treatment Capacity	Onsite Storage Capacity	Onsite Disposal Capacity
Transuranic	0	0	11	(d)	2.3	NA
Low-level radioactive						
Liquid	<6	0	6	(e)	(e)	(e)
Solid	80	63	74	NA	NA	0.28
Mixed low-level radioactive	<0.5	0	9	0.05	1.9	2.2
Hazardous	4	0	19	NA	NA	NA
Nonhazardous						
Process wastewater	98,000	22,000	15,000	(e)	(e)	(e)
Sanitary wastewater	5,700	1,900	3,800	2.4[f]	NA	NA
Solid	250	130	170	NA	NA	NA

a. See definitions in Appendix G.9.
b. These estimates represent only the increase in waste generated as a result of restart and operation of FFTF (i.e., operation minus standby waste generation estimates provided in the No Action Alternative, Table 4–6).
c. The estimated additional amounts of waste generated annually are compared with the annual site treatment capacities. The estimated total amounts of additional waste generated over the assumed 35-year operational period are compared with the site storage and disposal capacities.
d. Appropriate waste treatment and certification for disposal would be identified by the Hanford Site waste management contractor in order to meet the waste acceptance criteria for the suitable geologic repository.
e. Refer to the text.
f. Percent of capacity of the Energy Northwest Sewage Treatment Facility.

Note: To convert from cubic meters per year to cubic yards per year, multiply by 1.308; < means "less than."
Key: NA, not applicable (i.e., the majority of this waste is not routinely treated, stored, or disposed of on site).
Source: Chapin 2000; DOE 2000a; Nielsen 1999.

Canisters used to transport neptunium-237 to the site would constitute a very small additional amount of solid low-level radioactive waste—less than 10 cubic meters (13.1 cubic yards) over the 35-year operational period, even if no credit is taken for volume reduction by compaction (Brunson 1999a). The annual generation of this waste would fall within the range of accuracy of the generation rate of solid low-level radioactive waste given in Table 4–45, and its management need not be addressed separately.

In accordance with the Records of Decision for the *Waste Management PEIS* (DOE 1997a), wastes could be treated and disposed of on site at Hanford or at other DOE sites or commercial facilities. Based on the Record of Decision for transuranic waste issued on January 20, 1998 (63 FR 3629), transuranic waste would be certified on site and eventually shipped to a suitable geologic repository for disposal. Based on the Record of Decision for hazardous waste issued on August 5, 1998 (63 FR 41810), nonwastewater hazardous waste would continue to be treated and disposed of at offsite commercial facilities. Based on the Record of Decision for low-level radioactive waste and mixed low-level radioactive waste issued on February 18, 2000 (65 FR 10061), minimal treatment of low-level radioactive waste will be performed at all sites and, to the extent practicable, onsite disposal of low-level radioactive waste will continue. Hanford and the Nevada Test Site will be made available to all DOE sites for the disposal of low-level radioactive waste. Mixed low-level

radioactive waste analyzed in the *Waste Management PEIS* will be treated at Hanford, INEEL, ORR, and SRS and will be disposed of at Hanford and the Nevada Test Site.

It is also assumed in this NI PEIS that transuranic waste, low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous waste would be treated, stored, and disposed of in accordance with current and developing site practices. No high-level radioactive waste would be associated with irradiating targets in FFTF. No high-level radioactive waste would be associated with target fabricating or processing in FMEF.

Target fabrication and processing in FMEF would generate a total of 385 cubic meters (504 cubic yards) of transuranic waste over the 35-year operational period. This waste would be considered nondefense transuranic waste and, therefore, under current legislation, could not be disposed of at WIPP. Therefore, this waste would be stored on site at the Hanford Central Waste Complex pending availability of a suitable geologic repository for permanent disposal. Because this waste has no current disposition path, DOE Headquarters' approval, as required by DOE Order 435.1, would be necessary before a decision was made to generate this waste. If all the additional transuranic waste generated over the 35-year operational period were stored on site, it would represent 2.3 percent of the 17,000-cubic-meter (22,200-cubic-yard) storage capacity available at Hanford. Assuming that the waste were stored in 208-liter (55-gallon) drums that could be stacked two high, and allowing a 50 percent factor for aisle space, a storage area of only 0.069 hectare (0.17 acre) would be required. Therefore, impacts of managing the additional quantities of transuranic waste at Hanford would be minimal.

No transuranic waste would be associated with the irradiating targets in FFTF.

Solid low-level radioactive waste associated with target irradiation at FFTF and target fabrication and processing in FMEF would be packaged in appropriate containers or burial casks, certified, and transferred for additional treatment and disposal in existing onsite facilities.

An additional 2,200 cubic meters (2,900 cubic yards) of solid low-level radioactive waste would be generated over the 35-year operational period as a result of target irradiation at FFTF as compared to the current standby mode for FFTF. Target fabrication and processing at FMEF would generate about 2,600 cubic meters (3,400 cubic yards) of solid low-level radioactive waste over the 35-year operational period. The total amount of additional solid low-level radioactive waste resulting from operations at FFTF and FMEF represents approximately 0.28 percent of the 1.74-million-cubic-meter (2.28-million-cubic-yard) capacity of the low-level radioactive Burial Grounds. Using the 3,480-cubic-meter-per-hectare (1,842-cubic-yard-per-acre) disposal land usage factor for Hanford published in the *Storage and Disposition PEIS* (DOE 1996a:E-9), 4,800 cubic meters (6,300 cubic yards) of waste would require 1.4 hectares (3.5 acres) of disposal space at Hanford. The impacts of managing this additional low-level radioactive waste at Hanford would be minimal.

Liquid low-level radioactive waste associated with target irradiation at FFTF and target fabrication and processing in FMEF would be transported to the 200 Area Effluent Treatment Facility for processing and ultimate disposal.

There would be no increase in liquid low-level radioactive waste generation as a result of target irradiation at FFTF as compared to the current standby mode for FFTF. Target fabrication and processing at FMEF would generate about 210 cubic meters (270 cubic yards) of liquid low-level radioactive waste over the 35-year operational period. This total amount of additional liquid low-level radioactive waste resulting from operations at FFTF and FMEF represents a small amount of waste that can be managed by the 200 Area Liquid Effluent Treatment Facility, which has an operating capacity of 0.57 cubic meter (0.75 cubic yard) per minute.

Mixed low-level radioactive waste would be stabilized, packaged, and stored on site for treatment and disposal in a manner consistent with the Tri-Party Agreement (EPA et al. 1989) for Hanford. Over the 35-year operational period, no additional mixed low-level radioactive waste would be generated as a result of target irradiation at FFTF as compared to the current standby mode. Mixed low-level radioactive waste generated at FMEF that is associated with target fabrication and processing is estimated over the 35-year operation period to be about 320 cubic meters (420 cubic yards). This mixed low-level radioactive waste is expected to be treated at a nearby commercial facility. However, if this waste were treated on site, it is estimated to be about 0.5 percent of the 1,820-cubic-meter-per-year (2,380-cubic-yard-per-year) capacity of the Waste Receiving and Processing Facility. This additional waste is also estimated to be about 1.9 percent of the 16,800-cubic-meter (22,000-cubic-yard) storage capacity of the Central Waste Complex and about 2.2 percent of the 14,200-cubic-meter (18,600-cubic-yard) planned disposal capacity of the Radioactive Mixed Waste Disposal Facility. Therefore, this additional waste would only have a minimal impact on the management of mixed low-level radioactive waste at Hanford.

Hazardous wastes generated during operation would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities. The additional waste load generated during the 35-year operational period would have only a minimal impact on the Hanford hazardous waste management system.

Nonhazardous solid waste would be packaged and transported in conformance with standard industrial practice. Solid wastes such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent off site for that purpose. The remaining solid sanitary waste would be sent for offsite disposal. This additional waste load would have only a minimal impact on the nonhazardous solid waste management system at Hanford.

Nonhazardous process wastewater would be discharged into the 400 Area Ponds. This discharge is regulated by State Waste Discharge Permit ST-4501.

Nonhazardous sanitary wastewater would be discharged to the 400 Area sanitary sewer system, which connects to the Energy Northwest Sewage Treatment Facility. Nonhazardous sanitary wastewater generated at FFTF from target irradiation and at FMEF from target fabrication and processing would represent 2.4 percent of the 235,000-cubic-meter-per-year (307,000-cubic-yard-per-year) capacity of the Energy Northwest Sewage Treatment Facility.

The generation rates of wastes at Hanford that would be associated with this option (refer to Table 4–45), can be compared with the current waste generation rates at the site, given in Table 3–26 (Section 3.4.11). The waste generation rates associated with this alternative would be much smaller than the current waste generation rates at the site.

4.3.3.1.14 Spent Nuclear Fuel Management

Impacts associated with spent nuclear fuel management would be the same as for Option 1 and are given in Section 4.3.1.1.14.

4.3.4 Alternative 1 (Restart FFTF)—Option 4

Option 4 involves operating FFTF at Hanford to irradiate all targets and materials associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating REDC at ORR to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and operating facilities in RPL/306–E to fabricate and process the other targets and materials and to process the

associated products. This option includes storage in REDC of the neptunium-237 transported from SRS to ORR and storage in RPL/306–E of the other target materials transported from other offsite facilities to Hanford.

The transportation of the highly enriched uranium fuel to Hanford for use in FFTF, the transportation of the neptunium-237 to ORR and then to Hanford, the transportation of the other target material to Hanford, and the transportation of the product materials following irradiation and postirradiation processing are also part of this option.

FFTF would operate with a mixed oxide fuel core for the first 6 years and with a highly enriched uranium fuel core for the next 29 years.

4.3.4.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.3.4.1.1 Land Resources

LAND USE. The restart of FFTF would not result in impacts on land use at Hanford for the reasons described in Section 4.3.1.1.1.

Neptunium-237 target fabrication and processing at REDC would not result in impacts on land use at ORR for the reasons described in Section 4.3.1.1.1.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on land use at Hanford for the reasons described in Section 4.3.1.1.1.

VISUAL RESOURCES. The restart of FFTF would not result in impacts on visual resources at Hanford for the reasons described in Section 4.3.1.1.1.

Impacts on visual resources would not occur at ORR for the reasons described in Section 4.3.1.1.1.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on visual resources at Hanford for the reasons described in Section 4.3.1.1.1.

4.3.4.1.2 Noise

For the restart of FFTF, the change in noise impacts from construction and operation would be expected to be small as described in Section 4.3.1.1.2.

Noise impacts from neptunium-237 target fabrication and processing at the REDC at ORNL would be expected to be small as described in Section 4.3.1.1.2.

Noise impacts from research and development support and medical and industrial isotope target fabrication and processing at RPL/306–E at Hanford would be expected to be small as described in Section 4.3.1.1.2.

4.3.4.1.3 Air Quality

Air quality impacts would be the same as under Option 1 (Section 4.3.1.1.3).

4.3.4.1.4 Water Resources

Impacts on water resources at Hanford associated with the restart of FFTF would be similar to those described in Section 4.3.1.1.4.

REDC in the 7900 Area of ORNL would be used for neptunium-237 storage, target fabrication, and processing in support of plutonium-238 production with impacts on ORR water resources similar to those described in Section 4.3.1.1.4.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and nuclear research and development missions. Impacts on water resources at Hanford from use of RPL/306–E would be similar to those described in Section 4.3.1.1.4.

4.3.4.1.5 Geology and Soils

The restart of FFTF would not be expected to result in impacts on geology and soils at Hanford, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.1.2.5 and 4.3.1.1.5.

Neptunium-237 target fabrication and processing at REDC would not likely result in impacts on geology and soils at ORR, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.2.2.5 and 4.3.1.1.5.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not be expected to result in impacts on geology or soils at Hanford, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.1.2.5 and 4.3.1.1.5. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.3.4.1.6 Ecological Resources

The restart of FFTF would not result in impacts on ecological resources at Hanford for the reasons described in Section 4.3.1.1.6.

Impacts on ecological resources would not occur at ORR for the reasons described in Section 4.3.1.1.6.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on ecological resources at Hanford for the reasons described in Section 4.3.1.1.6.

4.3.4.1.7 Cultural and Paleontological Resources

The restart of FFTF would not result in impacts on cultural resources at Hanford for the reasons described in Section 4.3.1.1.7.

Impacts on cultural resources would not occur at ORR for the reasons described in Section 4.3.1.1.7.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on cultural resources at Hanford for the reasons described in Section 4.3.1.1.7.

4.3.4.1.8 Socioeconomics

Impacts associated with this option would be the same as those addressed in Section 4.3.1.1.8.

4.3.4.1.9 Public and Occupational Health and Safety—Normal Operations

Impacts associated with this option would be the same as those presented in Section 4.3.1.1.9.

4.3.4.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with FFTF target irradiation, REDC neptunium-237 target processing, and RPL medical and industrial isotope processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 mile) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are presented in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–46** and **4–47**, respectively.

FFTF would operate for 6 years with a mixed oxide core followed by 29 years with a highly enriched uranium core. As shown in Table 4–46, the hypothetical core disruptive accident would result in the largest radiological consequences among FFTF accidents. In order to provide a conservative estimate of FFTF accident risks, the accident frequency of 1×10^{-6} was selected for the hypothetical core disruptive accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.07×10^{-8} and 1.42×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00124.

Table 4–46 FFTF, REDC, and RPL Accident Consequences Under Alternative 1 (Restart FFTF)—Option 4

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
FFTF accidents						
Design-basis-accident primary sodium spill (MOX)	0.00113	5.65×10^{-7}	78.6	0.0393	0.00313	1.25×10^{-6}
Design-basis-accident primary sodium spill (HEU)	8.63×10^{-4}	4.32×10^{-7}	72.6	0.0363	0.00181	7.24×10^{-7}
Hypothetical core disruptive accident (MOX)	0.679	3.40×10^{-4}	6.68×10^{4}	33.4	0.679	2.72×10^{-4}
Hypothetical core disruptive accident (HEU)	0.481	2.41×10^{-4}	6.16×10^{4}	30.8	0.375	1.50×10^{-4}
BLTC driver fuel-handling accident (MOX)	0.00383	1.92×10^{-6}	1,280	0.639	0.357	1.43×10^{-4}
BLTC driver fuel-handling accident (HEU)	0.00384	1.92×10^{-6}	1,230	0.617	0.340	1.36×10^{-4}
BLTC neptunium-237 target-handling accident	2.61×10^{-4}	1.31×10^{-7}	25.8	0.0129	0.0279	1.12×10^{-5}
BLTC isotope target-handling accident	1.22×10^{-4}	6.10×10^{-8}	2.74	0.00137	0.0143	5.72×10^{-6}
REDC accidents						
Ion exchange explosion during neptunium-237 target fabrication	6.13×10^{-9}	3.06×10^{-12}	8.58×10^{-5}	4.29×10^{-8}	5.60×10^{-10}	2.24×10^{-13}
Target dissolver tank failure during plutonium-238 separation	1.76×10^{-7}	8.79×10^{-11}	0.00196	9.82×10^{-7}	1.69×10^{-8}	6.74×10^{-12}
Ion exchange explosion during plutonium-238 separation	4.68×10^{-4}	2.34×10^{-7}	5.23	0.00261	4.49×10^{-5}	1.79×10^{-8}
Processing facility beyond-design-basis earthquake	163	0.163	8.91×10^{5}	445	1,310	1.00[c]
RPL accidents						
Medical and industrial isotopes localized solvent fire	0.0135	6.74×10^{-6}	77.8	0.0389	0.0047	1.88×10^{-6}
Medical/industrial isotopes unlikely seismic event	1.52	7.60×10^{-4}	1,350	0.675	1.50	6.00×10^{-4}
Medical and industrial isotopes glovebox explosion	50.0	0.050	4.60×10^{4}	23.0	49.0	0.0392

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–47 FFTF, REDC, and RPL Accident Risks Under Alternative 1 (Restart FFTF)—Option 4

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Hypothetical core disruptive accident (MOX) (1×10^{-6})	3.40×10^{-10}	3.34×10^{-5}	2.72×10^{-10}
Hypothetical core disruptive accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-6})	1.92×10^{-12}	6.39×10^{-7}	1.43×10^{-10}
BLTC driver fuel-handling accident (HEU) (1×10^{-6})	1.92×10^{-12}	6.17×10^{-7}	1.36×10^{-10}
BLTC neptunium-237 target-handling accident (1×10^{-6})	1.31×10^{-13}	1.29×10^{-8}	1.12×10^{-11}
BLTC isotope target-handling accident (1×10^{-6})	6.10×10^{-14}	1.37×10^{-9}	5.72×10^{-12}
35-year FFTF risk	1.07×10^{-8}	0.00124	1.42×10^{-8}
Annual REDC risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	3.06×10^{-14}	4.29×10^{-10}	2.24×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	8.79×10^{-13}	9.82×10^{-9}	6.74×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	2.34×10^{-9}	2.61×10^{-5}	1.79×10^{-10}
Plutonium-238 processing facility beyond-design-basis earthquake (1×10^{-5})	1.63×10^{-6}	0.00445	1.00×10^{-5}[c]
35-year REDC risk	5.71×10^{-5}	0.157	3.50×10^{-4}
Annual RPL risks			
Medical and industrial isotopes localized solvent fire (0.044)	2.99×10^{-7}	0.00173	8.35×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	7.60×10^{-6}	0.00675	6.00×10^{-6}
Medical and industrial isotopes glovebox explosion (1×10^{-4})	5.00×10^{-6}	0.00230	3.92×10^{-6}
35-year RPL risk	4.51×10^{-4}	0.377	3.50×10^{-4}
35-year Option risk	4.51×10^{-4}	0.535	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years of REDC neptunium-237 target processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 5.71×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.157.

For 35 years of RPL medical, industrial, and research and development target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 4.51×10^{-4} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.377.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 4.51×10^{-4} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.535.

The consequences associated with chemical accidents would be the same as for Option 1 (Section 4.3.1.1.10).

4.3.4.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the REDC target fabrication facility at ORR. DOE would transport the unirradiated neptunium-237 targets from REDC to FFTF. Following irradiation in FFTF, the targets would be returned to REDC for processing. After this processing, the plutonium-238 product would be shipped to LANL. FFTF would receive highly enriched uranium fuel from a U.S. fuel fabrication facility. Additionally, medical and industrial isotopes would be shipped from FFTF to a local airport, and from there to locations throughout the country.

Approximately 38,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 8.0 million kilometers (5.0 million miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

The transportation impact analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 31 person-rem; the dose to the public, 303 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.012 latent cancer fatality among transportation workers and 0.15 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.030. About half of the crew risk, about 2 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to REDC with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting in 0.19 traffic fatality. Nearly all of the radiological and traffic accident risk would result from shipping medical and industrial isotopes.

4.3.4.1.12 Environmental Justice

NORMAL OPERATIONS. Environmental effects that would result from the implementation of Option 4 are nearly identical to those that would result from the implementation of Option 1 (Section 4.3.1.1.12). No disproportionately high and adverse radiological or nonradiological risks to minority or low-income populations would be expected to result from the implementation of Option 4.

4.3.4.1.13 Waste Management

The impacts of managing wastes associated with irradiating targets in FFTF, with processing and fabricating target materials for research and development support and medical and industrial isotope production in RPL/306–E, and with fabricating and processing neptunium-237 targets for plutonium-238 production in REDC at ORR are all assumed to be the same as for Option 1 (Section 4.3.1.1.13). This is because the waste generation would not be affected by the type of fuel used (i.e., mixed oxide or highly enriched uranium), and the same amount of plutonium-238 production, medical and industrial isotope production, and nuclear research and development support would be accomplished annually. As discussed in that section, the impacts on Hanford and ORR's waste management systems would be minimal.

4.3.4.1.14 Spent Nuclear Fuel Management

Impacts associated with spent nuclear fuel management would be the same as for Option 1 and are given in Section 4.3.1.1.14.

4.3.5 Alternative 1 (Restart FFTF)—Option 5

Option 5 involves operating FFTF at Hanford to irradiate all targets and materials associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating FDPF at INEEL to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and RPL/306–E in the Hanford 300 Area to fabricate and process the other targets and materials and to process the associated products. This option includes storage in Building CPP–651 or FDPF of the neptunium-237 transported to INEEL from SRS and storage in RPL/306–E of the other target materials transported to Hanford from other offsite facilities.

The transportation of the highly enriched uranium to Hanford for use in FFTF, the transportation of the neptunium-237 to INEEL and then to Hanford, the transportation of the other target material to Hanford, and the transportation of the product materials following irradiation and postirradiation processing are also part of this option.

FFTF would operate with a mixed oxide fuel core for the first 6 years and with a highly enriched uranium fuel core for the next 29 years.

4.3.5.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.3.5.1.1 Land Resources

LAND USE. The restart of FFTF would not result in impacts on land use at Hanford for the reasons described in Section 4.3.1.1.1.

Neptunium-237 storage in Building CPP–651 or FDPF and target fabrication and processing in FDPF would not result in impacts on land use at INEEL for the reasons described in Section 4.3.2.1.1.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on land use at Hanford for the reasons described in Section 4.3.1.1.1.

VISUAL RESOURCES. The restart of FFTF would not result in impacts on visual resources at Hanford for the reasons described in Section 4.3.1.1.1.

Impacts on visual resources would not occur at INEEL for the reasons described in Section 4.3.2.1.1.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on visual resources at Hanford for the reasons described in Section 4.3.1.1.1.

4.3.5.1.2 Noise

For the restart of FFTF, the change in noise impacts from construction and operation would be expected to be small as described in Section 4.3.1.1.2.

Noise impacts from neptunium-237 target fabrication and processing at Building CPP–651 and/or FDPF at INEEL would be expected to be small as described in Section 4.3.2.1.2.

Noise impacts from research and development support and medical and industrial isotope target fabrication and processing at RPL/306–E at Hanford would be expected to be small as described in Section 4.3.1.1.2.

4.3.5.1.3 Air Quality

Air quality impacts would be the same as under Option 2 (Section 4.3.2.1.3).

4.3.5.1.4 Water Resources

Impacts on water resources at Hanford associated with the restart of FFTF would be similar to those described in Section 4.3.1.1.4.

Building CPP–651 and/or FDPF in the INTEC area of INEEL would be used for neptunium-237 storage, with target fabrication and processing in support of plutonium-238 production in FDPF. Impacts on water resources at INEEL would be substantially the same as those described in Section 4.3.2.1.4.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and nuclear research and development missions. Impacts on water resources at Hanford would be very similar to those described in Section 4.3.1.1.4.

4.3.5.1.5 Geology and Soils

The restart of FFTF would not be expected to result in impacts on geology and soils at Hanford, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.1.2.5 and 4.3.1.1.5.

Neptunium-237 storage at Building CPP–651 and/or FDPF and target fabrication, and processing in FDPF would not likely result in impacts on geology and soils at INEEL, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.3.2.5 and 4.3.2.1.5.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not be expected to result in impacts on geology or soils at Hanford, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.1.2.5 and 4.3.1.1.5. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.3.5.1.6 Ecological Resources

The restart of FFTF would not result in impacts on ecological resources at Hanford for the reasons described in Section 4.3.1.1.6.

Impacts on ecological resources would not occur at INEEL for the reasons described in Section 4.3.2.1.6.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on ecological resources at Hanford for the reasons described in Section 4.3.1.1.6.

4.3.5.1.7 Cultural and Paleontological Resources

The restart of FFTF would not result in impacts on cultural resources at Hanford for the reasons described in Section 4.3.1.1.7.

Impacts on cultural resources would not occur at INEEL for the reasons described in Section 4.3.2.1.7.

Using RPL/306–E for research and development support and medical and industrial isotope target fabrication and processing would not result in impacts on cultural resources at Hanford for the reasons described in Section 4.3.1.1.7.

4.3.5.1.8 Socioeconomics

Impacts associated with this option would be the same as those addressed in Section 4.3.2.1.8.

4.3.5.1.9 Public and Occupational Health and Safety—Normal Operations

Impacts associated with this option would be the same as those presented in Section 4.3.2.1.9.

4.3.5.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with FFTF target irradiation, FDPF neptunium-237 target processing, and RPL medical and industrial target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 miles) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the

product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are presented in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–48** and **4–49**, respectively.

FFTF would operate for 6 years with a mixed oxide core followed by 29 years with a highly enriched uranium core. As shown in Table 4–48, the hypothetical core disruptive accident would result in the largest radiological consequences among FFTF accidents. In order to provide a conservative estimate of FFTF accident risks, the accident frequency of 1×10^{-6} was selected for the hypothetical core disruptive accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.07×10^{-8} and 1.42×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00124.

For 35 years of FDPF neptunium-237 target processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 1.49×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0287.

For 35 years of RPL medical, industrial, and research and development target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 4.51×10^{-4} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.377.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 4.51×10^{-4} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.407.

The consequences associated with chemical accidents would be the same as for Option 2 (Section 4.3.2.1.10).

Table 4–48 FFTF, FDPF, and RPL Accident Consequences Under Alternative 1 (Restart FFTF)—Option 5

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
FFTF accidents						
Design-basis-accident primary sodium spill (MOX)	0.00113	5.65×10^{-7}	78.6	0.0393	0.00313	1.25×10^{-6}
Design-basis-accident primary sodium spill (HEU)	8.63×10^{-4}	4.32×10^{-7}	72.6	0.0363	0.00181	7.24×10^{-7}
Hypothetical core disruptive accident (MOX)	0.679	3.40×10^{-4}	6.68×10^{4}	33.4	0.679	2.72×10^{-4}
Hypothetical core disruptive accident (HEU)	0.481	2.41×10^{-4}	6.16×10^{4}	30.8	0.375	1.50×10^{-4}
BLTC driver fuel-handling accident (MOX)	0.00383	1.92×10^{-6}	1,280	0.639	0.357	1.43×10^{-4}
BLTC driver fuel-handling accident (HEU)	0.00384	1.92×10^{-6}	1,230	0.617	0.340	1.36×10^{-4}
BLTC neptunium-237 target-handling accident	2.61×10^{-4}	1.31×10^{-7}	25.8	0.0129	0.0279	1.12×10^{-5}
BLTC isotope target-handling accident	1.22×10^{-4}	6.10×10^{-8}	2.74	0.00137	0.0143	5.72×10^{-6}
FDPF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.01×10^{-9}	1.01×10^{-12}	2.49×10^{-5}	1.24×10^{-8}	7.26×10^{-9}	2.91×10^{-12}
Target dissolver tank failure during plutonium-238 separation	6.11×10^{-8}	3.05×10^{-11}	5.65×10^{-4}	2.82×10^{-7}	2.17×10^{-7}	8.69×10^{-11}
Ion exchange explosion during plutonium-238 separation	1.63×10^{-5}	8.13×10^{-9}	0.150	7.51×10^{-5}	5.79×10^{-5}	2.31×10^{-8}
Processing facility beyond-design-basis earthquake	42.5	0.0425	1.64×10^{5}	82.0	1,200	1.0[c]
RPL accidents						
Medical and industrial isotopes localized solvent fire	0.0135	6.74×10^{-6}	77.8	0.0389	0.0047	1.88×10^{-6}
Medical and industrial isotopes unlikely seismic event	1.52	7.60×10^{-4}	1,350	0.675	1.50	6.00×10^{-4}
Medical and industrial isotopes glovebox explosion	50.0	0.050	4.60×10^{4}	23.0	49.0	0.0392

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–49 FFTF, FDPF, and RPL Accident Risks Under Alternative 1 (Restart FFTF)—Option 5

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Hypothetical core disruptive accident (MOX) (1×10^{-6})	3.40×10^{-10}	$3,34\times10^{-5}$	2.72×10^{-10}
Hypothetical core disruptive accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-6})	1.92×10^{-12}	6.39×10^{-7}	1.43×10^{-10}
BLTC driver fuel-handling accident (HEU) (1×10^{-6})	1.92×10^{-12}	6.17×10^{-7}	1.36×10^{-10}
BLTC neptunium-237 target-handling accident (1×10^{-6})	1.31×10^{-13}	1.29×10^{-8}	1.12×10^{-11}
BLTC isotope target-handling accident (1×10^{-6})	6.10×10^{-14}	1.37×10^{-9}	5.72×10^{-12}
35-year FFTF risk	1.07×10^{-8}	0.00124	1.42×10^{-8}
Annual FDPF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	1.24×10^{-10}	2.91×10^{-14}
Target dissolver tank failure during plutonium-238 separation (0.01)	3.05×10^{-13}	2.82×10^{-9}	8.69×10^{-13}
Ion exchange explosion during plutonium-238 separation (0.01)	8.13×10^{-11}	7.51×10^{-7}	2.31×10^{-10}
Plutonium-238 processing facility beyond-design-basis earthquake (1×10^{-5})	4.25×10^{-7}	8.20×10^{-4}	1.00×10^{-5}[c]
35-year FDPF risk	1.49×10^{-5}	0.0287	3.50×10^{-4}
Annual RPL risks			
Medical and industrial isotopes localized solvent fire (0.044)	2.99×10^{-7}	0.00173	8.35×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	7.60×10^{-6}	0.00675	6.00×10^{-6}
Medical and industrial isotopes glovebox explosion (1×10^{-6})	5.00×10^{-6}	0.00230	3.92×10^{-6}
35-year RPL risk	4.51×10^{-4}	0.377	3.50×10^{-4}
35-year Option risk	4.51×10^{-4}	0.407	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

4.3.5.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the FDPF target fabrication facility at INEEL. DOE would transport the unirradiated neptunium-237 targets from FDPF to FFTF. Following irradiation in

FFTF, the targets would be returned to FDPF for processing. After this processing, the plutonium-238 product would be shipped to LANL. FFTF would receive highly enriched uranium fuel from a U.S. fuel fabrication facility. Additionally, medical and industrial isotopes would be shipped from FFTF to a local airport, and from there to locations throughout the country.

Approximately 38,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 6.4 million kilometers (4.0 million miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

The transportation impact analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 23 person-rem; the dose to the public, 112 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.009 latent cancer fatality among transportation workers and 0.056 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.025. About half of the crew risk, about 7 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FDPF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting in 0.13 traffic fatality. Nearly all of the radiological and traffic accident risk would result from shipping medical and industrial isotopes.

4.3.5.1.12 Environmental Justice

NORMAL OPERATIONS. Environmental effects that would result from the implementation of Option 5 are nearly identical to those that would result from the implementation of Option 2 (Section 4.3.2.1.12). No disproportionately high and adverse radiological or nonradiological risks to minority or low-income populations would be expected to result from the implementation of Option 5.

4.3.5.1.13 Waste Management

The impacts of managing wastes associated with irradiating targets in FFTF, with processing and fabricating target materials for the research and development support and medical and industrial isotope production in RPL/306–E, and with fabricating and processing neptunium-237 targets for plutonium-238 production in FDPF, are all assumed to be the same as for Option 2 (Section 4.3.2.1.13). This is because the waste generation would not be affected by the type of fuel used (i.e., mixed oxide or highly enriched uranium) and the same amount of plutonium-238 production, medical and industrial isotope production, and nuclear research

and development support would be accomplished annually. As discussed in that section, the impacts on Hanford's and INEEL's waste management systems would be minimal.

4.3.5.1.14 Spent Nuclear Fuel Management

Impacts associated with spent nuclear fuel management would be the same as for Option 1 and are given in Section 4.3.1.1.14.

4.3.6 Alternative 1 (Restart FFTF)—Option 6

Option 6 involves operating FFTF at Hanford to irradiate all targets and materials associated with plutonium-238 production, medical and industrial isotope production, and research and development, and also operating FMEF at Hanford to fabricate and process these targets and materials and the associated irradiated products. This option includes storage in FMEF of the neptunium-237 transported to Hanford from SRS and of the other target materials transported to Hanford from other offsite facilities.

The transportation of the highly enriched uranium fuel to Hanford for use in FFTF, the transportation of the neptunium-237 and other target material to Hanford, and the transportation of the product materials following postirradiation processing are also part of this option.

FFTF would operate with a mixed oxide fuel core for the first 6 years and with a highly enriched uranium fuel core for the next 29 years.

4.3.6.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.3.6.1.1 Land Resources

LAND USE. The restart of FFTF would not result in impacts on land use at Hanford for the reasons described in Section 4.3.3.1.1.

Impacts on land use at Hanford from target material storage, target fabrication, and processing at FMEF would be minimal for the reasons described in Section 4.3.3.1.1.

VISUAL RESOURCES. The restart of FFTF would not result in impacts on visual resources at Hanford for the reasons described in Section 4.3.3.1.1.

Impacts on visual resources at Hanford from target material storage, target fabrication, and processing at FMEF would be minimal for the reasons described in Section 4.3.3.1.1.

4.3.6.1.2 Noise

For the restart of FFTF, the change in noise impacts from construction and operation would be expected to be small as described in Section 4.3.1.1.2.

Noise impacts from target material storage, target fabrication, and processing at the FMEF would be expected to be small as described in Section 4.3.3.1.2.

4.3.6.1.3 Air Quality

Air quality impacts would be the same as under Option 3 (Section 4.3.3.1.3).

4.3.6.1.4 Water Resources

Impacts on water resources at Hanford associated with the restart of FFTF and the operation of FMEF for target material storage, target fabrication, and processing would be similar to those described in Section 4.3.3.1.4.

4.3.6.1.5 Geology and Soils

The restart of FFTF would not be expected to result in impacts on geologic and soil resources at Hanford, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.1.2.5 and 4.3.1.1.5.

Impacts on geologic resources and soils at Hanford from the operation of FMEF for target material storage, target fabrication, and processing would not be expected for the reasons described in Section 4.3.3.1.5. Likewise, large-scale geologic conditions would not be expected to jeopardize FMEF. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.3.6.1.6 Ecological Resources

The restart of FFTF would not result in impacts on ecological resources at Hanford for the reasons described in Section 4.3.1.1.6.

Impacts on ecological resources at Hanford from target material storage, target fabrication, and processing at FMEF would not be expected for the reasons described in Section 4.3.3.1.6.

4.3.6.1.7 Cultural and Paleontological Resources

The restart of FFTF would not be expected to result in impacts on cultural resources at Hanford for the reasons described in Section 4.3.1.1.7.

Impacts on cultural resources at Hanford from target material storage, target fabrication, and processing at FMEF would not be expected for the reasons described in Section 4.3.3.1.7.

4.3.6.1.8 Socioeconomics

Impacts associated with this option would be the same as those presented in Section 4.3.3.1.8.

4.3.6.1.9 Public and Occupational Health and Safety—Normal Operations

Impacts associated with this option would be the same as those presented in Section 4.3.3.1.9.

4.3.6.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with FFTF target irradiation and FMEF target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 miles) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are presented in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–50** and **4–51**, respectively.

FFTF would operate for 6 years with a mixed oxide core followed by 29 years with a highly enriched uranium core. As shown in Table 4–50, the hypothetical core disruptive accident would result in the largest radiological consequences among FFTF accidents. In order to provide a conservative estimate of FFTF accident risks, the accident frequency of 1×10^{-6} was selected for the hypothetical core disruptive accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.07×10^{-8} and 1.42×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00124.

For 35 years of FMEF target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 6.79×10^{-6} and 4.17×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.208.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 6.80×10^{-6} and 4.17×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.209.

The consequences associated with chemical accidents would be the same as for Option 3 (Section 4.3.3.1.10).

4.3.6.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the FMEF target fabrication facility at Hanford. DOE would transport the unirradiated neptunium-237 targets from FMEF to FFTF. Following irradiation in FFTF, the targets would be returned to FMEF for processing. After this processing, the plutonium-238 product would be shipped to LANL. FFTF would receive highly enriched uranium fuel from a U.S. fuel

Table 4–50 FFTF and FMEF Accident Consequences Under Alternative 1 (Restart FFTF)—Option 6

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
FFTF accidents						
Design-basis-accident primary sodium spill (MOX)	0.00113	5.65×10^{-7}	78.6	0.0393	0.00313	1.25×10^{-6}
Design-basis-accident primary sodium spill (HEU)	8.63×10^{-4}	4.32×10^{-7}	72.6	0.0363	0.00181	7.24×10^{-7}
Hypothetical core disruptive accident (MOX)	0.679	3.40×10^{-4}	6.68×10^{4}	33.4	0.679	2.72×10^{-4}
Hypothetical core disruptive accident (HEU)	0.481	2.41×10^{-4}	6.16×10^{4}	30.8	0.375	1.50×10^{-4}
BLTC driver fuel-handling accident (MOX)	0.00383	1.92×10^{-6}	1,280	0.639	0.357	1.43×10^{-4}
BLTC driver fuel-handling accident (HEU)	0.00384	1.92×10^{-6}	1,230	0.617	0.340	1.36×10^{-4}
BLTC neptunium-237 target-handling accident	2.61×10^{-4}	1.31×10^{-7}	25.8	0.0129	0.0279	1.12×10^{-5}
BLTC isotope target-handling accident	1.22×10^{-4}	6.10×10^{-8}	2.74	0.00137	0.0143	5.72×10^{-6}
FMEF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.02×10^{-9}	1.01×10^{-12}	7.26×10^{-5}	3.63×10^{-8}	6.65×10^{-10}	2.66×10^{-13}
Target dissolver tank failure during plutonium-238 separation	4.64×10^{-8}	2.32×10^{-11}	0.00169	8.47×10^{-7}	1.95×10^{-8}	7.81×10^{-12}
Ion exchange explosion during plutonium-238 separation	1.24×10^{-5}	6.18×10^{-9}	0.451	2.25×10^{-4}	5.20×10^{-6}	2.08×10^{-9}
Medical and industrial isotopes localized solvent fire	0.00276	1.38×10^{-6}	56.2	0.0281	9.51×10^{-5}	3.80×10^{-8}
Medical and industrial isotopes glovebox explosion	1.00	5.00×10^{-4}	2.95×10^{4}	14.8	24.0	0.0192
Processing facility beyond-design-basis earthquake	16.5	0.00825	6.42×10^{5}	321	922	1.00[c]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Key: BLTC, bottom-loading transfer casks; HEU, highly enriched uranium core; MOX, mixed oxide core.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–51 FFTF and FMEF Accident Risks Under Alternative 1 (Restart FFTF)—Option 6

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Hypothetical core disruptive accident (MOX) (1×10^{-6})	3.40×10^{-10}	3.34×10^{-5}	2.72×10^{-10}
Hypothetical core disruptive accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-6})	1.92×10^{-12}	6.39×10^{-7}	1.43×10^{-10}
BLTC driver fuel-handling accident (HEU) (1×10^{-6})	1.92×10^{-12}	6.17×10^{-7}	1.36×10^{-10}
BLTC neptunium-237 target-handling accident (1×10^{-6})	1.31×10^{-13}	1.29×10^{-8}	1.12×10^{-11}
BLTC isotope target-handling accident (1×10^{-6})	6.10×10^{-14}	1.37×10^{-9}	5.72×10^{-12}
35-year FFTF risk	1.07×10^{-8}	0.00124	1.42×10^{-8}
Annual FMEF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	3.63×10^{-10}	2.66×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	2.32×10^{-13}	8.47×10^{-9}	7.81×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	6.18×10^{-11}	2.25×10^{-6}	2.08×10^{-11}
Medical and industrial isotopes localized solvent fire (0.044)	6.13×10^{-8}	1.25×10^{-3}	1.69×10^{-9}
Medical and industrial isotopes glovebox explosion (1×10^{-4})	5.00×10^{-8}	0.00148	1.92×10^{-6}
Processing facility beyond-design-basis earthquake (1×10^{-5})	8.25×10^{-8}	0.00321	1.00×10^{-5}[c]
35-year FMEF risk	6.79×10^{-6}	0.208	4.17×10^{-4}
35-year Option risks	6.80×10^{-6}	0.209	4.17×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

fabrication facility. Additionally, medical and industrial isotopes would be shipped from FFTF to a local airport, and from there to locations throughout the country.

Approximately 38,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 5.8 million kilometers (3.6 million miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

The transportation impact analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 21 person-rem; the dose to the public, 47 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0082 latent cancer fatality among transportation workers and 0.023 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.024. About half of the crew risk, about 16 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) would not breach the transportation package. The probability of severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 was evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting in 0.12 traffic fatality. Nearly all of the radiological and traffic accident risk would result from shipping medical and industrial isotopes.

4.3.6.1.12 Environmental Justice

NORMAL OPERATIONS. Environmental effects that would result from the implementation of Option 6 are nearly identical to those that would result from the implementation of Option 3 (Section 4.3.3.1.12). No disproportionately high and adverse radiological or nonradiological risks to minority or low-income populations would be expected to result from the implementation of Option 6.

4.3.6.1.13 Waste Management

Impacts of managing wastes associated with irradiating targets in FFTF, and with processing and fabricating target materials for the research and development support and medical and industrial isotope production and plutonium-238 production in FMEF, are assumed to be the same as for Option 3 (Section 4.3.3.1.13). This is because the waste generation would not be affected by the type of fuel used (i.e., mixed oxide or highly enriched uranium) and the same amount of plutonium-238 production, medical and industrial isotope production and nuclear research and development support would be accomplished annually. As discussed in that section, the impacts on Hanford's waste management systems would be small.

4.3.6.1.14 Spent Nuclear Fuel Management

Impacts associated with spent nuclear fuel management would be the same as for Option 1 and are given in Section 4.3.1.1.14.

4.4 ALTERNATIVE 2—USE ONLY EXISTING OPERATIONAL FACILITIES

Under Alternative 2, DOE would use existing operating DOE reactors or U.S. commercial nuclear power plants to produce plutonium-238 for future space missions. The production of medical and industrial isotopes and support of nuclear research and development in DOE reactors and accelerators would continue at the No Action Alternative levels. However, the currently operating DOE reactors, HFIR and ATR, cannot fully meet the projected long-term needs for medical isotope production and nuclear research and development with or without adding the plutonium-238 production mission.

Depending on the combination of facilities used in Alternative 2, HFIR and ATR could continue their current support of the medical and industrial isotope and research and development missions, including some near-term growth, while accommodating the production of plutonium-238. Under other scenarios, some of the near-term growth in medical and industrial isotope production and nuclear research and development, possible in these reactors, could be limited by the addition of the plutonium-238 production. In any case, non-DOE use of these facilities would be affected by the addition of the plutonium-238 mission. If a commercial reactor were used for plutonium-238 production, the DOE facilities would be unaffected and would continue operating as discussed under the No Action Alternative.

Another component of Alternative 2 is permanent deactivation of FFTF. Permanent deactivation of FFTF (Alternative 5) could occur in conjunction with any of the options under Alternatives 2, 3, or 4. Ongoing operations at existing facilities as described in Chapter 3, Affected Environment, would continue under Alternative 2.

Targets for plutonium-238 production would be fabricated in one of three facilities at ORNL, INEEL, or Hanford. The material needed for target fabrication (neptunium-237) would be processed and transported from SRS to the fabrication facilities. The targets would be irradiated at existing reactor facilities (HFIR, ATR, CLWR, as described in Section 2.3.1) and would be transported back to the fabricating facilities for postirradiation processing.

Under Alternative 2, nonirradiated targets, irradiated targets, and processed materials would be transported between the locations selected for storage, target fabrication, target irradiation, and postirradiation processing, as well as transportation of the plutonium-238 product to LANL.

Nine options are proposed under this alternative. Options 1 through 3 involve the irradiation of targets in ATR at INEEL. Options 4 through 6 involve the irradiation of targets in a generic CLWR. Options 7 through 9 involve the irradiation of targets in both INEEL's ATR and ORNL's HFIR. These options and the associated target fabrication, postirradiation processing, and transportation activities are discussed below.

- **Option 1.** REDC at ORNL would be used to store the neptunium-237 transported from SRS to ORNL and to fabricate and process the targets irradiated at ATR. Option 1 also involves transportation of the neptunium-237 targets from ORNL to INEEL for irradiation in ATR, transportation of the irradiated targets from INEEL back to ORNL for postirradiation processing, and subsequent transportation of the plutonium-238 product from ORNL to LANL following postirradiation processing.

- **Option 2.** FDPF at INEEL would be used to store the neptunium transported from SRS to INEEL and to fabricate and process the targets (irradiated at ATR). Building CPP–651 would also be used for storage. Option 2 also involves transportation of the plutonium-238 product from INEEL to LANL following postirradiation processing.

- **Option 3.** FMEF at Hanford would be used to fabricate and process the targets (irradiated at ATR) and to store the neptunium-237 transported from SRS to Hanford. Option 3 also involves transportation of the neptunium-237 to Hanford for target fabrication, transportation of the targets from Hanford to INEEL for irradiation, transportation of the irradiated targets back to Hanford for postirradiation processing in FMEF, and subsequent transportation of the plutonium-238 product from Hanford to LANL.

- **Option 4.** REDC at ORNL would be used to store the neptunium-237 transported from SRS to ORNL and to fabricate and process the targets (irradiated at a generic CLWR). Option 4 also involves transportation of the neptunium-237 targets from ORNL to the generic CLWR location for irradiation, transportation of the irradiated targets back to ORNL for postirradiation processing, and transportation of the plutonium-238 product from ORNL to LANL.

- **Option 5.** FDPF at INEEL would be used to store the neptunium transported from SRS to INEEL and to fabricate and process the targets (irradiated at a generic CLWR). Building CPP–651 would also be used for storage. In addition, Option 5 involves transportation of the neptunium-237 targets from INEEL to the generic CLWR location for irradiation, transportation of the irradiated targets back to INEEL for postirradiation processing, and transportation of the plutonium-238 product from INEEL to LANL.

- **Option 6.** FMEF at Hanford would be used to store the neptunium-237 transported from SRS to Hanford and to fabricate and process the targets (irradiated at a generic CLWR). Option 6 also involves transportation of neptunium-237 to Hanford for target fabrication, transportation of the targets from Hanford to the generic CLWR location for irradiation, transportation of the irradiated targets back to Hanford for postirradiation processing, and transportation of the plutonium-238 product from Hanford to LANL.

- **Option 7.** REDC at ORNL would be used to store the neptunium-237 transported from SRS to ORNL and to fabricate and process the targets (irradiated at ATR and HFIR). Option 7 also involves transportation of the neptunium-237 targets from ORNL to the reactors for irradiation, transportation of the irradiated targets back to ORNL for processing, and transportation of the plutonium-238 product from ORNL to LANL.

- **Option 8.** FDPF at INEEL would be used to store the neptunium transported from SRS to INEEL and to fabricate and process the targets (irradiated at ATR and HFIR). Building CPP–651 would also be used for storage. Option 8 also involves transportation of the neptunium-237 targets from INEEL to the reactors for irradiation, transportation of the irradiated targets back to INEEL for postirradiation processing, and transportation of the plutonium-238 product from INEEL to LANL.

- **Option 9.** FMEF at Hanford would be used to store the neptunium-237 transported from SRS to Hanford and to fabricate and process the targets (irradiated at ATR and HFIR). Option 9 also involves transportation of neptunium-237 to Hanford for target fabrication, transportation of the targets from Hanford to the reactors for irradiation, transportation of the irradiated targets back to Hanford for postirradiation processing, and transportation of the plutonium-238 product from Hanford to LANL.

The baseline operational impacts at ORR, INEEL, and Hanford are presented in Table 4–1. The baseline impacts associated with operations of the generic CLWR are presented in **Table 4–52**.

The incremental environmental impacts presented in this section for each option under Alternative 2 can be added to the baseline to provide total site impacts.

Table 4–52 Baseline Environmental Impacts at Generic CLWR Site[a]

Parameter	CLWR Site Value
Air quality	
Concentration (micrograms per cubic meter)	
• Carbon monoxide	
8-hour averaging period	1,250
1-hour averaging period	1,250
• Nitrogen dioxide	
Annual averaging period	26.3
• PM_{10}	
Annual averaging period	20.3
24-hour averaging period	39
• Sulfur dioxide	
Annual averaging period	10.5
24-hour averaging period	65.5
3-hour averaging period	204
Radiation impacts (35 years)	
Latent cancer fatalities	
Maximally exposed individual (risk)	5.1×10^{-6}
Population within 80 kilometers (50 miles)	0.0089
Site workforce	1.6
Waste generation (cubic meters over 35 years)	
Transuranic	0
Low-level radioactive	1,400
Mixed low-level radioactive	<35
Hazardous	36
Nonhazardous	86,000
Site employment	1,073
Water usage (million liters over 35 years)	5.1×10^{6}

a. Impacts are associated with a representative site on which an operating CLWR is located.
Note: To convert from cubic meters to cubic yards, multiply by 1.308; to convert from liters to gallons, multiply by 0.264.
Source: DOE 1999b.

4.4.1 Alternative 2 (Use Only Existing Operational Facilities)—Option 1

Option 1 involves operating the Advanced Test Reactor (ATR) at INEEL to irradiate neptunium-237 targets to produce plutonium-238, and operating the REDC facility at ORR to both fabricate and process these targets and to store the neptunium-237 transported to ORR from SRS.

The transportation of the neptunium-237 from SRS to ORR for processing and fabrication into neptunium-237 targets in REDC, the transportation of these targets from ORR to INEEL for irradiation in ATR, the transportation of the irradiated targets from INEEL back to ORR for postirradiation processing in REDC, and the transportation of the plutonium-238 product from ORR to LANL also constitute part of this option.

All options under this alternative include the permanent deactivation of FFTF at Hanford.

4.4.1.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.4.1.1.1 Land Resources

LAND USE. ATR is an operating facility in the Test Reactor Area at INEEL; use of the facility for neptunium-237 target irradiation would be compatible with its current mission. Further, because it is an existing facility, no new construction would be required, and thus, there would be no change in land use in the Test Reactor Area or INEEL.

REDC would be used for neptunium-237 storage, target fabrication, and processing. REDC is an existing operating facility in the 7900 Area of ORNL, and the use of this facility would require internal modifications, but no new facilities would be built. Because no additional land would be disturbed and the use of REDC for neptunium-237 target fabrication and processing would be compatible with its present mission, there would be no change in land use at ORR.

VISUAL RESOURCES. The irradiation of neptunium-237 targets would take place in the existing ATR at INEEL. The use of ATR would not require any external modifications that would alter the appearance of the facility. Therefore, the current Visual Resource Management Class IV rating for the Test Reactor Area would not change. Because there would be no change in the appearance of ATR or the Test Reactor Area, there would be no additional impact on visual resources.

All activities associated with neptunium-237 storage, target fabrication, and processing would take place in REDC at ORR. Because REDC is an existing facility that would require no external modifications, there would be no change in its appearance. Therefore, the current Visual Resource Management Class IV rating for the 7900 Area would not change, and there would be no impact on visual resources.

4.4.1.1.2 Noise

Noise associated with neptunium-237 target irradiation in ATR would be similar to sound levels generated by current reactor operations, as well as other operations in the Test Reactor Area. Onsite noise impacts would be expected to be minimal, and changes in offsite noise levels would not be noticeable because the nearest site boundary is 11 kilometers (6.8 miles) to the northwest. Noise levels associated with increased traffic going to and from the facility would be low, and would result in only minor changes to existing onsite and offsite noise levels. Neptunium-237 target irradiation in ATR would not produce any sudden loud noises that would adversely affect wildlife.

Noise associated with neptunium-237 storage, target fabrication, and processing would be similar to sound levels generated by present REDC operations, as well as other operations in the 7900 Area. Onsite noise impacts would be expected to be minimal, and changes in offsite noise levels would not be noticeable because the nearest site boundary is 2.5 kilometers (1.6 miles) to the southeast. Changes in traffic volume going to and from REDC would be minor, and would not lead to noticeable changes in noise levels either on site or off site. There would be no loud noises associated with target fabrication and processing that would adversely impact wildlife.

4.4.1.1.3 Air Quality

It is estimated that there would be no measurable increases in nonradiological air pollutant emissions at INEEL associated with this option (Moor and Peterson 1999). The baseline air quality at INEEL would be unchanged.

The air pollutant concentrations at ORR attributable to REDC are presented in **Table 4–53**. The concentrations are based on a dispersion-modeling screening analysis conducted with maximum expected emission rates and a set of worst-case meteorological conditions. Only those air pollutants expected to be

emitted that have ambient air quality standards are presented in the table. The changes in concentrations were determined to be small and would be below the applicable standard even when ambient monitored values and the contribution from other site activities were included. There are no Prevention of Significant Deterioration increment-consuming sources at ORR; therefore, a Prevention of Significant Deterioration increment consumption analysis was not conducted. Health effects from hazardous chemicals associated with this option are addressed in Section 4.4.1.1.9.

The air quality impacts of transportation among SRS, INEEL, ORR, and LANL are presented in Section 4.4.1.1.11.

Table 4–53 Incremental ORR Concentrations[a] Associated with Alternative 2 (Use Only Existing Operational Facilities)—Option 1

Pollutant	Averaging Time	Most Stringent Standard or Guideline (micrograms per cubic meter)	Modeled Increment (micrograms per cubic meter)
Nitrogen dioxide	Annual	100	1.99×10^{-4}
Sulfur dioxide	Annual	80	0.04
	24 hours	365	0.31
	3 hours	1,300	0.70

a. For comparison with ambient air quality standards.
Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995).

4.4.1.1.4 Water Resources

The production of plutonium-238 would not measurably increase groundwater usage from the Snake River Plain aquifer or measurably affect the quantity or quality of effluents discharged from ATR (Moor and Peterson 1999:6). Information on current water usage, effluent discharge, and water quality for INEEL is presented in Section 3.3.4.

REDC in the 7900 Area of ORNL would be used for neptunium-237 storage, target fabrication, and processing in support of plutonium-238 production with impacts on ORR water resources similar to those described in Section 4.3.1.1.4. In summary, little or no change in water use would be anticipated, and any change in the quantity or quality of wastewater discharges would be small. Also, there would be no radiological liquid effluent discharge to the environment under normal operations. Information on current water usage, effluent discharge, and water quality for ORR is presented in Section 3.2.4.

4.4.1.1.5 Geology and Soils

ATR, an existing facility, would be used for the irradiation of neptunium-237 targets. Since no new construction is planned, there would be no disturbance to either geologic or soil resources in the Test Reactor Area. As previously summarized in Section 4.2.3.2.5, hazards from large-scale geologic conditions at INEEL, such as earthquakes and volcanoes, were evaluated in the *Storage and Disposition PEIS* (DOE 1996a:4-148). The analysis determined that these hazards present a low risk to INEEL facilities. That analysis was reviewed in the SPD EIS (DOE 1999a: 4-267-268). Further review of the data and analyses presented in these referenced documents and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions likewise present a low risk to proposed ATR operations. This is because regional seismic conditions do not preclude the safe operation of properly or specially designed or upgraded facilities and the potential for future volcanic activity is low. The potential for nontectonic events to threaten INEEL facilities is also low.

Because the existing REDC facility would be used for neptunium-237 storage, target fabrication, and processing under this option, there would be no disturbance to either geologic or soil resources in the 7900 Area of ORNL. Hazards from large-scale geologic conditions at ORR were previously analyzed as discussed in Section 4.2.2.2.5 and determined to present a low risk to REDC.

As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.4.1.1.6 Ecological Resources

The existing ATR facility at INEEL would be used to irradiate neptunium-237 targets. Terrestrial resources would not be adversely affected because ATR is in the highly disturbed and fenced Test Reactor Area, and no new construction is planned. Further, as noted in Section 4.4.1.1.2, there would be no sudden loud noises that would adversely affect wildlife. Because there would be no measurable increase in water use or wastewater discharge, and discharge chemistry would not be expected to change, there would be no impact on aquatic habitat (Section 4.4.1.1.4). Due to the developed nature of the area, and because no new construction would take place, impacts on threatened and endangered species would not occur. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service. Consultations have also been initiated with the state.

REDC, an existing facility at ORR, would be used for neptunium-237 storage, target fabrication, and processing. No new construction would take place; thus, direct disturbance to ecological resources would not occur. As noted in Section 4.4.1.1.2, there would be no sudden loud noises that would adversely affect wildlife. There would be no change in impacts on aquatic resources because additional water usage and wastewater discharge would be small fractions of current values and discharge chemistry would not be expected to change (Section 4.4.1.1.4). Threatened and endangered species would not be impacted because an existing facility in the developed area would be used. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service. Consultations have also been initiated with the state.

4.4.1.1.7 Cultural and Paleontological Resources

The irradiation of neptunium-237 targets would take place in ATR. Because no new construction is planned, impacts on cultural and paleontological resources would not occur. The Materials Test Reactor, the Engineering Test Reactor, and ATR, as well as a number of support facilities, are potentially eligible for nomination to the National Register of Historic Places. The use of ATR would not affect the potential eligibility of these structures for listing. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office. Consultation has also been initiated with interested Native American tribes.

Neptunium-237 storage, target fabrication, and processing would take place at the existing REDC facility in the 7900 Area of ORNL. Because no new construction would take place, impacts on cultural and paleontological resources would not occur. One structure within ORNL, the Graphite Reactor, is listed on the National Register of Historic Places as a National Historic Landmark. Additionally, several other structures proposed for listing on the National Register of Historic Places are found within or near ORNL. However, neither the Graphite Reactor nor any of the other structures is in the 7900 Area and, thus, their status would not change by the use of REDC for target fabrication and processing. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office.

4.4.1.1.8 Socioeconomics

After facility modifications, startup, and testing of the plutonium-238 reactor operation facilities at INEEL and target fabrication/processing facilities at ORR, approximately 41 additional workers would be required to operate these facilities (none at INEEL and approximately 41 at ORR [Wham et al. 1998]). The socioeconomic impacts at ORR are the same as those addressed in Section 4.3.1.1.8.

4.4.1.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with Alternative 2, Option 1 are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from operations are given in **Table 4–54** for INEEL and ORR: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual operations of ATR at INEEL and REDC at ORR, the projected total incremental population dose in the year 2020 would be 8.8×10^{-5} person-rem. The corresponding number of latent cancer fatalities in the populations surrounding INEEL and ORR from 35 years of operations would be 1.5×10^{-6}. The total incremental dose to the maximally exposed member of the public from annual ATR operations would be 0 millirem because there would be no increase in radiological releases to the environment from ATR associated with this option. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would, therefore, be zero. The incremental dose to the maximally exposed member of the public from annual REDC operations would be 1.9×10^{-6} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 3.3×10^{-11}.

Incremental doses to involved workers from normal operations are given in **Table 4–55**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to ATR workers would be 0 millirem; for REDC workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0 and approximately 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–55. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–54 Incremental Radiological Impacts on the Public Around INEEL and ORR from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 1

Receptor	INEEL ATR	ORR REDC	Total
Population within 80 kilometers (50 miles) in the year 2020			
Dose (person-rem)	0	8.8×10^{-5}	8.8×10^{-5}
35-year latent cancer fatalities	0	1.5×10^{-6}	1.5×10^{-6}
Maximally exposed individual			
Annual dose (millirem)	0	1.9×10^{-6}	NA[a]
35-year latent cancer fatality risk	0	3.3×10^{-11}	NA[a]
Average exposed individual within 80 kilometers (50 miles)			
Annual dose[b] (millirem)	0	7.8×10^{-8}	NA[a]
35-year latent cancer fatality risk	0	1.4×10^{-12}	NA[a]

a. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of REDC in the year 2020 (1,134,200).
Key: NA, not applicable.
Source: Model results, using the GENII computer code (Napier et al. 1988).

Table 4–55 Incremental Radiological Impacts on Involved INEEL and ORR Workers from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 1

Receptor—Involved Workers[a]	INEEL ATR	ORR REDC	Total
Total dose (person-rem per year)	0	22[b]	22
35-year latent cancer fatalities	0	0.31	0.31
Average worker dose (millirem per year)	0	290	NA[c]
35-year latent cancer fatality risk	0	0.0041	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 75 badged workers.
c. Values cannot be given for the average worker because the workers would be at two different facilities and sites.
Key: NA, not applicable.
Source: LMER 1997:22; Mecham 1999; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts at INEEL would be the same as those of current site operations because no new chemicals are expected to be emitted at ATR.

At ORR, both carcinogenic and noncarcinogenic health effects from exposure to hazardous chemicals were evaluated. It was assumed that under normal operating conditions, the primary exposure pathway for members of the public would be from air emissions released through the 7911 stack. Emissions of chemicals were estimated based on anticipated chemical usage. A worst-case dispersion modeling screening analysis was performed to estimate annual concentrations for each chemical, based on the emissions.

The annual concentration for each noncarcinogenic chemical was divided by the corresponding inhalation reference concentration to estimate the Hazard Quotient for each chemical. The Hazard Quotients were summed to give the Hazard Index from all noncarcinogenic chemicals associated with this option. A Hazard Index of less than one indicates that adverse health effects from non-cancer-causing agents are not expected. For carcinogens, the annual concentration was multiplied by the unit cancer risk to estimate the increased cancer risk from that chemical. Hazardous chemical health effects are summarized in **Table 4–56**.

Table 4–56 Incremental Hazardous Chemical Impacts on the Public Around ORR Under Alternative 2 (Use Only Existing Operational Facilities)—Option 1

Chemical	Modeled Annual Increment (milligrams per cubic meter)	RfC - Inhalation (milligrams per cubic meter)	Unit Cancer Risk (risk per milligram per cubic meter)	Hazard Quotient	Cancer Risk
Diethyl benzene	3.37×10^{-5}	1	0.0078	3.37×10^{-5}	2.63×10^{-7}
Methanol	1.23×10^{-6}	1.75	NA	7.03×10^{-7}	NA
Nitric acid	1.53×10^{-6}	0.1225	NA	1.25×10^{-5}	NA
Tributyl phosphate	6.34×10^{-5}	0.01	NA	0.00634	NA
			Hazard Index =	0.00639	

Note: For diethyl benzene, the reference concentration for ethyl benzene and the unit cancer risk for benzene were used to estimate Hazard Quotient and cancer risk because no information was available for diethyl benzene. For tributyl phosphate, the reference concentration for phosphoric acid was used to estimate the Hazard Quotient because no information was available for tributyl phosphate.
Key: NA, not applicable (the chemical is not a known carcinogen or it is a carcinogen and only unit risk will apply); RfC, reference concentration.
Source: DOE 1996a; EPA 1999; modeled increments are based on the SCREEN 3 computer code (EPA 1995).

4.4.1.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with ATR target irradiation and REDC target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 miles) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are given in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–57** and **4–58**, respectively. Because ATR is currently operating, the consequences and risks are presented for both the current reactor configuration without neptunium-237 targets and for the worst-case neptunium-237 target-loading reactor configuration. Baseline accident risks attributed to ATR operations refer to accidents that could occur under the current ATR configuration (without neptunium-237 targets). Baseline accident risks are obtained from the data in Table 4–58 by summing the annual risks in columns 2, 3, or 4 for the baseline ATR configuration (0 kilograms per year plutonium-238 production), and then multiplying the sum by 35. The baseline ATR accident risk to the public would be 0.0089 latent cancer fatality. Baseline ATR accident risks to the maximally exposed

offsite individual and a noninvolved worker would be 8.2×10^{-7} and 7.2×10^{-6} latent cancer fatalities, respectively.

For 35 years of ATR target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.45×10^{-7} and 3.48×10^{-6}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00140.

Table 4–57 ATR and REDC Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 1

	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
Accident	**Dose (rem)**	**Latent Cancer Fatality[a]**	**Dose (person-rem)**	**Latent Cancer Fatalities[b]**	**Dose (rem)**	**Latent Cancer Fatality[a]**
ATR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	0.465	2.33×10^{-4}	5.11×10^{4}	25.5	5.15	0.00206
Large-break LOCA with 5 kg/yr plutonium-238 production	0.604	3.02×10^{-4}	5.17×10^{4}	25.9	7.61	0.00304
Target handling with 0 kg/yr plutonium-238 production[c]	0.0	0.0	0.0	0.0	0.0	0.0
Target handling with 5 kg/yr plutonium-238 production	2.05×10^{-4}	1.03×10^{-7}	0.128	6.41×10^{-5}	0.00324	1.30×10^{-6}
REDC accidents						
Ion exchange explosion during neptunium-237 target fabrication	6.13×10^{-9}	3.06×10^{-12}	8.58×10^{-5}	4.29×10^{-8}	5.60×10^{-10}	$2.24\text{x}0^{-13}$
Target dissolver tank failure during plutonium-238 separation	1.76×10^{-7}	8.79×10^{-11}	0.00196	9.82×10^{-7}	1.09×10^{-8}	6.74×10^{-12}
Ion exchange explosion during plutonium-238 separation	4.68×10^{-4}	2.34×10^{-7}	5.23	0.00261	4.49×10^{-5}	1.79×10^{-8}
Processing facility beyond-design-basis earthquake	163	0.163	8.91×10^{5}	445	1,310	1.00[d]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be no associated accident consequences.
d. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–58 ATR and REDC Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 1

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual ATR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (1×10^{-4})	2.33×10^{-8}	0.00255	2.06×10^{-7}
Large-break LOCA with 5 kg/yr plutonium-238 production (1×10^{-4})	3.02×10^{-8}	0.00259	3.04×10^{-7}
Target handling with 0 kg/yr plutonium-238 production[c]	0.0	0.0	0.0
Target handling with 5 kg/yr plutonium-238 production (0.001)	1.03×10^{-10}	6.41×10^{-8}	1.30×10^{-9}
35-year ATR risk[d]	2.45×10^{-7}	0.00140	3.48×10^{-6}
Annual REDC risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	3.06×10^{-14}	4.29×10^{-10}	2.24×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	8.79×10^{-13}	9.82×10^{-9}	6.74×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	2.34×10^{-9}	2.61×10^{-5}	1.79×10^{-10}
Processing facility beyond-design-basis earthquake (1×10^{-5})	1.63×10^{-6}	0.00445	1.00×10^{-5}[e]
35-year REDC risk	5.71×10^{-5}	0.157	3.50×10^{-4}
35-year Option risk	5.71×10^{-5}	0.158	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be no associated accident risks.
d. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.
e. Risk of an early fatality.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years of REDC target processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 5.71×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.157.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 5.71×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.158.

The irradiation of neptunium-237 targets to produce plutonium-238 at ATR would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of neptunium-237 targets at ATR.

Processing associated with the plutonium-238 production program at REDC, including storage of neptunium-237 and plutonium-238, neptunium-237 target fabrication, postirradiation processing to extract plutonium-238 and to recycle the unconverted neptunium-237 into new targets, would not require the introduction of hazardous chemicals that are not in current use in the facility. The quantities of in-process hazardous chemicals for the plutonium-238 production program are bounded by the quantities of the material currently stored in the facility. The impacts of in-process hazardous chemical accidents associated with the plutonium-238 production are bounded by the impacts of hazardous chemical accidents for existing storage facilities at REDC.

4.4.1.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the REDC target fabrication facility at ORR. DOE would transport the unirradiated neptunium-237 targets from REDC to ATR at INEEL. Following irradiation in ATR, the targets would be returned to REDC for processing. After processing, the plutonium-238 product would be shipped to LANL. The analysis is described in Appendix J.

Approximately 763 shipments of radioactive materials would be made by DOE under this option. The total distance traveled on public roads by trucks carrying radioactive materials would be 2.2 million kilometers (1.4 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 12 person-rem; the dose to the public, 245 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.005 latent cancer fatality among transportation workers and 0.12 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 0.0068.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to REDC with a severity category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent fatal cancer risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 were also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total ground transportation accident risks are as follows: a radiological dose to the population of 0.088 person-rem, resulting in 4.4×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.06 traffic fatality.

4.4.1.1.12 Environmental Justice

NORMAL OPERATIONS. The risk of latent cancer fatalities among populations residing within 80 kilometers (50 miles) of ATR and REDC would be less than 2×10^{-6} for 35 years of normal operations (derived from information in Table 4–54). As shown in Table 4–56, the release of hazardous chemicals at ORR would pose no significant risk of cancer or toxic effects among the public. As discussed in Section K.5.1, the likelihood that a latent cancer fatality would result from the ingestion of food that could be radiologically contaminated due to normal operations would be essentially zero at INEEL and ORR. No credible pattern of food consumption by persons residing in potentially affected areas would result in significant health risks due to

radiological contamination of food supplies near INEEL or ORR. As discussed in Section 4.4.1.1.11, no fatalities would be expected for incident-free transportation.

ACCIDENTS. Latent cancer fatalities among populations at risk due to radiological accidents listed in Table 4–58 would be approximately 0.17. If a radiological accident were to occur at ATR and northwesterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Fort Hall Indian Reservation (see Figure K–2). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the population or maximally exposed individual residing within the boundary of the Fort Hall Indian Reservation. In the event a radiological accident were to occur at REDC and southerly winds prevailed at the time of the accident, radiological contamination would be directed toward the predominately minority population of the Scarboro Community adjacent to the northern boundary of ORR (see Figure K–6). If the winds were blowing from the west-southwest at the time of the accident, radiological contamination would be directed toward minority populations residing in Knoxville, Tennessee. Accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the minority populations or maximally exposed individuals residing in the Scarboro Community or Knoxville.

As discussed in Section 4.4.1.1.11, no fatalities due to transportation accidents would be expected.

In summary, the implementation of this option would pose no significant radiological risk to persons residing in potentially affected areas or along representative transportation routes. Under the conservative assumption that all food consumed in potentially affected areas during the 35-year operational period would be radioactively contaminated, no credible pattern of food consumption would pose a significant radiological health risk due to the ingestion of contaminated food supplies. As discussed in other parts of Section 4.4.1.1, the implementation of this option would not result in significant nonradiological impacts on populations at risk. Thus, implementation would not pose significant and adverse environmental risks to persons residing within potentially affected areas, including minority and low-income persons.

4.4.1.1.13 Waste Management

Virtually no additional wastes would be generated as a result of irradiating the neptunium-237 targets in ATR because this reactor would already be operating for other purposes. Only the devices that position the neptunium-237 targets in the core would add to the ATR waste stream. The incremental amount of this waste is anticipated to be very small (about 1 cubic meter [1.3 cubic yards] per year of solid low-level radioactive waste), and therefore, no impacts on the waste management systems at INEEL would be anticipated. However, there would be impacts on ORR's waste management systems as a result of the operation of REDC to fabricate and process the neptunium-237 targets.

The impacts of managing wastes associated with neptunium-237 target fabrication and processing in REDC are assumed to be the same as for Option 1 under Alternative 1 (Section 4.3.1.1.13) because the same amount of plutonium-238 would be produced annually. As shown in that section, the impacts on the waste management systems at ORR would be minimal.

4.4.1.1.14 Spent Nuclear Fuel Management

Under all options of this alternative, no additional spent nuclear fuel would be generated from reactor operations specific to neptunium-237 target irradiation. The reactor(s) would already be operating to provide other irradiation services (refer to Appendix B). Thus, there would be no incremental impacts associated with the management of spent nuclear fuel.

4.4.1.2 Permanent Deactivation of FFTF

The environmental impacts associated with the permanent deactivation of FFTF are analyzed in *Environmental Assessment, Shutdown of FFTF, Hanford Site, Richland, Washington*, DOE/EA-0993 (DOE 1995a). Summaries of these impacts are given in the following sections. Activities associated with final decontamination and decommissioning are not within the scope of this NI PEIS. They would be addressed in subsequent NEPA documentation.

4.4.1.2.1 Land Resources

LAND USE. Activities associated with the permanent deactivation of FFTF would not affect land use in the 400 Area because the industrial nature of the area would not change.

VISUAL RESOURCES. The permanent deactivation of FFTF would not involve the removal of existing structures with only minimal construction of small support structures in previously disturbed area facilities; thus, visual resources would not be affected, and the Visual Resource Management Class IV rating of the 400 Area would not change.

4.4.1.2.2 Noise

Noise associated with the permanent deactivation of FFTF would be similar to sound levels generated by current activities in the 400 Area. Onsite noise impacts from deactivation would be expected to be minimal, and changes in offsite noise levels would not be noticeable since the nearest site boundary is 6.1 kilometers (3.8 miles) to the east. Noise levels associated with traffic during deactivation may be slightly higher as a result of moving fuel assemblies, equipment, and materials. When deactivation is complete, noise levels associated with traffic may decrease somewhat if the FFTF shutdown results in a decrease in the Hanford workforce (DOE 1995a). The contribution of FFTF deactivation activities to traffic noise levels on site and off site would be minor and would not lead to noticeable changes in noise levels either on site or off site. There would be no loud noises associated with the deactivation of FFTF that would adversely affect wildlife.

4.4.1.2.3 Air Quality

No substantial increase in the impacts on air quality around Hanford would be expected from activities associated with permanently deactivating FFTF. Some decrease in air quality impacts may occur when generators and pumps are shut down.

4.4.1.2.4 Water Resources

The permanent deactivation of FFTF would eventually result in the cessation of sanitary and process wastewater discharges (i.e., cooling tower blowdown) from the facility because auxiliary systems are shut down following hot sodium drainage. This would eliminate the annual discharge of 76 million liters (20 million gallons) of nonradioactive process wastewater to the 400 Area process sewer system and ultimately to the 400 Area Pond (i.e., 4608 B/C percolation ponds). The FFTF component of 400 Area sanitary wastewater discharges to the Energy Northwest treatment system would also be eliminated. In addition, groundwater withdrawals by 400 Area facilities of approximately 197 million liters (52 million gallons) per year would be greatly reduced (Section 4.3.1.1.4). As part of the sodium-removal process, residual sodium would be washed from fuel assemblies and other reactor components, including instrumentation assemblies from the reactor core. This would be conducted in FFTF's Interim Examination and Maintenance Cell using the existing process and equipment designed for this purpose. Ion exchange would reduce the entire volume of radioactive wastewater generated to less than 7,600 liters (2,000 gallons). This wastewater would be

disposed of at existing onsite waste management facilities; spent ion exchange resin would be packaged and properly disposed of as well (DOE 1995a:3-9, 3-15).

4.4.1.2.5 Geology and Soils

No facilities would be demolished to effect permanent deactivation of FFTF. Minor construction of support facilities would be necessary. These facilities would be relatively small with ground disturbance confined to previously disturbed areas immediately adjacent to the FFTF complex. As a result, the impact on geologic and soil resources in the 400 Area of Hanford would be expected to be negligible. Activities associated with final decontamination and decommissioning and related activities that could impact geologic or soil resources to a greater degree would be addressed in subsequent NEPA documentation.

4.4.1.2.6 Ecological Resources

Activities associated with the permanent deactivation of FFTF would not impact the limited ecological resources present in the 400 Area. No threatened and endangered species reside in the vicinity of the 400 Area; consequently, no adverse impacts on such species would occur from the proposed action.

4.4.1.2.7 Cultural and Paleontological Resources

The 400 Area is highly disturbed with little potential for the occurrence of cultural and paleontological resources. For this reason and because there would be no ground disturbance beyond previously disturbed areas associated with the permanent deactivation of FFTF, impacts on cultural and paleontological resources from the proposed action would not occur.

4.4.1.2.8 Socioeconomics

The deactivation of FFTF would result in a loss of about 300 jobs at Hanford (DOE 1997b). However, it should coincide with an increase in overall site employment at Hanford in connection with construction of the tank waste remediation system. The personnel who had worked at FFTF would be absorbed into other operations at Hanford. If this were not the case, the loss of 300 jobs would result in the loss of 760 indirect jobs in the region around Hanford. The potential employment loss of 1,060 direct and indirect jobs represents less than 0.3 percent of the projected regional economic area workforce and, therefore, would not result in a noticeable impact on the regional economic area.

In the region of influence, the loss of employment resulting from this alternative would not significantly impact community services in the Hanford region of influence. Assuming that 91 percent of those losing their jobs left the Hanford region of influence with their families (refer to Section 3.4.8), the region's population would decrease by approximately 1,789 persons. Given the current population-to-student ratio in the region of influence, this would likely result in a decrease of about 370 students, dropping the average school enrollment from 92.8 percent to 91.8 percent.

Community services in the region of influence may change to accommodate the population decrease as follows: 23 less teachers would be needed, if the current student-to-teacher ratio of 16.0:1 was maintained; 3 less police officers would be needed to maintain the current officer-to-population ratio of 1.5:1000; 6 less firefighters would be needed to maintain the current firefighter-to-population ratio of 3.4:1000; and 2 less doctors would be needed to maintain the current physician-to-population ratio of 1.4:1000. Thus, 34 additional positions could be lost if community services were maintained at current levels. Hospitals in the region of influence would not experience any change from the 2.1 beds per 1,000 persons currently available. None of

these projected changes should have a major impact on the level of community services currently offered in the region of influence.

4.4.1.2.9 Public and Occupational Health and Safety—Normal Deactivation Activities

Assessments of incremental radiological and chemical impacts associated with the permanent deactivation of FFTF are presented in this section. Supplemental information is provided in Appendix H. During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from deactivation of FFTF at Hanford are given in **Table 4–59**: the population within 80 kilometers (50 miles), the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding populations and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual deactivation activities, the projected estimated total incremental population dose is estimated to be 0.036 person-rem. The corresponding number of latent cancer fatalities in the population surrounding Hanford would be 1.8×10^{-5}. The total annual incremental dose to the maximally exposed member of the public from deactivation activities would be 2.6×10^{-4} millirem. The corresponding risk of a latent cancer fatality to this individual would be 1.3×10^{-10}.

Estimated incremental doses to involved workers associated with annual deactivation activities are given in **Table 4–60**; these workers are defined as those directly associated with all planned deactivation activities. Under this alternative, the incremental annual average dose to FFTF deactivation workers is estimated not to exceed 6 millirem. The incremental annual dose received by the FFTF deactivation workforce is estimated not to exceed 0.06 person-rem. The risks and numbers of latent cancer fatalities among these workers from annual operations are included in Table 4–60. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–59 Incremental Radiological Impacts on the Public Around Hanford from FFTF Deactivation Activities

Receptor	FFTF Deactivation
Estimated population within 80 kilometers (50 miles)	
Dose (person-rem)	0.036
1-year latent cancer fatalities	1.8×10^{-5}
Maximally exposed individual	
Annual dose (millirem)	2.6×10^{-4}
1-year latent cancer fatality risk	1.3×10^{-10}
Average exposed individual within 80 kilometers (50 miles)	
Annual dose[a] (millirem)	7.2×10^{-5}
1-year latent cancer fatality risk	3.6×10^{-11}

a. Obtained by dividing the estimated population dose by the number of people projected to live within 80 kilometers (50 miles) of FFTF (about 500,000).

Source: DOE 1995a.

Table 4–60 Incremental Radiological Impacts on Involved FFTF Workers from Deactivation Activities

Receptor	FFTF Deactivation
Involved workers[a]	
Total dose (person-rem per year)	<0.06[b]
1-year latent cancer fatalities	$<2.4\times10^{-5}$
Average worker dose (millirem per year)	<6
1-year latent cancer fatality risk	$<2.4\times10^{-6}$

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations will be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program will be enforced.

b. Based on an estimated 10 badged workers.

Note: < means "less than."

Source: DOE 1995a.

HAZARDOUS CHEMICAL IMPACTS. No hazardous chemicals are anticipated to be released in substantial quantities from activities associated with permanently deactivating FFTF when compared to the annual amount routinely generated throughout Hanford. The deactivation of FFTF would result in a decrease of both near-term and long-term exposures (DOE 1995a).

4.4.1.2.10 Public and Occupational Health and Safety—Deactivation Accidents

Impacts from a postulated accident associated with the permanent deactivation of FFTF are presented in this section. The FFTF shutdown environmental assessment (DOE 1995a) describes several accident scenarios and their consequences. Rather than a summary of the environmental assessment accidents, a reevaluation of a limiting deactivation accident was performed. The reevaluation was performed because the current FFTF status is significantly different than at the time the environmental assessment was completed.

FFTF is currently defueled; therefore, accidents related to defueling need not be considered. Also because of defueling and decay of radioactivity over time, the current sodium radionuclide inventories are much less than when the environmental assessment was completed. Considering the current FFTF conditions, it was determined that a primary heat transport system sodium drain accident would be the accident with the highest consequences. A detailed description of the accident analysis is provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 miles) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are given in Section 4.2.1.2.10.

The FFTF deactivation accident is a sodium spill during the transfer of primary sodium to a treatment tank. The accident frequency is the probability of a sodium spill during the transfer process. The frequency is per event (sodium transfer) rather than per year. Since the risk remains constant for any time period, the 35-year risk is the same as the accident risk presented.

Consequences and associated risks are presented in **Tables 4–61** and **4–62**, respectively.

For an FFTF deactivation accident, the increased risk of a latent cancer fatality to the MEI and to a noninvolved worker would be 2.38×10^{-14} and 1.55×10^{-13}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 1.82×10^{-9}.

Table 4–61 Consequences of FFTF Deactivation Accident

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
Primary heat transport system sodium drain accident	4.75×10^{-10}	2.38×10^{-13}	3.64×10^{-5}	1.82×10^{-8}	3.88×10^{-9}	1.55×10^{-12}

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
Source: Model results, using the MACCS2 computer code (Chanin and Young 1997).

Table 4–62 Risks of FFTF Deactivation Accident

Accident (Frequency)[a]	Maximally Exposed Offsite Individual[b]	Population to 80 Kilometers (50 Miles)[c]	Noninvolved Worker[b]
Primary heat transport system sodium drain accident (0.10)	2.38×10^{-14}	1.82×10^{-9}	1.55×10^{-13}

a. Per event.
b. Increased likelihood of a latent cancer fatality.
c. Increased number of latent cancer fatalities.
Source: Model results, using the MACCS2 computer code (Chanin and Young 1997).

Deactivating FFTF would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to deactivating FFTF.

4.4.1.2.11 Public and Occupational Health and Safety—Transportation

There would be no transportation impacts associated with permanently deactivating FFTF.

4.4.1.2.12 Environmental Justice

NORMAL OPERATIONS. For deactivation activities at Hanford, the number of expected latent cancer fatalities among populations residing within 80 kilometers (50 miles) of FFTF would be less than 2×10^{-5} (derived from information in Table 4–59). As discussed in Section 4.4.1.2.9, the release of hazardous chemicals at FFTF would pose no significant risk of cancer or toxic effects among the public. There would be no intersite transportation associated with deactivation activities, and therefore, no transportation effects on the public.

ACCIDENTS. Accidents at FFTF also pose no significant environmental risk to the public. As shown, in Table 4–61, the risk of a public fatality associated with a sodium drain accident at FFTF would be essentially zero.

In summary, deactivating FFTF would have no significant environmental effects on the public. Thus, the deactivation would pose no disproportionately high and adverse risks for minority or low-income populations.

4.4.1.2.13 Waste Management

As discussed in the *Environmental Assessment, Shutdown of FFTF, Hanford Site, Richland, Washington* (DOE 1995b), the hazardous materials (e.g., solvents, glycols, polychlorinated biphenyls, asbestos) which may be removed or stabilized as a result of the deactivation of FFTF would be managed and reused, recycled, or disposed of in accordance with applicable Federal and state regulations. Such materials include approximately 360,000 liters (94,000 gallons) of ethylene glycol, 32,000 liters (8,500 gallons) of polychlorinated biphenyls, transformer oil, and 370,000 liters (99,000 gallons) of fuel oil. Approximately 8,200 drums of sodium sulfate (at approximately 208 liters or 55 gallons, each) could be generated for disposal. None of the materials would be anticipated to be generated in substantial quantities when compared to the annual amount routinely generated throughout Hanford (DOE 1995b:5-12).

The inventory of bulk metallic sodium (approximately 980,000 liters [260,000 gallons]) would undergo appropriate excess evaluations to determine if alternative sponsors and/or uses were available. In the event no viable use were determined, the bulk metallic sodium would be converted to an acceptable stable form (e.g., sodium sulfate), dried, collected into containers, and transported to an appropriate facility at Hanford for disposal (DOE 1995b:ES-2).

4.4.1.2.14 Spent Nuclear Fuel Management

Under deactivation, the irradiated FFTF assemblies and pin containers have been, or would be, placed into dry storage casks and transferred to storage at the 400 Area Interim Storage Area. Each fuel assembly or pin container would be limited to a maximum decay heat value of 250 watts (850 BTU per hour) for fuel offload handling. At this heat level, no active cooling would be required, and many of the fission products and noble gases would have decayed substantially.

A typical FFTF spent nuclear fuel–handling sequence is as follows: sodium-wetted fuel assemblies are washed using existing FFTF process equipment; the spent nuclear fuel is subjected to a moist argon atmosphere to slowly react residual sodium in a controlled manner; several water rinses of the fuel are conducted; the fuel receives a final dry; the fuel is transferred to the dry storage casks for interim storage in the Interim Storage Area. The dry casks subsequently would be transferred to the Canister Storage Building Complex in the 200-East Area for storage of the spent nuclear fuel pending disposition (DOE 1997b). When the geologic repository becomes available, the spent nuclear fuel would be transferred from the 200-East Area to the repository for disposal.

4.4.2 Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Option 2 involves operating ATR at INEEL to irradiate neptunium-237 targets, and operating FDPF at INEEL to fabricate and process these targets. This alternative also includes storage of the neptunium-237 transported to INEEL from SRS in Building CPP–651 or FDPF.

The transportation of the neptunium-237 from SRS to INEEL for processing and fabrication into neptunium-237 targets in FDPF, and the transportation of the plutonium-238 product from INEEL to LANL following postirradiation processing in FDPF also constitute part of this option.

All options under this alternative include the permanent deactivation of FFTF at Hanford.

4.4.2.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.4.2.1.1 Land Resources

LAND USE. The use of ATR to irradiate neptunium-237 targets would not result in impacts on land use at INEEL for the reasons described in Section 4.4.1.1.1.

Building CPP–651 or FDPF at INEEL would be used for neptunium-237 storage, and FDPF for target fabrication and processing. These are existing facilities in the INTEC area. The use of these facilities would require internal modifications, but no new facilities would be built. Because no additional land would be disturbed and use of the facilities would be compatible with the missions for which they were designed, there would be no change in land use at INEEL.

VISUAL RESOURCES. The use of ATR to irradiate neptunium-237 targets would not result in impacts on visual resources at INEEL for the reasons described in Section 4.4.1.1.1.

All activities associated with neptunium-237 storage, target fabrication, and processing would take place in existing facilities that would require no external modifications. Thus, there would be no change in appearance. The current Visual Resource Management Class IV rating for INTEC would not change, and there would be no impact on visual resources.

4.4.2.1.2 Noise

The irradiation of neptunium-237 targets in ATR would not be expected to result in noise impacts at INEEL for the reasons described in Section 4.4.1.1.2.

Neptunium-237 storage in Building CPP–651 or FDPF, and target fabrication and processing at FDPF would generate noise levels similar to those presently associated with operations in INTEC. Onsite noise impacts would be expected to be minimal, and changes in offsite noise levels should not be noticeable because the nearest site boundary is 12 kilometers (7.5 miles) to the south. Changes in traffic volume going to and from INTEC would be small and would result in only minor changes to onsite and offsite noise levels. There would be no loud noises associated with neptunium-237 storage that would adversely impact wildlife.

4.4.2.1.3 Air Quality

The concentrations at INEEL attributable to this option are presented in **Table 4–63**. The concentrations for the option are based on a dispersion modeling screening analysis conducted with maximum expected emission rates and a set of worst-case meteorological conditions.

Table 4–63 Incremental INEEL Concentrations[a] Associated with Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Pollutant	Averaging Time	Most Stringent Standard or Guideline (micrograms per cubic meter)	Modeled Increment (micrograms per cubic meter)
Criteria pollutants			
Nitrogen dioxide	Annual	100	3.66×10^{-4}
Sulfur dioxide	Annual	80	0.024
	24 hours	365	0.19
	3 hours	1,300	0.43
Toxic air pollutants			
Methanol	24 hours	13,000	0.0048
Nitric acid	24 hours	250	0.0097
Paraffin hydrocarbons	24 hours	100	0.44
Tributyl phosphate	24 hours	110	0.25

a. For comparison with ambient air quality standards.
Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995).

Only those air pollutants expected to be emitted that have ambient air quality standards are presented in the table. The change in concentrations of these pollutants would be small and would be below the applicable ambient air quality standards even when ambient monitoring values and the contribution from other site activities are included.

The concentrations at INEEL attributed to this option are compared to the Prevention of Significant Deterioration Class II increments for nitrogen dioxide and sulfur dioxide in **Table 4–64**.

Table 4–64 PSD Class II Increments Compared to INEEL Concentrations Associated with Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Pollutant	Averaging Time	Allowable PSD Increment (micrograms per cubic meter)	Modeled Increment (micrograms per cubic meter)
Nitrogen dioxide	Annual	25	3.66×10^{-4}
Sulfur dioxide	Annual	20	0.024
	24 hours	91	0.19
	3 hours	512	0.43

Key: PSD, Prevention of Significant Deterioration.
Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995).

Health effects from hazardous chemicals associated with this option are addressed in Section 4.4.2.1.9. The air quality impacts of transportation among SRS, INEEL, and LANL are presented in Section 4.4.2.1.11.

4.4.2.1.4 Water Resources

Impacts on water resources at INEEL associated with operating ATR to irradiate neptunium-237 targets would be negligible as previously described in Section 4.4.1.1.4.

Building CPP–651 and/or FDPF, existing facilities in the INTEC area of INEEL, would be used for neptunium-237 storage; FDPF would also be used for the fabrication and processing of targets in support of plutonium-238 production. Impacts on water resources at INEEL would be similar to those described in Section 4.3.2.1.4. In summary, no change in water use would be anticipated, and any change in the quantity

or quality of wastewater discharges would be small. Also, there would be no radiological liquid effluent discharge to the environment under normal operations.

4.4.2.1.5 Geology and Soils

The irradiation of neptunium-237 targets in ATR would not be expected to result in impacts on geologic or soil resources at INEEL, nor be jeopardized by large-scale geologic conditions, for the reasons described in Section 4.4.1.1.5.

Building CPP–651 and/or FDPF would be used to store neptunium-237, and FDPF would be used to fabricate and process targets. Because both are existing facilities, there would be no disturbance to either geologic or soil resources at INTEC. Hazards from large-scale geologic conditions at INEEL, such as earthquakes and volcanoes, were previously evaluated as discussed in Section 4.2.3.2.5. The analysis determined that these hazards present a low risk for neptunium-237 storage in INTEC facilities. Likewise, large-scale geologic conditions do not present a substantial risk to use of the proposed facilities for neptunium-237 storage, target fabrication, and processing. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.4.2.1.6 Ecological Resources

The irradiation of neptunium-237 targets in ATR would not result in impacts on ecological resources at INEEL for the reasons described in Section 4.4.1.1.6.

Because no new construction is planned, the use of Building CPP–651 and/or FDPF would not result in direct disturbance to ecological resources. As noted in Section 4.4.2.1.2, there would be no loud noises that would adversely impact wildlife. Because water usage and wastewater discharge would be small fractions of current values, there would be no impact on aquatic resources (Section 4.4.2.1.4). Due to the developed nature of the area and the fact that no new construction would take place, impacts on threatened and endangered species would not occur. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service. Consultations have also been initiated with the state.

4.4.2.1.7 Cultural and Paleontological Resources

The irradiation of neptunium-237 targets in ATR would not result in impacts on cultural and paleontological resources at INEEL for the reasons described in Section 4.4.1.1.7.

Because no new construction would take place, impacts on cultural and paleontological resources at INTEC would not occur. Use of Building CPP–651 and/or FDPF to store neptunium-237 or FDPF to fabricate and process neptunium-237 targets would not change the status of six historic structures located at INTEC. Native American resources occurring in the vicinity of INTEC would not be impacted by neptunium-237 storage, target fabrication, or processing. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office. Consultation has also been initiated with interested Native American tribes.

4.4.2.1.8 Socioeconomics

After facility modifications, startup, and testing of the plutonium-238 reactor operation and target fabrication/processing facilities at INEEL, approximately 24 additional workers would be required to operate these facilities (Hill et al. 1999). The socioeconomic impacts at INEEL are the same as those addressed in Section 4.3.2.1.8.

4.4.2.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from operations are given in **Table 4–65** for INEEL: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual operations of both facilities, the projected total incremental population dose in the year 2020 would be 3.9×10^{-6} person-rem. The corresponding number of latent cancer fatalities in the population surrounding INEEL from 35 years of operations would be 6.8×10^{-8}. The total incremental dose to the maximally exposed member of the public from annual ATR operations would be 0 millirem because there would be no increase in radiological releases to the environment from ATR associated with this option. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would, therefore, be zero. The incremental dose to the maximally exposed member of the public from annual FDPF operations would be 2.6×10^{-7} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 4.6×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–66**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to ATR workers would be 0 millirem; for FDPF workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0 and approximately 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–66. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–65 Incremental Radiological Impacts on the Public Around INEEL from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Receptor	INEEL ATR	INEEL FDPF	Total
Population within 80 kilometers (50 miles) in the year 2020			
Dose (person-rem)	0	3.9×10^{-6}	3.9×10^{-6}
35-year latent cancer fatalities	0	6.8×10^{-8}	6.8×10^{-8}
Maximally exposed individual			
Annual dose (millirem)	0	2.6×10^{-7}	2.6×10^{-7}
35-year latent cancer fatality risk	0	4.6×10^{-12}	4.6×10^{-12}
Average exposed individual within 80 kilometers (50 miles)			
Annual dose[a] (millirem)	0	2.1×10^{-8}	2.1×10^{-8}
35-year latent cancer fatality risk	0	3.7×10^{-13}	3.7×10^{-13}

a. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FDPF in the year 2020 (188,400).

Source: Model results, using the GENII computer code (Napier et al. 1988).

Table 4–66 Incremental Radiological Impacts on Involved INEEL Workers from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Receptor—Involved Workers[a]	INEEL ATR	INEEL FDPF	Total
Total dose (person-rem per year)	0	22[b]	22
35-year latent cancer fatalities	0	0.31	0.31
Average worker dose (millirem per year)	0	290	NA[c]
35-year latent cancer fatality risk	0	0.0041	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.

b. Based on an estimated 75 badged workers.

c. Values cannot be given for the average worker because the workers would be at two different facilities.

Key: NA, not applicable.

Source: LMER 1997:22; Mecham 1999; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. At INEEL, both carcinogenic and noncarcinogenic health effects from exposure to hazardous chemicals were evaluated. It was assumed that under normal operating conditions, the primary exposure pathway for members of the public would be from air emissions released through the FDPF stack. Emissions of chemicals were estimated based on anticipated chemical usage. A worst-case dispersion modeling screening analysis was performed to estimate annual concentrations for each chemical, based on the emissions.

The annual concentration for each noncarcinogenic chemical was divided by the corresponding inhalation reference concentration to estimate the Hazard Quotient for each chemical. The Hazard Quotients were summed to give the Hazard Index from all noncarcinogenic chemicals associated with this option. A Hazard Index of less than one indicates that adverse health effects from non-cancer-causing agents are not expected. For carcinogens, the annual concentration was multiplied by the unit cancer risk to estimate the increased cancer risk from that chemical. Hazardous chemical health effects are summarized in **Table 4–67**.

Table 4–67 Incremental Hazardous Chemical Impacts on the Public Around INEEL Under Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Chemical	Modeled Annual Increment (milligrams per cubic meter)	RfC - Inhalation (milligrams per cubic meter)	Unit Cancer Risk (risk per milligram per cubic meter)	Hazard Quotient	Cancer Risk
Diethyl benzene	1.65×10^{-5}	1	0.0078	1.65×10^{-5}	1.29×10^{-7}
Methanol	6.02×10^{-7}	1.75	NA	3.44×10^{-7}	NA
Nitric acid	1.21×10^{-6}	0.1225	NA	9.86×10^{-6}	NA
Tributyl phosphate	3.10×10^{-5}	0.01	NA	0.00310	NA
			Hazard Index =	0.0031	

Note: For diethyl benzene, the reference concentration for ethyl benzene and the unit cancer risk for benzene were used to estimate Hazard Quotient and cancer risk because no information was available for diethyl benzene. For tributyl phosphate, the reference concentration for phosphoric acid was used to estimate the Hazard Quotient because no information was available for tributyl phosphate.
Key: NA, not applicable (the chemical is not a known carcinogen); RfC, reference concentration.
Source: DOE 1996a; EPA 1999; modeled increments are based on the SCREEN 3 computer code (EPA 1995).

4.4.2.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with ATR target irradiation and FDPF target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 mile) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed individual or a uninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are given in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–68** and **4–69**, respectively. Because ATR is currently operating, the consequences and risks are presented for both the current reactor configuration without neptunium-237 targets and for the worst-case neptunium-237 target-loading reactor configuration.

For 35 years of ATR target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.45×10^{-7} and 3.48×10^{-6}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00140.

For 35 years of FDPF target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 1.49×10^{-5} and

Table 4–68 ATR and FDPF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
ATR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	0.465	2.33×10^{-4}	5.11×10^{4}	25.5	5.15	0.00206
Large-break LOCA with 5 kg/yr plutonium-238 production	0.604	3.02×10^{-4}	5.17×10^{4}	25.9	7.61	0.00304
Target handling with 0 kg/yr plutonium-238 production	0.0	0.0	0.0	0.0	0.0	0.0
Target handling with 5 kg/yr plutonium-238 production	2.05×10^{-4}	1.03×10^{-7}	0.128	6.41×10^{-5}	0.00324	1.30×10^{-6}
FDPF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.01×10^{-9}	1.01×10^{-12}	2.49×10^{-5}	1.24×10^{-8}	7.26×10^{-9}	2.91×10^{-12}
Target dissolver tank failure during plutonium-238 separation	6.11×10^{-8}	3.05×10^{-11}	5.65×10^{-4}	2.82×10^{-7}	2.17×10^{-7}	8.69×10^{-11}
Ion exchange explosion during plutonium-238 separation	1.63×10^{-5}	8.13×10^{-9}	0.150	7.51×10^{-5}	5.79×10^{-5}	2.31×10^{-8}
Processing facility beyond-design-basis earthquake	42.5	0.0425	1.64×10^{5}	82.0	1,200	1.0[d]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be no associated accident consequences.
d. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0287.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 1.51×10^{-5} and 3.53×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0301.

Table 4–69 ATR and FDPF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual ATR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (1×10^{-4})	2.33×10^{-8}	0.00255	2.06×10^{-7}
Large-break LOCA with 5 kg/yr plutonium-238 production (1×10^{-4})	3.02×10^{-8}	0.00259	3.04×10^{-7}
Target handling with 0 kg/yr plutonium-238 production[c]	0.0	0.0	0.0
Target handling with 5 kg/yr plutonium-238 production (0.001)	1.03×10^{-10}	6.41×10^{-8}	1.30×10^{-9}
35-year ATR risk[d]	2.45×10^{-7}	0.00140	3.48×10^{-6}
Annual FDPF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	1.24×10^{-10}	2.91×10^{-14}
Target dissolver tank failure during plutonium-238 separation (0.01)	3.05×10^{-13}	2.82×10^{-9}	8.69×10^{-13}
Ion exchange explosion during plutonium-238 separation (0.01)	8.13×10^{-11}	7.51×10^{-7}	2.31×10^{-10}
Processing facility beyond-design-basis earthquake (1×10^{-5})	4.25×10^{-7}	8.20×10^{-4}	1.00×10^{-5}[e]
35-year FDPF risk	1.49×10^{-5}	0.0287	3.50×10^{-4}
35-year Option risk	1.51×10^{-5}	0.0301	3.53×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be no associated accident risks.
d. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.
e. Risk of an early fatality.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

The irradiation of neptunium-237 targets to produce plutonium-238 at ATR would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of neptunium-237 targets at ATR.

No chemical processing activities are currently performed at FDPF and no chemicals are stored in this facility. Processing activities in support of plutonium-238 production would require the introduction of hazardous chemicals, specifically nitric acid and nitric oxide. Potential health impacts from accidental releases of nitric acid were assessed by comparing estimated airborne concentrations of the chemicals to Emergency Response Planning Guidelines (ERPG) developed by the American Industrial Hygiene Association. The ERPG-1 value (0.5 part per million) is the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour, resulting in only mild, transient, and reversible adverse health effects. The ERPG-2 value (10 parts per million) is protective of irreversible or serious health effects or impairment of an individual's ability to take protective action. The ERPG-3 value (25 parts per million) is indicative of potentially life threatening health effects.

The maximum distances, in meters, needed to reach the ERPG values for nitric acid releases at FDPF for Stability Classes D and F are shown in **Table 4–70**. Two separate atmospheric conditions were evaluated, Stability Classes D and F. Stability Class D represents average meteorological conditions while Stability Class F represents worst-case meteorological conditions. The number of involved and noninvolved workers potentially exposed would vary with a number of factors such as the time of day and whether they are sheltered within buildings at the time of release. Individuals at the nearest access road (5,800 meters [3.8 miles]) and at the nearest site boundary (13,952 meters [8.7 miles]) from FDPF would be exposed to levels well below ERPG-1.

Table 4–70 ERPG Distances for Nitric Acid Releases at FDPF Under Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Evaluation Parameter	Stability Class D (meters)	Stability Class F (meters)
ERPG-3	375	450
ERPG-2	500	600
ERPG-1	2,000	3,000

Note: To convert from meters to miles, multiply by 6.22×10^{-4}.
Key: ERPG, Emergency Response Planning Guideline.

There are no ERPG values for nitric oxide. For nitric oxide accidents, the level of concern has been estimated by using one-tenth of the "Immediately Dangerous to Life and Health" level published by the National Institute for Occupational Safety and Health. The Immediately Dangerous to Life and Health value for nitric oxide is 100 parts per million. The level of concern value used for this NI PEIS is 10 parts per million. The level of concern is defined as the concentration of an extremely hazardous substance in air above which there may be serious irreversible health effects as a result of a single exposure for a relatively short period of time.

For FDPF, the maximum distances needed to reach the level of concern for nitric oxide releases for Stability Classes D and F are 500 and 2,000 meters (0.31 and 1.24 miles), respectively. The number of involved and noninvolved workers potentially exposed would vary with a number of factors such as the time of day and whether they are sheltered within buildings at the time of release. Individuals at the nearest access road (5,800 meters [3.6 miles]) and at the nearest site boundary (13,952 meters [8.7 miles]) from FDPF would be exposed to levels well below the level of concern for nitric oxide.

Potential health impacts from the accidental release of the hazardous chemicals were assessed for offsite individuals who are members of the public located at the nearest site boundary and onsite individuals who are members of the public located at the nearest point of public access onsite.

The impacts associated with the accidental release of nitric acid and nitric oxide at FDPF are presented in **Table 4–71**.

Table 4–71 FDPF Hazardous Chemical Accident Impacts Under Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Receptor	Evaluation Parameter	Nitric Acid		Nitric Oxide	
		Stability Class D	Stability Class F	Stability Class D	Stability Class F
Onsite individual	Parts per million Level of concern Potential health effects	0.05 < ERPG-1 None	0.15 ERPG-1 Mild, transient	0.09 < LOC None	0.87 < LOC None
Offsite individual	Parts per million Level of concern Potential health effects	<<0.05 < ERPG-1 None	<<0.15 ERPG-1 Mild, transient	<<0.09 < LOC None	<<0.87 < LOC None

Key: ERPG, Emergency Response Planning Guideline; LOC, level of concern.
Note: < means "less than"; << means "much less than."
Source: Model results.

4.4.2.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to INEEL for target fabrication in FDPF. DOE would transport the unirradiated neptunium-237 targets from FDPF to ATR, also on the INEEL site. Following irradiation in ATR, the targets would be returned to FDPF for processing. After this processing, the plutonium-238 product would be shipped to LANL. The analysis is described in Appendix J.

Approximately 133 intersite shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 0.43 million kilometers (0.27 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 4 person-rem; the dose to the public, 32 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0014 latent cancer fatality among transportation workers and 0.016 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 0.0019.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident (probability of occurrence: 1 in 10 million per year) would not breach the transportation package. The consequences of more severe accidents that could breach the transportation package and release radioactive material were evaluated and estimated to have probabilities of less than 1 in 10 million per year.

Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 0.042 person-rem, resulting in 2.1×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.0017 traffic fatality.

4.4.2.1.12 Environmental Justice

NORMAL OPERATIONS. For 35 years of normal operations under this option, the number of latent cancer fatalities among populations residing within 80 kilometers (50 miles) of ATR and FDPF would be essentially zero (derived from information in Table 4–65). As shown in Table 4–67, the release of hazardous chemicals at INEEL would pose no significant risk of cancer or toxic effects among the public. As discussed in Section K.5.1 of Appendix K, the likelihood that a latent cancer fatality would result from the ingestion of food that could be radiologically contaminated due to normal operations would be essentially zero at INEEL. No credible pattern of food consumption by persons residing in potentially affected areas would result in

significant health risks due to radiological contamination of food supplies near INEEL. As discussed in Section 4.4.2.1.11, no fatalities due to transportation activities would be expected.

ACCIDENTS. The number of latent cancer fatalities among the populations at risk due to radiological accidents listed in Table 4–69 would be less than 0.03. If a radiological accident were to occur at ATR or FDPF and northwesterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Fort Hall Indian Reservation (see Figure K–2). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the population or maximally exposed individual residing within the boundary of the Fort Hall Indian Reservation.

As discussed in Section 4.4.2.1.11, no fatalities due to transportation accidents would be expected.

In summary, the implementation of this option would pose no significant radiological risk to persons residing in potentially affected areas or along representative transportation routes. Under the conservative assumption that all food consumed in potentially affected areas during the 35-year operational period would be radioactively contaminated, no credible pattern of food consumption would pose a significant radiological health risk due to the ingestion of contaminated food supplies. As discussed in other parts of Section 4.4.2.1, the implementation of this option would not result in significant nonradiological impacts on populations at risk. Thus, implementation would not pose significant and adverse environmental risks to persons residing within potentially affected areas, including minority and low-income persons.

4.4.2.1.13 Waste Management

Only an extremely small amount of additional waste would be generated as a result of irradiating neptunium-237 targets in ATR (Section 4.4.1.1.13). However, wastes would be associated with FDPF operations to fabricate and process neptunium-237 targets.

The impacts of managing wastes associated with neptunium-237 target fabrication and processing in FDPF are assumed to be the same as for Option 2 under Alternative 1 (Section 4.3.2.1.13) because the same amount of plutonium-238 would be produced annually. As shown in that section, the impacts on the waste management systems at INEEL would be minimal.

4.4.2.1.14 Spent Nuclear Fuel Management

No incremental impacts would be associated with the management of spent nuclear fuel (refer to Section 4.4.1.1.14).

4.4.2.2 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.4.3 Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Option 3 involves operating ATR at INEEL to irradiate neptunium-237 targets, and operating FMEF at Hanford to fabricate and process these targets and to store the neptunium-237 transported to Hanford from SRS.

The transportation of the neptunium-237 from SRS to Hanford for processing and fabrication into neptunium-237 targets in FMEF, the transportation of these targets from Hanford to INEEL for irradiation in

ATR, the transportation of the irradiated targets back to Hanford for postirradiation processing in FMEF, and the transportation of the plutonium-238 product from Hanford to LANL also constitute part of this option.

All options under this alternative include the permanent deactivation of FFTF at Hanford.

4.4.3.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.4.3.1.1 Land Resources

LAND USE. The use of ATR to irradiate neptunium-237 targets would not result in impacts on land use at INEEL for the reasons described in Section 4.4.1.1.1.

FMEF, an existing facility in the 400 Area of Hanford, would be used for neptunium-237 storage, target fabrication, and processing. The use of FMEF would require the construction of a new 76-meter (250-foot) stack. Because the stack would be placed on previously disturbed land, and the use of FMEF for target fabrication and processing would be compatible with the mission for which is was designed, change in land use in the 400 Area would be minimal.

VISUAL RESOURCES. The use of ATR to irradiate neptunium-237 targets would not result in impacts on visual resources at INEEL for the reasons described in Section 4.4.1.1.1.

Neptunium-237 storage, target fabrication, and processing would take place in FMEF. Although FMEF is an existing facility, its use would require construction of a 76-meter (250-foot) stack. While the stack would be visible from surrounding areas, it would not change the overall appearance of the 400 Area or its Visual Resource Management Class IV rating. Thus, impacts on visual resources would be minimal.

4.4.3.1.2 Noise

The irradiation of neptunium-237 targets in ATR would not be expected to result in noise impacts at INEEL for the reasons described in Section 4.4.1.1.2.

A new 76-meter (250-foot) stack would be required for neptunium-237 target processing at FMEF. Noise associated with construction of the new stack would be typical of small construction projects and would be of short duration. During neptunium-237 target processing operations, sound levels would be similar to those associated with other operations in the 400 Area. Thus, the change in overall onsite noise impacts would be minimal. Offsite noise impacts from these operations would also be minor because the nearest site boundary is 7 kilometers (4.3 miles) to the east and changes in traffic volume going to and from FMEF would be small. There would be no loud noises associated with neptunium-237 target processing that would adversely impact wildlife.

4.4.3.1.3 Air Quality

It is estimated that there would be no measurable increases in nonradiological air pollutant emissions at INEEL associated with this option (Moor and Peterson 1999); therefore, no increased nonradiological air quality impacts would be expected.

The concentrations at Hanford attributable to this option are presented in **Table 4–72**. The concentrations for the option are based on a dispersion modeling screening analysis conducted with maximum expected emission rates and a set of worst-case meteorological conditions. Only those air pollutants expected to be emitted that have ambient air quality standards are presented in the table. The change in ambient concentrations were determined to be small, and would be below the applicable ambient air quality standards even when ambient monitoring values and the contributions from the other site activities are included.

Table 4–72 Incremental Hanford Concentrations[a] Associated with Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Pollutant	Averaging Time	Most Stringent Standard or Guideline (micrograms per cubic meter)	Modeled Increment (micrograms per cubic meter)
Criteria pollutants			
Nitrogen dioxide	Annual	100	4.43×10^{-5}
Sulfur dioxide	Annual	50	0.0087
	24 hours	260	0.069
	3 hours	1,300	0.16
	1 hour	660	0.17
Toxic air pollutants			
Methanol	24 hours	870	0.0018
Nitric acid	24 hours	17	0.0022
Paraffin hydrocarbons	24 hours	7	0.16
Tributyl phosphate	24 hours	7.3	0.090

a. For comparison with ambient air quality standards.
Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995).

The concentrations at Hanford attributed to this option are compared to the Prevention of Significant Deterioration Class II increments for nitrogen dioxide and sulfur dioxide in **Table 4–73**.

Table 4–73 PSD Class II Increments Compared to Hanford Concentrations Associated with Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Pollutant	Averaging Time	Allowable PSD Increment (micrograms per cubic meter)	Modeled Increment (micrograms per cubic meter)
Nitrogen dioxide	Annual	25	4.43×10^{-5}
Sulfur dioxide	Annual	20	0.0087
	24 hours	91	0.069
	3 hours	512	0.16

Key: PSD, Prevention of Significant Deterioration.
Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995).

Health effects from hazardous chemicals associated with this option are addressed in Section 4.4.3.1.9. The air quality impacts of transportation among SRS, INEEL, Hanford, and LANL are presented in Section 4.4.3.1.11.

4.4.3.1.4 Water Resources

Impacts on water resources at INEEL associated with operating ATR to irradiate neptunium-237 targets would be negligible as previously described in Section 4.4.1.1.4.

Impacts on water resources at Hanford associated with the operation of FMEF for target material storage, target fabrication, and processing would be similar to those described in Section 4.3.3.1.4. Specifically, the operation

of FMEF for this purpose would be likely to increase groundwater withdrawals in the Hanford 400 Area by approximately 19 million liters (5 million gallons). This would include approximately 15 million liters (4 million gallons) per year to primarily support FMEF cooling needs, as well as material processing activities, and an additional 3.8 million liters (1 million gallons) per year for potable and sanitary water demands due to increased staffing. However, no impact on regional groundwater levels would be expected from increased withdrawals. FMEF groundwater usage would constitute an increase of about 10 percent over the 197 million liters (52 million gallons) withdrawn annually in the 400 Area during standby operations. Sanitary wastewater discharges from FMEF would also increase by roughly 3.8 million liters (1 million gallons) per year to the Energy Northwest treatment system, which has sufficient capacity. Also, the operation of FMEF for target fabrication and processing would generate approximately 15 million liters (4 million gallons) per year of process wastewater. This wastewater would be discharged to the 400 Area process sewer system and ultimately to the 400 Area Pond (i.e., 4608 B/C percolation ponds) (Chapin 2000; Nielsen 1999:38, 39, 41). Because discharges to the pond are regulated under State Waste Discharge Permit No. ST-4501 and there are no radiological liquid effluent pathways to the environment from FMEF, the impact on groundwater quality would be negligible.

Waste management aspects of this option and their effects are further discussed in Section 4.4.3.1.13.

4.4.3.1.5 Geology and Soils

The irradiation of neptunium-237 targets in ATR would not be expected to result in impacts on geologic or soil resources at INEEL, nor be jeopardized by large-scale geologic conditions, for the reasons described in Section 4.4.1.1.5.

Because the existing FMEF would be used for neptunium-237 storage, target fabrication, and processing and the new 76-meter (250-foot) stack would be built on previously disturbed land, impacts on geologic resources and native soils would be negligible. Hazards from large-scale geologic conditions at Hanford, such as earthquakes and volcanoes, were previously evaluated as discussed in Sections 4.2.4.2.5 and 4.3.3.1.5 and found to present a low risk to FMEF operations.

As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.4.3.1.6 Ecological Resources

The irradiation of neptunium-237 targets in ATR would not result in impacts on ecological resources at INEEL for the reasons described in Section 4.4.1.1.6.

FMEF, an existing facility at Hanford, would be used for neptunium-237 target fabrication and processing. While a new 76-meter (250-foot) stack would be built, it would be placed on previously disturbed land in the 400 Area; thus, no natural terrestrial habitat would be lost. As noted in Section 4.4.3.1.2, there would be no sudden loud noises that would adversely impact wildlife. Because water usage and wastewater discharge would be small fractions of current values and discharge chemistry would not be expected to change, there would be no change in impacts on aquatic habitat or wetlands associated with the Columbia River (Section 4.4.3.1.4). Due to the developed nature of the area and the fact that construction would not disturb any natural habitat, impacts on threatened and endangered species would not occur. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. Consultations have also been initiated with the State of Washington.

4.4.3.1.7 Cultural and Paleontological Resources

The irradiation of neptunium-237 targets in ATR would not result in impacts on cultural and paleontological resources at INEEL for the reasons described in Section 4.4.1.1.7.

Neptunium-237 storage, target fabrication, and processing would take place at FMEF, which is in the 400 Area of Hanford. Although a new 76-meter (250-foot) stack would be built, it would be placed on previously disturbed land in the 400 Area; thus, impacts on cultural and paleontological resources would not be expected. No prehistoric, historic, or paleontological sites have been identified either in the 400 Area or within 2 kilometers (1.2 miles) of the 400 Area. Six buildings in the 400 Area have been determined to be eligible for listing on the National Register of Historic Places as contributing properties within the Historic District recommended for mitigation. The use of FMEF for neptunium-237 target fabrication and processing would not affect the eligibility of these structures for the National Register of Historic Places. No Native American resources are known to occur in the 400 Area. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office. Consultation has also been initiated with interested Native American tribes.

4.4.3.1.8 Socioeconomics

After facility modifications, startup, and testing of the plutonium-238 reactor operation facilities at INEEL and target fabrication/processing facilities at Hanford, approximately 62 additional workers would be required to operate these facilities (none at INEEL and 62 at Hanford) (Hoyt et al. 1999). This level of employment would not generate any indirect jobs in the region around INEEL. At Hanford, as this option would also include deactivation of FFTF, the additional workers could potentially transfer from FFTF. If not, this option could generate about 157 indirect jobs in the region around Hanford. The potential total employment increase of 219 direct and indirect jobs in the Hanford region represents less than 0.1 percent of the projected regional economic area workforce. It would have no noticeable impact on the regional economic area.

Additional employment resulting from this option would not have any noticeable impact on community services in the Hanford region of influence. Assuming that 91 percent of the new employment associated with this option would reside in Hanford's region of influence (refer to Section 3.4.8), 219 total new jobs could increase the region's population by approximately 370 persons. This increase, in conjunction with normal population growth forecasted by the State of Washington, would not have any noticeable effect on the availability of housing and/or the price of housing in the region of influence. Given the current population-to-student ratio in the region of influence, this would likely result in an increase of about 77 students, requiring local school districts to slightly increase the number of classrooms to accommodate them.

Community services in the region of influence would be expected to change to accommodate the population growth as follows: five new teachers would be needed to maintain the current student-to-teacher ratio of 16:1; one new police officer would need to be added to maintain the current officer-to-population ratio of 1.5:1000; one new firefighter would need to be added to maintain the current firefighter-to-population ratio of 3.4:1000; and one new doctor would be added to maintain the current physician-to-population ratio of 1.4:1000. Thus, an additional eight positions would have to be created to maintain community services at current levels. Hospitals in the region of influence would not experience any change from the 2.1 beds per 1,000 persons currently available. Additionally, the average school enrollment would not change. None of these projected changes should have a major impact on the level of community services currently offered in the region of influence.

4.4.3.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with Alternative 2, Option 3 are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from operations are given in **Table 4–74** for INEEL and Hanford: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual operations of ATR at INEEL and FMEF at Hanford, the projected total incremental population dose in the year 2020 would be 4.4×10^{-5} person-rem. The corresponding number of latent cancer fatalities in the populations surrounding INEEL and Hanford from 35 years of operations would be 7.7×10^{-7}. The total incremental dose to the maximally exposed member of the public from annual ATR operations would be 0 millirem because there would be no increase in radiological releases to the environment from ATR associated with this option. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would, therefore, be zero. The incremental dose to the maximally exposed member of the public from annual FMEF operations would be 4.7×10^{-7} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 8.2×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–75**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to ATR workers would be 0 millirem; for FMEF workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0 and approximately 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–75. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts at INEEL would be the same as those of ongoing site operations because no new chemicals would be emitted at ATR.

At Hanford, both carcinogenic and noncarcinogenic health effects from exposure to hazardous chemicals were evaluated. It was assumed that under normal operating conditions, the primary exposure pathway for members of the public would be from air emissions released through the process stack. Emissions of chemicals were estimated based on anticipated chemical usage. A worst-case dispersion modeling screening analysis was performed to estimate annual concentrations for each chemical, based on the emissions.

Table 4–74 Incremental Radiological Impacts on the Public Around INEEL and Hanford from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Receptor	INEEL ATR	Hanford FMEF	Total
Population within 80 kilometers (50 miles) in the year 2020			
Dose (person-rem)	0	4.4×10^{-5}	4.4×10^{-5}
35-year latent cancer fatalities	0	7.7×10^{-7}	7.7×10^{-7}
Maximally exposed individual			
Annual dose (millirem)	0	4.7×10^{-7}	NA[a]
35-year latent cancer fatality risk	0	8.2×10^{-12}	NA[a]
Average exposed individual within 80 kilometers (50 miles)			
Annual dose[b] (millirem)	0	8.9×10^{-8}	NA[a]
35-year latent cancer fatality risk	0	1.6×10^{-12}	NA[a]

a. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FMEF in the year 2020 (494,400).

Key: NA, not applicable.
Source: Model results, using the GENII computer code (Napier et al. 1988).

Table 4–75 Incremental Radiological Impacts on Involved INEEL and Hanford Workers from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Receptor—Involved Workers[a]	INEEL ATR	Hanford FMEF	Total
Total dose (person-rem per year)	0	22[b]	22
35-year latent cancer fatalities	0	0.31	0.31
Average worker dose (millirem per year)	0	290	NA[c]
35-year latent cancer fatality risk	0	0.0041	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 75 badged workers.
c. Values cannot be given for the average worker because the workers would be at two different facilities and sites.

Key: NA, not applicable.
Source: LMER 1997:22; Mecham 1999; Wham 1999b.

The annual concentration for each noncarcinogenic chemical was divided by the corresponding inhalation reference concentration to estimate the Hazard Quotient for each chemical. The Hazard Quotients were summed to give the Hazard Index from all noncarcinogenic chemicals associated with this option. A Hazard Index of less than one indicates that adverse health effects from non-cancer-causing agents are not expected. For carcinogens, the annual concentration was multiplied by the unit cancer risk to estimate the increased cancer risk from that chemical. Hazardous chemical health effects are summarized in **Table 4–76**.

Table 4–76 Incremental Hazardous Chemical Impacts on the Public Around Hanford Under Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Chemical	Modeled Annual Increment (milligrams per cubic meter)	RfC - Inhalation (milligrams per cubic meter)	Unit Cancer Risk (risk per milligram per cubic meter)	Hazard Quotient	Cancer Risk
Diethyl benzene	6.01×10^{-6}	1	0.0078	6.01×10^{-6}	4.69×10^{-8}
Methanol	2.19×10^{-7}	1.75	NA	1.25×10^{-7}	NA
Nitric acid	2.73×10^{-7}	0.1225	NA	2.22×10^{-6}	NA
Tributyl phosphate	1.13×10^{-5}	0.01	NA	0.00113	NA
			Hazard Index =	0.00114	

Note: For diethyl benzene, the reference concentration for ethyl benzene and the unit cancer risk for benzene were used to estimate Hazard Quotient and cancer risk because no information was available for diethyl benzene. For tributyl phosphate, the reference concentration for phosphoric acid was used to estimate the Hazard Quotient because no information was available for tributyl phosphate.
Key: NA, not applicable (the chemical is not a known carcinogen); RfC, reference concentration.
Source: DOE 1996a; EPA 1999; modeled increments are based on the SCREEN 3 computer code (EPA 1995).

4.4.3.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with ATR target irradiation and FMEF target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 mile) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are given in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–77** and **4–78**, respectively. Because ATR is currently operating, the consequences and risks are presented for both the current reactor configuration without neptunium-237 targets and for the worst-case neptunium-237 target-loading reactor configuration.

For 35 years of ATR target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.45×10^{-7} and 3.48×10^{-6}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00140.

For 35 years of FMEF target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 2.88×10^{-6} and

3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.112.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 2.88×10^{-6} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.114.

The irradiation of neptunium-237 targets to produce plutonium-238 at ATR would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of neptunium-237 targets at ATR.

No chemical processing activities are currently performed at FMEF and no chemicals are stored in this facility. Processing activities in support of plutonium-238 production would require the introduction of hazardous chemicals, specifically nitric acid and nitric oxide. Potential health impacts from accidental releases of nitric acid were assessed by comparing estimated airborne concentrations of the chemicals to Emergency Response Planning Guidelines (ERPG) developed by the American Industrial Hygiene Association. The ERPG-1 value (0.5 part per million) is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour, resulting in only mild, transient, and reversible adverse health effects. The ERPG-2 value (10 parts per million) is protective of irreversible or serious health effects or impairment of an individual's ability to take protective action. The ERPG-3 value (25 parts per million) is indicative of potentially life threatening health effects.

Table 4–77 ATR and FMEF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
ATR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	0.465	2.33×10^{-4}	5.11×10^{4}	25.5	5.15	0.00206
Large-break LOCA with 5 kg/yr plutonium-238 production	0.604	3.02×10^{-4}	5.17×10^{4}	25.9	7.61	0.00304
Target handling with 0 kg/yr plutonium-238 production	0.0	0.0	0.0	0.0	0.0	0.0
Target handling with 5 kg/yr plutonium-238 production	2.05×10^{-4}	1.03×10^{-7}	0.128	6.41×10^{-5}	0.00324	1.30×10^{-6}
FMEF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.02×10^{-9}	1.01×10^{-12}	7.26×10^{-5}	3.63×10^{-8}	6.65×10^{-10}	2.66×10^{-13}
Target dissolver tank failure during plutonium-238 separation	4.64×10^{-8}	2.32×10^{-11}	0.00169	8.47×10^{-7}	1.95×10^{-8}	7.81×10^{-12}
Ion exchange explosion during plutonium-238 separation	1.24×10^{-5}	6.18×10^{-9}	0.451	2.25×10^{-4}	5.20×10^{-6}	2.08×10^{-9}
Processing facility beyond-design-basis earthquake	16.5	0.0165	6.41×10^{5}	321	921	1.0[d]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be no associated accident consequences.
d. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–78 ATR and FMEF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual ATR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (1×10^{-4})	2.33×10^{-8}	0.00255	2.06×10^{-7}
Large-break LOCA with 5 kg/yr plutonium-238 production (1×10^{-4})	3.02×10^{-8}	0.00259	3.04×10^{-7}
Target handling with 0 kg/yr plutonium-238 production[c]	0.0	0.0	0.0
Target handling with 5 kg/yr plutonium-238 production (0.001)	1.03×10^{-10}	6.41×10^{-8}	1.30×10^{-9}
35-year ATR risk[d]	2.45×10^{-7}	0.00140	3.48×10^{-6}
Annual FMEF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	3.63×10^{-10}	2.66×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	2.32×10^{-13}	8.47×10^{-9}	7.81×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	6.18×10^{-11}	2.25×10^{-6}	2.08×10^{-11}
Processing facility beyond-design-basis earthquake (1×10^{-5})	8.23×10^{-8}	0.00321	1.00×10^{-5}[(e)]
35-year FMEF risk	2.88×10^{-6}	0.112	3.50×10^{-4}
35-year Option risk	2.88×10^{-6}	0.114	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be no associated accident risks.
d. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.
e. Risk of an early fatality.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

The maximum distances, in meters, needed to reach the ERPG values for nitric acid releases at FMEF for Stability Classes D and F are shown in **Table 4–79**. Two separate atmospheric conditions were evaluated, Stability Classes D and F. Stability Class D represents average meteorological conditions while Stability Class F represents worst-case meteorological conditions. The number of involved and noninvolved workers potentially exposed would vary with a number of factors such as the time of day and whether they are sheltered within buildings at the time of release. Individuals at the nearest access road (7,100 meters [4.4 miles]) and at the nearest site boundary (7,210 meters [4.5 miles]) from FMEF would be exposed to levels well below ERPG-1.

Table 4–79 ERPG Distances for Nitric Acid Releases at FDPF Under Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Evaluation Parameter	Stability Class D (meters)	Stability Class F (meters)
ERPG-3	375	450
ERPG-2	500	600
ERPG-1	2,000	3,000

Note: To convert from meters to miles, multiply by 6.22×10^{-4}.
Key: ERPG, Emergency Response Planning Guideline.

There are no ERPG values for nitric oxide. For nitric oxide accidents, the level of concern has been estimated by using one-tenth of the "Immediately Dangerous to Life and Health" level published by the National Institute for Occupational Safety and Health. The Immediately Dangerous to Life and Health value for nitric oxide is 100 parts per million. The level of concern value used for this NI PEIS is 10 parts per million. The level of concern is defined as the concentration of an extremely hazardous substance in air above which there may be serious irreversible health effects as a result of a single exposure for a relatively short period of time.

For FMEF, the maximum distances needed to reach the level of concern for nitric oxide releases for Stability Classes D and F are 500 and 2,000 meters (0.31 and 1.24 miles), respectively. The number of involved and noninvolved workers potentially exposed would vary with a number of factors such as the time of day and whether they are sheltered within buildings at the time of release. Individuals at the nearest access road (7,100 meters [4.4 miles]) and at the nearest site boundary (7,210 meters [4.5 miles]) from FMEF would be exposed to levels well below the level of concern for nitric oxide.

Potential health impacts from the accidental release of the hazardous chemicals were assessed for offsite individuals who are members of the public located at the nearest site boundary and onsite individuals who are members of the public located at the nearest point of public access onsite.

The impacts associated with the accidental release of nitric acid and nitric oxide at FMEF are presented in **Table 4–80**.

Table 4–80 FMEF Hazardous Chemical Accident Impacts Under Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Receptor	Evaluation Parameter	Nitric Acid		Nitric Oxide	
		Stability Class D	Stability Class F	Stability Class D	Stability Class F
Onsite individual	Parts per million Level of concern Potential health effects	0.03 < ERPG-1 None	0.1 ERPG-1 Mild, transient	0.09 < LOC None	0.55 < LOC None
Offsite individual	Parts per million Level of concern Potential health effects	0.03 < ERPG-1 None	0.1 ERPG-1 Mild, transient	0.09 < LOC None	0.53 < LOC None

Key: ERPG, Emergency Response Planning Guideline; LOC, level of concern.
Note:< means "less than."
Source: Model results.

4.4.3.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the FMEF target fabrication facility at Hanford. DOE would transport the unirradiated neptunium-237 targets from FMEF to ATR at INEEL. Following irradiation in ATR, the targets would be returned to FMEF for processing. After this processing, the plutonium-238 product would be shipped to LANL. The analysis is described in Appendix J.

Approximately 763 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 1.2 million kilometers (0.72 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 8 person-rem; the dose to the public, 109 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0031 latent cancer fatality among transportation workers and 0.055 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 0.0027.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FMEF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 were also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 0.06 person-rem, resulting in 3.0×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.019 traffic fatality.

4.4.3.1.12 Environmental Justice

NORMAL OPERATIONS. For 35 years of normal operations under this option, the likelihood of an incremental latent cancer fatality among the populations residing within 80 kilometers (50 miles) of ATR and FMEF would be essentially zero (derived from information in Table 4–74). As shown in Table 4–76, the release of hazardous chemicals at Hanford would pose no significant risk of cancer or toxic effects among the public. As discussed in Sections K.5.1 and K.5.3 of Appendix K, the number of latent cancer fatalities that would result from the ingestion of food that could be radiologically contaminated due to normal operations would be essentially zero at INEEL and approximately 0.001 at Hanford. No credible pattern of food consumption by persons residing in potentially affected areas would result in significant health risks due to radiological contamination of food supplies near INEEL or Hanford. As discussed in Section 4.4.3.1.11, no fatalities would be expected from incident-free transportation activities.

ACCIDENTS. The number of a latent cancer fatalities among the populations at risk due to radiological accidents listed in Table 4–77 would be approximately 0.11. If a radiological accident were to occur at ATR and northwesterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Fort Hall Indian Reservation (see Figure K–2). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the population or maximally exposed individual residing within the boundary of the Fort Hall Indian Reservation. If a radiological accident were to occur at FMEF and northeasterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Yakama Indian Reservation (see Figure K–11). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the population or maximally exposed individual residing within the boundary of Yakama Indian Reservation.

As discussed in Section 4.4.3.1.11, no fatalities would be expected to result from transportation accidents.

In summary, the implementation of this option would pose no significant radiological risk to persons residing in potentially affected areas or along representative transportation routes. Under the conservative assumption that all food consumed in potentially affected areas during the 35-year operational period would be radioactively contaminated, no credible pattern of food consumption would pose a significant radiological health risk due to the ingestion of contaminated food supplies. As discussed in other parts of Section 4.4.3.1, the implementation of this option would not result in significant nonradiological impacts on populations at risk. Thus, implementation would not pose significant and adverse environmental risks to persons residing within potentially affected areas, including minority and low-income persons.

4.4.3.1.13 Waste Management

Only an extremely small amount of additional waste would be generated as a result of irradiating neptunium-237 targets in ATR (Section 4.4.1.1.13). Therefore, no impacts on the waste management systems at INEEL would be anticipated. However, there would be impacts on Hanford's waste management systems as a result of FMEF operations to fabricate and process neptunium-237 targets for plutonium-238 production.

The expected generation rates of wastes at Hanford that would be associated with the operation of FMEF for this target fabrication and processing are compared with Hanford's treatment, storage, and disposal capacities in **Table 4–81**. The impacts on the Hanford waste management systems, in terms of managing these additional wastes, are discussed in this section. Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.4.3.1.9 through 4.4.3.1.11.

The canisters used to transport neptunium-237 to the site would constitute a very small additional amount of solid low-level radioactive waste—less than 10 cubic meters (13.1 cubic yards) over the 35-year operational period, even if no credit is taken for volume reduction by compaction (Brunson 1999a). The annual generation of this waste would fall within the range of accuracy of the solid low-level radioactive waste generation rate given in Table 4–81, and its management need not be addressed separately.

In accordance with the Records of Decision for the *Waste Management PEIS* (DOE 1997a), wastes could be treated and disposed of on site at Hanford or at other DOE sites or commercial facilities. Based on the Record of Decision for transuranic waste issued on January 20, 1998 (63 FR 3629), transuranic waste would be certified on site and eventually shipped to a suitable geologic repository for disposal. Based on the Record of Decision for hazardous waste issued on August 5, 1998 (63 FR 41810), nonwastewater hazardous waste would continue to be treated and disposed of at offsite commercial facilities.

Based on the Record of Decision for low-level radioactive waste and mixed low-level radioactive waste issued on February 18, 2000 (65 FR 10061), minimal treatment of low-level radioactive waste will be performed at all sites and, to the extent practicable, onsite disposal of low-level radioactive waste will continue. Hanford and the Nevada Test Site will be made available to all DOE sites for disposal of low-level radioactive waste. Mixed low-level radioactive waste analyzed in the *Waste Management Programmatic PEIS* will be treated at Hanford, INEEL, ORR, and SRS and will be disposed at Hanford and the Nevada Test Site.

It is also assumed in this NI PEIS that low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous waste would be treated, stored, and disposed of in accordance with current and developing site practices. No high-level radioactive waste would be associated with neptunium-237 target fabrication or processing in FMEF.

Table 4–81 Incremental Waste Management Impacts of Operating FMEF at Hanford Under Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Waste Type[a]	Estimated Additional Waste Generation[b] (cubic meters per year)	Estimated Additional Waste Generation as a Percent of[c]		
		Onsite Treatment Capacity	Onsite Storage Capacity	Onsite Disposal Capacity
Transuranic[d]	11	(e)	2.3	NA
Low-level radioactive				
Liquid	6	(f)	(f)	(f)
Solid	54	NA	NA	0.82
Mixed low-level radioactive	<5	0.27	1.0	1.2
Hazardous	18	NA	NA	NA
Nonhazardous				
Process wastewater	15,000	(f)	(f)	(f)
Sanitary wastewater	3,800	1.6[g]	NA	NA
Solid	150	NA	NA	NA

a. See definitions in Appendix G.9.
b. Assumed to be equal to the generation rates of REDC at ORR.
c. The estimated additional amounts of waste generated annually are compared with the annual site treatment capacities. For nonhazardous liquid waste, the estimated additional annual generation rate is also compared with the annual site disposal capacity. The estimated total amounts of additional waste generated over the 35-year operational period are compared with the site's storage capacities, and, for other than nonhazardous liquid waste, with the site's disposal capacities.
d. Includes mixed transuranic waste. The transuranic waste, as given in this table, is in the form of a solid. Facilities are not expected to generate remotely handled transuranic waste.
e. Appropriate waste treatment and certification for disposal would be identified by the Hanford site waste management contractor in order to meet the waste acceptance criteria for the suitable geologic repository.
f. Refer to the text.
g. Percent of capacity of the Energy Northwest system.

Note: To convert from cubic meters per year to cubic yards per year, multiply by 1.308; < means "less than."

Key: NA, not applicable (i.e., the majority of this waste is not routinely treated or is not routinely stored or is not routinely disposed of on site; refer to the text).

Source: Brunson 1999b; Chapin 2000; DOE 1999a; DOE 2000a; Hoyt et al. 1999; Nielsen 1999; Wham 1999d.

Neptunium-237 fabrication and processing in FMEF would generate a total of 385 cubic meters (504 cubic yards) of transuranic waste over the 35-year operational period. This waste would be considered nondefense transuranic waste and, therefore, under current legislation, could not be disposed of at WIPP. Therefore, this waste would be stored on site pending availability of a suitable geologic repository for permanent disposal. Because this waste has no current disposition path, DOE Headquarters' approval, as required by DOE Order 435.1, would be necessary before a decision were made to generate this waste. If all the additional transuranic waste generated over the 35-year operational period were stored on site, it would represent 2.3 percent of the 17,000-cubic-meter (22,200-cubic-yard) storage capacity available at Hanford. Assuming that the waste were stored in 208-1iter (55-gallon) drums that could be stacked two high, and allowing a 50 percent factor for aisle space, a storage area of only 0.069 hectare (0.17 acre) would be required. Therefore, impacts of managing the additional quantities of transuranic waste at Hanford would be minimal.

Solid low-level radioactive waste would be packaged, certified, and accumulated at FMEF before transfer for additional treatment and disposal in existing onsite facilities. Neptunium-237 target fabrication and processing would generate 1,890 cubic meters (2,470 cubic yards) of low-level radioactive waste over the 35-year operational period. This amount of low-level radioactive waste represents approximately 0.11 percent of the 1.74 million-cubic-meter (2.28 million-cubic-yard) capacity of the low-level radioactive waste Burial Grounds and 0.82 percent of the 230,000-cubic-meter (301,000-cubic-yard) capacity of the Grout Vaults. Using the 3,480-cubic-meter-per-hectare (1,842-cubic-yard-per-acre) disposal land usage factor for Hanford published in the *Storage and Disposition PEIS* (DOE 1996a:E-9), 1,890 cubic meters (2,470 cubic yards) of waste would

require 0.54 hectares (1.3 acres) of disposal space at Hanford. The impacts of managing this additional low-level radioactive waste at Hanford would be minimal.

Liquid low-level radioactive waste associated with target fabrication and processing at FMEF would be transported to the 200 Area Effluent Treatment Facility for processing and ultimate disposal. Target fabrication and processing at FMEF would generate about 210 cubic meters (270 cubic yards) of liquid low-level radioactive waste over the 35-year operational period. This total amount of additional liquid low-level radioactive waste represents a small amount of waste which can be managed by the 200 Area Liquid Effluent Treatment Facility with an operating capacity of 0.57 cubic meter (0.75 cubic yard) per minute.

Mixed low-level radioactive waste would be stabilized, packaged, and stored on site for treatment and disposal in a manner consistent with the Tri-Party Agreement (EPA et al. 1989) for Hanford. Over the 35-year operational period, 175 cubic meters (229 cubic yards) of mixed low-level radioactive waste would be generated at FMEF associated with neptunium-237 target fabrication and processing. This mixed low-level radioactive waste is expected to be treated at a nearby commercial facility. However, if this waste were treated on site, it is estimated to be 0.27 percent of the 1,820-cubic-meter-per-year (2,380-cubic-yard-per-year) capacity of the Waste Receiving and Processing Facility. This waste also represents 1.0 percent of the 16,800-cubic-meter (22,000-cubic-yard) storage capacity of the Central Waste Complex and 1.2 percent of the 14,200-cubic-meter (18,600-cubic-yard) planned disposal capacity of the Radioactive Mixed Waste Disposal Facility. Therefore, this additional waste would only have a minimal impact on the management of mixed low-level radioactive waste at Hanford.

Hazardous wastes generated during operation would be packaged in DOT-approved containers and shipped off site to permitted commercial recycling, treatment, and disposal facilities. The additional waste load generated during the operational period would have only a minimal impact on the Hanford hazardous waste management system.

Nonhazardous solid waste would be packaged and transported in conformance with standard industrial practice. Solid wastes such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent off site for that purpose. The remaining solid sanitary waste would be sent for offsite disposal. This additional waste load would have only a minimal impact on the nonhazardous solid waste management system at Hanford.

Nonhazardous process wastewater would be discharged into the 400 Area Ponds. This discharge is regulated by State Waste Discharge Permit ST-4501.

Nonhazardous sanitary wastewater would be discharged to the 400 Area sanitary sewer system, which connects to the Energy Northwest Sewage Treatment Facility. Nonhazardous sanitary wastewater generated from neptunium-237 target fabrication and processing in FMEF would represent 1.6 percent of the 235,000-cubic-meter-per-year (307,000-cubic-yard-per-year) capacity of the Energy Northwest Sewage Treatment Facility and would be well within the 138,000-cubic-meter-per-year (181,000-cubic-yard-per-year) excess capacity of this facility (DOE 1999a). Management of nonhazardous liquid waste at Hanford would only have a minimal impact on the treatment system.

The generation rates of wastes at Hanford that would be associated with this option (refer to Table 4–81) can be compared with the current waste generation rates at the site, given in Table 3–26 (Section 3.4.11). The waste generation rates associated with plutonium-238 production would be much smaller than the current waste generation rates at the site.

4.4.3.1.14 Spent Nuclear Fuel Management

No incremental impacts would be associated with the management of spent nuclear fuel (refer to Section 4.4.1.1.14).

4.4.3.2 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.4.4 Alternative 2 (Use Only Existing Operational Facilities)—Option 4

Option 4 involves operating a commercial light water reactor (CLWR) at an unspecified location to irradiate neptunium-237 targets, and operating the REDC facility at ORR to fabricate and process these targets and to store the neptunium-237 transported to ORR from SRS.

The transportation of the neptunium-237 from SRS to ORR for processing and fabrication into neptunium-237 targets in REDC, the transportation of the targets from ORR to the generic CLWR site for irradiation, the transportation of the irradiated targets back to ORR for postirradiation processing in REDC, and the transportation of the plutonium-238 product from ORR to LANL also constitute part of this option.

All options under this alternative include the permanent deactivation of FFTF at Hanford.

4.4.4.1 Operations and Transportation

Environmental impacts associated with storage, processing, and irradiation operations and with all transportation activities are assessed in this section.

4.4.4.1.1 Land Resources

LAND USE. A currently operating CLWR would be used to irradiate neptunium-237 targets. There would be no impacts on land use because no new construction would be required, and use of the facility for target irradiation would be compatible with is current function.

There would be no impacts on land use at ORR from neptunium-237 storage, target fabrication, and processing at REDC for the reasons described in Section 4.4.1.1.1.

VISUAL RESOURCES. There would be no impacts on visual resources because use of a CLWR for neptunium-237 target irradiation would not require any external modifications that would alter the appearance of the facility.

There would be no impacts on visual resources at ORR from neptunium-237 storage, target fabrication, and processing at REDC for the reasons described in Section 4.4.1.1.1.

4.4.4.1.2 Noise

Noise associated with the irradiation of neptunium-237 targets at a CLWR site would be indistinguishable from other noises generated during normal operation of the facility. Noise associated with increased traffic going to and from the facility would be low and would result in only minor changes to existing onsite and offsite noise levels. Neptunium-237 target irradiation in a CLWR would not produce any sudden loud noises that would adversely affect wildlife.

Noise impacts at ORR would be minimal from neptunium-237 storage, target fabrication, and processing at REDC and changes in traffic noise would be minimal for the reasons described in Section 4.4.1.1.2.

4.4.4.1.3 Air Quality

It is expected that there would be no measurable increases in nonradiological air pollutant emissions at a CLWR site associated with this option; therefore, no changes in nonradiological air quality impacts would be expected.

Impacts for this option at ORR would be the same as those described for Option 1 (Section 4.4.1.1.3).

The air quality impacts of transportation among SRS, the generic site, ORR, and LANL are presented in Section 4.4.4.1.11.

4.4.4.1.4 Water Resources

No measurable impact on water resources at a CLWR site is expected under this option, because neptunium-237 target irradiation would not measurably increase water use or change the quantity or quality of effluent discharges. Information on water resources for the generic CLWR site is presented in Section 3.5.4.

Impacts for this option at ORR would be substantially the same as described for Option 1 (Section 4.4.1.1.4).

4.4.4.1.5 Geology and Soils

This option involves the irradiation of neptunium-237 targets in a CLWR. Because no new construction would take place, geologic and soil resources within the site area would not be disturbed. Assessment of hazards from large-scale geologic conditions for reactor sites, including assessment of seismic and nonseismic features, is governed by 10 CFR Part 100 and is beyond the scope of this analysis. Information on geology and soils for the generic CLWR site is presented in Section 3.5.5.

Neptunium-237 storage, target fabrication, and processing at REDC would not be expected to impact geologic and soil resources at ORR, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.2.2.5 and 4.4.1.1.5. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.4.4.1.6 Ecological Resources

A currently operating CLWR would be used to irradiate neptunium-237 targets. Terrestrial resources and wetlands would not be adversely affected because no new construction would be required. Further, as noted in Section 4.4.4.1.2, there would be no loud noises that would adversely affect wildlife. The irradiation of neptunium-237 targets would not impact aquatic resources because there would be no measurable change in water withdrawal or wastewater discharge (Section 4.4.4.1.4). Threatened and endangered species would not be impacted for the reasons noted above.

Impacts on ecological resources at ORR would not result from neptunium-237 storage, target fabrication, and processing at REDC for the reasons described in Section 4.4.1.1.6.

4.4.4.1.7 Cultural and Paleontological Resources

The irradiation of neptunium-237 targets would take place in a currently operating CLWR. Because no new construction would take place, impacts on cultural and paleontological resources would not occur.

Impacts on cultural and paleontological resources at ORR would not result from neptunium-237 storage, target fabrication, and processing at REDC for the reasons described in Section 4.4.1.1.7.

4.4.4.1.8 Socioeconomics

Reactor operations at a CLWR site would not require additional workers. Target fabrication and processing of plutonium-238 at ORR would require approximately 41 additional workers (Wham et al. 1998). The socioeconomic impacts at ORR are the same as those addressed in Section 4.3.1.1.8.

4.4.4.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from operations are given in **Table 4–82** for the generic CLWR site and ORR: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

Target irradiation in a CLWR would not result in any incremental radiological emissions during normal operations or increased worker exposures. Therefore, the incremental impact of CLWR target irradiation is zero.

Table 4–82 Incremental Radiological Impacts on the Public Around the Generic CLWR Site and ORR from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 4

Receptor	Generic CLWR	ORR REDC	Total
Population within 80 kilometers (50 miles) in the year 2020			
Dose (person-rem)	0	8.8×10^{-5}	8.8×10^{-5}
35-year latent cancer fatalities	0	1.5×10^{-6}	1.5×10^{-6}
Maximally exposed individual			
Annual dose (millirem)	0	1.9×10^{-6}	NA[a]
35-year latent cancer fatality risk	0	3.3×10^{-11}	NA[a]
Average exposed individual within 80 kilometers (50 miles)			
Annual dose[b] (millirem)	0	7.8×10^{-8}	NA[a]
35-year latent cancer fatality risk	0	1.4×10^{-12}	NA[a]

a. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of REDC in the year 2020 (1,134,200).
Key: NA, not applicable.
Source: Model results, using the GENII computer code (Napier et al. 1988).

As a result of annual operations of the generic CLWR and REDC, the projected total incremental population dose in the year 2020 would be 8.8×10^{-5} person-rem. The corresponding number of latent cancer fatalities in the populations surrounding the generic CLWR site and ORR from 35 years of operations would be 1.5×10^{-6}. The total incremental dose to the maximally exposed member of the public from annual generic CLWR operations would be 0 millirem because there would be no increase in radiological releases to the environment from the generic CLWR associated with this option. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would, therefore, be zero. The incremental dose to the maximally exposed member of the public from annual REDC operations would be 1.9×10^{-6} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 3.3×10^{-11}.

Incremental doses to involved workers from normal operations are given in **Table 4–83**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to generic CLWR workers would be 0 millirem; for REDC workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0 and approximately 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–83. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts at the generic CLWR site would be the same as those of ongoing site operations because no new chemicals would be emitted.

Hazardous chemical impacts for this option at ORR were determined to be the same as described for Option 1 (Section 4.4.1.1.9).

Table 4–83 Incremental Radiological Impacts on Involved CLWR and ORR Workers from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 4

Receptor—Involved Workers[a]	Generic CLWR	ORR REDC	Total
Total dose (person-rem per year)	0	22[b]	22
35-year latent cancer fatalities	0	0.31	0.31
Average worker dose (millirem per year)	0	290	NA[c]
35-year latent cancer fatality risk	0	0.0041	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with REDC operations at a DOE facility would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced at all facilities.
b. Based on an estimated 75 badged workers.
c. Values cannot be given for the average worker because the workers would be at two different facilities and sites.
Key: NA, not applicable.
Source: LMER 1997:22; Wham 1999b.

4.4.4.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with target irradiation in a generic CLWR and REDC target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual (MEI) and the offsite population within 80 kilometers (50 miles) of the facility. Consequences to a noninvolved worker are not included for the generic CLWR analysis. Details regarding the exclusion of a noninvolved worker are provided in Appendix I.

Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality for an individual and as the increased number of latent cancer fatalities in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are given in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–84** and **4–85**, respectively. Certain extremely unlikely or incredible severe accidents at commercial nuclear reactors could result in doses sufficiently high to cause early fatalities. The early fatality consequences and risks are presented in **Table 4–86**. The early fatalities shown in Table 4–86 are considered to be conservative estimates based upon the assumption that some individuals very close to the reactor do not evacuate. Because the generic CLWR is operational, the consequences and risks are presented for both the current reactor configuration without neptunium-237 targets and for the worst-case neptunium-237 target-loading reactor configuration. Baseline accident risks attributed to generic CLWR operations refer to accidents that could occur under the current CLWR configuration

Table 4–84 Generic CLWR and REDC Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 4

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
Generic CLWR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	0.0312	1.56×10^{-5}	173	0.0866	NA[c]	NA
Large-break LOCA with 5 kg/yr plutonium-238 production	0.0313	1.57×10^{-5}	174	0.0869	NA	NA
Early containment failure with 0 kg/yr plutonium-238 production	3,350	1.00[d]	2.05×10^{6}	1,330	NA	NA
Early containment failure with 5 kg/yr plutonium-238 production	3,670	1.00[d]	2.18×10^{6}	1,420	NA	NA
Late containment failure with 0 kg/yr plutonium-238 production	1.11	5.55×10^{-4}	1.00×10^{5}	50.2	NA	NA
Late containment failure with 5 kg/yr plutonium-238 production	1.12	5.60×10^{-4}	1.00×10^{5}	50.2	NA	NA
Containment bypass with 0 kg/yr plutonium-238 production	1,540	1.00[d]	1.57×10^{6}	1,020	NA	NA
Containment bypass with 5 kg/yr plutonium-238 production	1,680	1.00[d]	1.65×10^{6}	1,080	NA	NA
REDC accidents						
Ion exchange explosion during neptunium-237 target fabrication	6.13×10^{-9}	3.06×10^{-12}	8.58×10^{-5}	4.29×10^{-8}	5.60×10^{-10}	2.24×10^{-13}
Target dissolver tank failure during plutonium-238 separation	1.76×10^{-7}	8.79×10^{-11}	0.00196	9.82×10^{-7}	1.09×10^{-8}	6.74×10^{-12}
Ion exchange explosion during plutonium-238 separation	4.68×10^{-4}	2.34×10^{-7}	5.23	0.00261	4.49×10^{-5}	1.79×10^{-8}
Processing facility beyond-design-basis earthquake	163	0.163	8.91×10^{5}	445	1,310	1.00[d]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Not applicable (refer to Appendix I). Evacuation of noninvolved workers and other noninvolved worker issues are addressed in Appendix I.
d. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident; NA, not applicable.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–85 Generic CLWR and REDC Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 4

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual generic CLWR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (4.65×10^{-5})	7.25×10^{-10}	4.03×10^{-6}	NA[c]
Large-break LOCA with 5 kg/yr plutonium-238 production (4.65×10^{-5})	7.30×10^{-10}	4.04×10^{-6}	NA
Early containment failure with 0 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}[(d)]	1.05×10^{-4}	NA
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}[(d)]	1.12×10^{-4}	NA
Late containment failure with 0 kg/yr plutonium-238 production (1.07×10^{-5})	5.94×10^{-9}	5.37×10^{-4}	NA
Late containment failure with 5 kg/yr plutonium-238 production (1.07×10^{-5})	5.99×10^{-9}	5.37×10^{-4}	NA
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}[(d)]	0.00156	NA
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}[(d)]	0.00165	NA
35-year CLWR risk[d]	1.93×10^{-9}	0.00340	NA
Annual REDC risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	3.06×10^{-14}	4.29×10^{-10}	2.24×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	8.79×10^{-13}	9.82×10^{-9}	6.74×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	2.34×10^{-9}	2.61×10^{-5}	1.79×10^{-10}
Processing facility beyond-design-basis earthquake (1×10^{-5})	1.63×10^{-6}	0.00445	1.00×10^{-5}[(e)]
35-year REDC risk	5.71×10^{-5}	0.157	3.50×10^{-4}
35-year Option risk	5.71×10^{-5}	0.160	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Not applicable (refer to Appendix I). Evacuation of noninvolved workers and other noninvolved worker issues are addressed in Appendix I.
d. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.
e. Risk of an early fatality.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident; NA, not applicable.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–86 Generic CLWR Early Fatalities and Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 4

Accident (Frequency)	Population to 80 Kilometers (50 Miles)	
	Early Fatalities[a]	Annual Risk[b]
Annual generic CLWR risks		
Early containment failure with 0 kg/yr plutonium-238 production (7.92×10^{-8})	28.9	2.29×10^{-6}
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	29.4	2.33×10^{-6}
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	7.86	1.20×10^{-5}
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	7.93	1.21×10^{-5}
35-year CLWR risk[c]	NA	4.90×10^{-6}

a. Number of early fatalities assuming that the accident has occurred.
b. Risk of an early fatality.
c. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; NA, not applicable.
Source: Model results, using the MACCS2 computer code (Chanin and Young 1997).

(without neptunium-237 targets). Baseline accident risks are obtained from the data in Tables 4–85 and 4–86 by summing the annual risks for the baseline CLWR configuration (0 kilograms per year plutonium-238 production), and then multiplying the sum by 35. The baseline CLWR accident risk to the public would be 0.0078 latent cancer fatality. Baseline CLWR accident risks to the maximally exposed offsite individual would be 5.7×10^{-5} latent cancer fatality. Baseline risk to noninvolved workers is discussed in Appendix I.

For 35 years of CLWR target fabrication and irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual would be 1.93×10^{-9}. The increased number of latent cancer fatalities in the surrounding population would be 0.00340. The increased risk of an early fatality in the surrounding population would be 4.90×10^{-6}.

For 35 years of REDC target fabrication and processing, the increased risk of a latent cancer fatality to the MEI and of an early fatality to a noninvolved worker would be 5.71×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.157.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 5.71×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.160.

The irradiation of neptunium-237 targets at the generic CLWR would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of neptunium-237 targets at the generic CLWR.

Processing associated with the plutonium-238 production program at REDC, including storage of neptunium-237 and plutonium-238, neptunium-237 target fabrication, postirradiation processing to extract plutonium-238 and to recycle the unconverted neptunium-237 into new targets, does not require the introduction of hazardous chemicals that are not in current use in the facility. The quantities of in-process hazardous chemicals for the plutonium-238 production program are bounded by the quantities of the material currently stored in the facility. The impacts of in-process hazardous chemical accidents associated with the

plutonium-238 production are bounded by the impacts of hazardous chemical accidents for existing storage facilities at REDC.

4.4.4.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the REDC target fabrication facility at ORR. DOE would transport the unirradiated neptunium-237 targets from REDC to a CLWR. Following irradiation in a CLWR, the targets would be returned to REDC for processing. After this processing, the plutonium-238 product would be shipped to LANL. The impact analysis, described in Appendix J, assumes the most distant CLWR is used for target irradiation.

Approximately 763 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 2.7 million kilometers (1.7 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 15 person-rem; the dose to the public, 304 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0059 latent cancer fatality among transportation workers and 0.15 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 0.0059.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to REDC with a severity category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 were also evaluated and estimated to have a probability of lower than 1 in 10 million per year.

Estimates of the total ground transportation accident risks are as follows: a radiological dose to the population of 0.088 person-rem, resulting in 4.4×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.075 traffic fatality.

4.4.4.1.12 Environmental Justice

Under this option, neptunium-237 targets would be irradiated in a CLWR at an unspecified site. Target fabrication and processing would be performed at REDC located at ORR. Activities at REDC were evaluated under other alternatives and options in this NI PEIS (e.g., Section 4.4.1.1.12) and found to pose no significant radiological or other risks to minority and low-income populations. The analysis of accidents at specific sites shows that accidents at the fabrication and target facilities would result in radiological risks to the public that are small, but which are several orders of magnitude larger than those that would result from accidents at specific reactor sites. It is plausible that a similar difference would exist between accident risks at an unspecified CLWR site and the fabrication and processing facilities. However, evaluations of environmental justice are necessarily site specific and cannot be performed for unspecified locations. In the event that this option were selected for implementation and a specific CLWR were selected for irradiation services, additional evaluation of environmental justice at the CLWR site would be performed prior to implementation.

4.4.4.1.13 Waste Management

There would be no change in the amounts of wastes generated as the result of irradiating neptunium-237 targets in a CLWR. Thus, there would be no impact on the CLWR site's waste management systems as the result of target irradiation.

The impacts of managing wastes associated with neptunium-237 target fabrication and processing in REDC are assumed to be the same as for Option 1 under Alternative 1 (Section 4.3.1.1.13) because the same amount of plutonium-238 would be produced annually. As shown in that section, the impacts on the waste management systems at ORR would be minimal.

4.4.4.1.14 Spent Nuclear Fuel Management

No incremental impacts would be associated with the management of spent nuclear fuel (refer to Section 4.4.1.1.14).

4.4.4.2 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.4.5 Alternative 2 (Use Only Existing Operational Facilities)—Option 5

This option involves operating a generic CLWR at a generic site to irradiate neptunium-237 targets, and operating FDPF at INEEL to fabricate and process these targets. This option also includes storage of the neptunium-237 transported to INEEL from SRS, in either Building CPP–651 or FDPF.

The transportation of the neptunium-237 from SRS to INEEL for processing and fabrication into neptunium-237 targets in FDPF, the transportation of the targets from INEEL to the generic CLWR site for irradiation in the CLWR, the transportation of the irradiated targets back to INEEL for postirradiation processing in FDPF, and the transportation of the plutonium-238 product from INEEL to LANL also constitute part of this option.

All options under this alternative include the permanent deactivation of FFTF at Hanford.

4.4.5.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all intersite transportation activities, are assessed in this section.

4.4.5.1.1 Land Resources

LAND USE. The use of a CLWR to irradiate neptunium-237 targets would not be expected to result in impacts on land use for the reasons described in Section 4.4.4.1.1.

Impacts on land use at INEEL from neptunium-237 storage, target fabrication, and processing would not result for the reasons described in Section 4.4.2.1.1.

VISUAL RESOURCES. The use of a CLWR to irradiate neptunium-237 targets would not result in impacts on visual resources for the reasons described in Section 4.4.4.1.1.

Impacts on visual resources at INEEL from neptunium-237 storage, target fabrication, and processing would not result for the reasons described in Section 4.4.2.1.1.

4.4.5.1.2 Noise

The irradiation of neptunium-237 targets in a CLWR would not be expected to result in noise impacts for the reasons described in Section 4.4.4.1.2.

Noise impacts at INEEL would not be expected from neptunium-237 storage, target fabrication, and processing and changes in traffic noise would be small for the reasons described in Section 4.4.2.1.2.

4.4.5.1.3 Air Quality

Impacts for this option at a generic CLWR site would be the same as those described for Option 4 (Section 4.4.4.1.3).

Impacts for this option at INEEL would be the same as those described for Option 2 (Section 4.4.2.1.3).

The air quality impacts of transportation among SRS, the generic CLWR site, INEEL, and LANL are presented in Section 4.4.5.1.11.

4.4.5.1.4 Water Resources

Impacts for this option at a generic CLWR site would be negligible as described for Option 4 (Section 4.4.4.1.4).

Impacts for this option at INEEL would be negligible as described for Option 2 (Section 4.4.2.1.4).

4.4.5.1.5 Geology and Soils

The irradiation of neptunium-237 targets in a CLWR would not be expected to result in impacts on geologic or soil resources for the reasons described in Section 4.4.4.1.5. Assessment of hazards from large-scale geologic conditions for reactor sites, including assessment of seismic and nonseismic features, is governed by 10 CFR 100 and is beyond the scope of this analysis.

Neptunium-237 storage, target fabrication, and processing would not be expected to impact geologic and soil resources at INEEL, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.3.2.5 and 4.4.2.1.5. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.4.5.1.6 Ecological Resources

The irradiation of neptunium-237 targets in a CLWR would not result in impacts on ecological resources for the reasons described in Section 4.4.4.1.6.

Impacts on ecological resources at INEEL would not result from neptunium-237 storage, target fabrication, and processing for the reasons described in Section 4.4.2.1.6.

4.4.5.1.7 Cultural and Paleontological Resources

The irradiation of neptunium-237 targets in a CLWR would not result in impacts on cultural and paleontological resources for the reasons described in Section 4.4.4.1.7.

Impacts on cultural and paleontological resources at INEEL would not result from neptunium-237 storage, target fabrication, and processing for the reasons described in Section 4.4.2.1.7.

4.4.5.1.8 Socioeconomics

Reactor operations at a CLWR site would not require additional workers. Target fabrication and processing of plutonium-238 at INEEL would require approximately 24 additional workers (Hill et al. 1999). The socioeconomic impacts at INEEL are the same as those assessed in Section 4.3.2.1.8.

4.4.5.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from operations are given in **Table 4–87** for the generic CLWR site and INEEL: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

Target irradiation in a CLWR would not result in any increased radiological emissions during normal operations or increased worker exposure. Therefore, the incremental impact of CLWR target irradiation is zero.

As a result of annual operations of the generic CLWR and FDPF, the projected total incremental population dose in the year 2020 would be 3.9×10^{-6} person-rem. The corresponding number of latent cancer fatalities in the populations surrounding the generic CLWR site and INEEL from 35 years of operations would be 6.8×10^{-8}. The total incremental dose to the maximally exposed member of the public from annual generic CLWR operations would be 0 millirem because there would be no increase in radiological releases to the environment from the generic CLWR associated with this option. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would, therefore, be zero. The incremental dose to the maximally exposed member of the public from annual FDPF operations would be 2.6×10^{-7} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 4.6×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–88**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to CLWR

workers would be 0 millirem; for FDPF workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0 and approximately 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–88. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–87 Incremental Radiological Impacts on the Public Around the Generic CLWR Site and INEEL from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 5

Receptor	Generic CLWR	INEEL FDPF	Total
Population within 80 kilometers (50 miles) in the year 2020			
Dose (person-rem)	0	3.9×10^{-6}	3.9×10^{-6}
35-year latent cancer fatalities	0	6.8×10^{-8}	6.8×10^{-8}
Maximally exposed individual			
Annual dose (millirem)	0	2.6×10^{-7}	NA[a]
35-year latent cancer fatality risk	0	4.6×10^{-12}	NA[a]
Average exposed individual within 80 kilometers (50 miles)			
Annual dose[b] (millirem)	0	2.1×10^{-8}	NA[a]
35-year latent cancer fatality risk	0	3.7×10^{-13}	NA[a]

a. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FDPF in the year 2020 (188,400).

Key: NA, not applicable.
Source: Model results, using the GENII computer code (Napier et al. 1988).

Table 4–88 Incremental Radiological Impacts on Involved CLWR and INEEL Workers from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 5

Receptor—Involved Workers[a]	Generic CLWR	INEEL FDPF	Total
Total dose (person-rem per year)	0	22[b]	22
35-year latent cancer fatalities	0	0.31	0.31
Average worker dose (millirem per year)	0	290	NA[c]
35-year latent cancer fatality risk	0	0.0041	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with FDPF operations at a DOE facility would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced at all facilities.
b. Based on an estimated 75 badged workers.
c. Values cannot be given for the average worker because the workers would be at two different facilities and sites.

Key: NA, not applicable.
Source: LMER 1997:22; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts at the generic CLWR site for this option would be the same as those of ongoing site operations because no new chemicals would be emitted.

Hazardous chemical impacts at INEEL for this option would be the same as those described for Option 2 (Section 4.4.2.1.9).

4.4.5.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with target irradiation in a generic CLWR and FDPF target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual and the offsite population within 80 kilometers (50 miles) of the facility. Consequences to a noninvolved worker are not included for the generic CLWR analysis. Details regarding the exclusion of a noninvolved worker are provided in Appendix I.

Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality for an individual and as the increased number of latent cancer fatalities in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are given in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–89** and **4–90**, respectively. Certain extremely unlikely or incredible severe accidents at commercial nuclear reactors could result in doses sufficiently high to cause early fatalities. The early fatality consequences and risks are presented in **Table 4–91**. The early fatalities shown in Table 4–91 are considered to be conservative estimates based upon the assumption that some individuals very close to the reactor do not evacuate. Because the CLWR is currently operating, the consequences and risks are presented for both the current reactor configuration without neptunium-237 targets and for the worst-case neptunium-237 target-loading reactor configuration.

For 35 years of CLWR target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual would be 1.93×10^{-9}. The increased number of latent cancer fatalities in the surrounding population would be 0.00340. The increased risk of an early fatality in the surrounding population would be 4.90×10^{-6}.

For 35 years of FDPF target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 1.49×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0287.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 1.49×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0321.

Table 4–89 Generic CLWR and FDPF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 5

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
Generic CLWR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	0.0312	1.56×10^{-5}	173	0.0866	NA[c]	NA
Large-break LOCA with 5 kg/yr plutonium-238 production	0.0313	1.57×10^{-5}	174	0.0869	NA	NA
Early containment failure with 0 kg/yr plutonium-238 production	3,350	1.00[d]	2.05×10^{6}	1,330	NA	NA
Early containment failure with 5 kg/yr plutonium-238 production	3,670	1.00[d]	2.18×10^{6}	1,420	NA	NA
Late containment failure with 0 kg/yr plutonium-238 production	1.11	5.55×10^{-4}	1.00×10^{5}	50.2	NA	NA
Late containment failure with 5 kg/yr plutonium-238 production	1.12	5.60×10^{-4}	1.00×10^{5}	50.2	NA	NA
Containment bypass with 0 kg/yr plutonium-238 production	1,540	1.00[d]	1.57×10^{6}	1,020	NA	NA
Containment bypass with 5 kg/yr plutonium-238 production	1,680	1.00[d]	1.65×10^{6}	1,080	NA	NA
FDPF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.01×10^{-9}	1.01×10^{-12}	2.49×10^{-5}	1.24×10^{-8}	7.26×10^{-9}	2.91×10^{-12}
Target dissolver tank failure during plutonium-238 separation	6.11×10^{-8}	3.05×10^{-11}	5.65×10^{-4}	2.82×10^{-7}	2.17×10^{-7}	8.69×10^{-11}
Ion exchange explosion during plutonium-238 separation	1.63×10^{-5}	8.13×10^{-9}	0.150	7.51×10^{-5}	5.79×10^{-5}	2.31×10^{-8}
Processing facility beyond-design-basis earthquake	42.5	0.0425	1.64×10^{5}	82.0	1,200	1.0[d]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Not applicable (refer to Appendix I). Evacuation of noninvolved workers and other noninvolved worker issues are addressed in Appendix I.
d. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–90 Generic CLWR and FDPF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 5

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual generic CLWR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (4.65×10^{-5})	7.25×10^{-10}	4.03×10^{-6}	NA[c]
Large-break LOCA with 5 kg/yr plutonium-238 production (4.65×10^{-5})	7.30×10^{-10}	4.04×10^{-6}	NA
Early containment failure with 0 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}[(d)]	1.05×10^{-4}	NA
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}[(d)]	1.12×10^{-4}	NA
Late containment failure with 0 kg/yr plutonium-238 production (1.07×10^{-5})	5.94×10^{-9}	5.37×10^{-4}	NA
Late containment failure with 5 kg/yr plutonium-238 production (1.07×10^{-5})	5.99×10^{-9}	5.37×10^{-4}	NA
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}[(d)]	0.00156	NA
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}[(d)]	0.00165	NA
35-year CLWR risk[d]	1.93×10^{-9}	0.00340	NA
Annual FDPF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	1.24×10^{-10}	2.91×10^{-14}
Target dissolver tank failure during plutonium-238 separation (0.01)	3.05×10^{-13}	2.82×10^{-9}	8.69×10^{-13}
Ion exchange explosion during plutonium-238 separation (0.01)	8.13×10^{-11}	7.51×10^{-7}	2.31×10^{-10}
Processing facility beyond-design-basis earthquake (1×10^{-5})	4.25×10^{-7}	8.20×10^{-4}	1.00×10^{-5}[(e)]
35-year FDPF risk	1.49×10^{-5}	0.0287	3.50×10^{-4}
35-year Option risk	1.49×10^{-5}	0.0321	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Not applicable (refer to Appendix I). Evacuation of noninvolved workers and other noninvolved worker issues are addressed in Appendix I.
d. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.
e. Risk of an early fatality.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident; NA, not applicable.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–91 Generic CLWR Early Fatalities and Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 5

Accident (Frequency)	Population to 80 Kilometers (50 Miles)	
	Early Fatalities[a]	Annual Risk[b]
Annual generic CLWR risks		
Early containment failure with 0 kg/yr plutonium-238 production (7.92×10^{-8})	28.9	2.29×10^{-6}
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	29.4	2.33×10^{-6}
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	7.86	1.20×10^{-5}
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	7.93	1.21×10^{-5}
35-year CLWR risk[c]	NA	4.90×10^{-6}

a. Number of early fatalities assuming that the accident has occurred.
b. Risk of an early fatality.
c. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; NA, not applicable.
Source: Model results, using the MACCS2 computer code (Chanin and Young 1997).

The irradiation of neptunium-237 targets at the generic CLWR would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of neptunium-237 targets at the generic CLWR.

No chemical processing activities are currently performed at FDPF and no chemicals are stored in this facility. Processing activities in support of plutonium-238 production would require the introduction of hazardous chemicals, specifically nitric acid and nitric oxide. Potential health impacts from accidental releases of nitric acid were assessed by comparing estimated airborne concentrations of the chemicals to Emergency Response Planning Guidelines (ERPG) developed by the American Industrial Hygiene Association. The ERPG-1 value (0.5 part per million) is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour, resulting in only mild, transient, and reversible adverse health effects. The ERPG-2 value (10 parts per million) is protective of irreversible or serious health effects or impairment of an individual's ability to take protective action. The ERPG-3 value (25 parts per million) is indicative of potentially life threatening health effects.

The maximum distances, in meters, needed to reach the ERPG values for nitric acid releases at FDPF for Stability Classes D and F are shown in **Table 4–92**. Two separate atmospheric conditions were evaluated, Stability Classes D and F. Stability Class D represents average meteorological conditions, while Stability Classes F represents worst-case meteorological conditions. The number of involved and noninvolved workers potentially exposed would vary with a number of factors, such as the time of day and whether they were sheltered within buildings at the time of release. Individuals at the nearest access road (5,800 meters [3.6 miles]) and at the nearest site boundary (13,952 meters [8.7 miles]) from FDPF would be exposed to levels well below ERPG-1.

Table 4–92 ERPG Distances for Nitric Acid Releases at FDPF Under Alternative 2 (Use Only Existing Operational Facilities)—Option 5

Evaluation Parameter	Stability Class D (meters)	Stability Class F (meters)
ERPG-3	375	450
ERPG-2	500	600
ERPG-1	2,000	3,000

Note: To convert from meters to miles, multiply by 6.22×10^{-4}.
Key: ERPG, Emergency Response Planning Guideline.

There are no ERPG values for nitric oxide. For nitric oxide accidents, the level of concern has been estimated by using one-tenth of the "Immediately Dangerous to Life and Health" level published by the National Institute for Occupational Safety and Health. The Immediately Dangerous to Life and Health value for nitric oxide is 100 parts per million. The level of concern value used for this NI PEIS is 10 parts per million. The level of concern is defined as the concentration of an extremely hazardous substance in air above which there may be serious irreversible health effects as a result of a single exposure for a relatively short period of time.

For FDPF, the maximum distances needed to reach the level of concern for nitric oxides releases for Stability Class D and F are 500 and 2,000 meters (0.31 and 1.24 miles), respectively. The number of involved and noninvolved workers potentially exposed would vary with a number of factors, such as the time of day and whether they were sheltered within buildings at the time of release. Individual at the nearest access road (5,800 meters [3.6 miles]) and the nearest site boundary (13,952 meters [8.7 miles]) from FDPF would be exposed to levels well below the level of concern for nitric oxide.

Potential health impacts from the accidental release of the hazardous chemicals were assessed for offsite individuals who are members of the public located at the nearest site boundary and on site individuals who are members of the public located at the nearest point of public access onsite.

The impacts associated with the accidental release of nitric acid and nitric oxide at FDPF are presented in **Table 4–93**.

Table 4–93 FDPF Hazardous Chemical Accident Impacts Under Alternative 2 (Use Only Existing Operational Facilities)—Option 5

Receptor	Evaluation Parameter	Nitric Acid		Nitric Oxide	
		Stability Class D	Stability Class F	Stability Class D	Stability Class F
Onsite individual	Parts per million Level of concern Potential health effects	0.05 < ERPG-1 None	0.15 ERPG-1 Mild, transient	0.09 < LOC None	0.87 < LOC None
Offsite individual	Parts per million Level of concern Potential health effects	<<0.05 < ERPG-1 None	<<0.15 ERPG-1 Mild, transient	<<0.09 < LOC None	<<0.87 < LOC None

Note: < means "less than"; << means "much less than."
Key: ERPG, Emergency Response Planning Guideline; LOC, level of concern.
Source: Model results.

4.4.5.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the target fabrication facility at INEEL. DOE would transport the unirradiated neptunium-237 targets from FDPF to a CLWR. Following irradiation in the CLWR, the targets would be returned to FDPF for processing. After this processing, the plutonium-238 product would be shipped to LANL. The impact analysis, described in Appendix J, assumes the most distant CLWR is used for target irradiation.

Approximately 763 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 3.4 million kilometers (2.1 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 19 person-rem; the dose to the public, 382 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0078 latent cancer fatality among transportation workers and 0.19 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 0.0079.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FDPF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 were also evaluated and estimated to have a probability of lower than 1 in 10 million per year.

Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 0.0042 person-rem, resulting in 2.1×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.089 traffic fatality.

4.4.5.1.12 Environmental Justice

Under this option, neptunium-237 targets would be irradiated in a CLWR at an unspecified site. Target fabrication and processing would be performed at FDPF located at INEEL. Activities at FDPF were evaluated under other alternatives and options in this NI PEIS (e.g., Section 4.4.2.1.12) and found to pose no significant radiological or other risks to minority and low-income populations. The analysis of accidents at specific sites shows that accidents at the fabrication and target facilities would result in radiological risks to the public that are small, but which are several orders of magnitude larger than those that would result from accidents at specific reactor sites. It is plausible that a similar difference would exist between accident risks at an unspecified CLWR site and the fabrication and processing facilities. However, evaluations of environmental justice are necessarily site specific and cannot be performed for unspecified locations. In the event that this option were selected for implementation and a specific CLWR were selected for irradiation services, additional evaluation of environmental justice at the CLWR site would be performed prior to implementation.

4.4.5.1.13 Waste Management

There would be no change in the amounts of wastes generated as the result of irradiating neptunium-237 targets in the CLWR. Thus, there would be no impact on the CLWR site's waste management systems as the result of target irradiation.

The impacts of managing wastes associated with neptunium-237 target fabrication and processing in FDPF are assumed to be the same as for Option 2 under Alternative 1 (Section 4.3.2.1.13) because the same amount of plutonium-238 would be produced annually. As shown in that section, the impacts on the waste management systems at INEEL would be minimal.

4.4.5.1.14 Spent Nuclear Fuel Management

No incremental impacts would be associated with the management of spent nuclear fuel (refer to Section 4.4.1.1.14).

4.4.5.2 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.4.6 Alternative 2 (Use Only Existing Operational Facilities)—Option 6

This option involves operating a generic CLWR at a generic site to irradiate neptunium-237 targets, and operating FMEF at Hanford to both fabricate and process these targets and to store the neptunium-237 transported to Hanford from SRS.

The transportation of the neptunium-237 from SRS to Hanford for processing and fabrication into neptunium-237 targets in FMEF, the transportation of the targets from Hanford to the generic CLWR site for irradiation in the CLWR, the transportation of the irradiated targets back to Hanford for postirradiation processing in FMEF, and the transportation of the plutonium-238 product from Hanford to LANL also constitute part of this option.

All options under this alternative include the permanent deactivation of FFTF at Hanford.

4.4.6.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all intersite transportation activities, are assessed in this section.

4.4.6.1.1 Land Resources

LAND USE. The use of a CLWR to irradiate neptunium-237 targets would not result in impacts on land use for the reasons described in Section 4.4.4.1.1.

Impacts on land use at Hanford from neptunium-237 storage, target fabrication, and processing at FMEF would be expected to be minimal for the reasons described in Section 4.4.3.1.1.

VISUAL RESOURCES. The use of a CLWR to irradiate neptunium-237 targets would not result in impacts on visual resources for the reasons described in Section 4.4.4.1.1.

Impacts on visual resources at Hanford from neptunium-237 target fabrication and processing at FMEF would be expected to be minimal for the reasons described in Section 4.4.3.1.1.

4.4.6.1.2 Noise

The irradiation of neptunium-237 targets in a CLWR would not result in noise impacts for the reasons described in Section 4.4.4.1.2.

Noise impacts at Hanford would be minimal from neptunium-237 storage, target fabrication, and processing at FMEF, and changes in traffic noise would be small for the reasons described in Section 4.4.3.1.2.

4.4.6.1.3 Air Quality

Impacts for this option at the generic CLWR site would be the same as those described for Option 4 (Section 4.4.4.1.3).

Impacts for this option at Hanford would be the same as those described for Option 3 (Section 4.4.3.1.3).

The air quality impacts of transportation among SRS, the generic CLWR site, Hanford, and LANL are presented in Section 4.4.6.1.11.

4.4.6.1.4 Water Resources

Impacts for this option at a generic CLWR site would be negligible as described for Option 4 (Section 4.4.4.1.4).

Impacts for this option at Hanford would be the same as described for Option 3 (Section 4.4.3.1.4). Groundwater withdrawals and discharge of process and sanitary effluents are projected to increase over current rates.

4.4.6.1.5 Geology and Soils

The irradiation of neptunium-237 targets in a CLWR would not be expected to result in impacts on geologic or soil resources for the reasons described in Section 4.4.4.1.5. Assessment of hazards from large-scale geologic conditions for reactor sites, including assessment of seismic and nonseismic features, is governed by 10 CFR Part 100 and is beyond the scope of this analysis.

Neptunium-237 storage, target fabrication, and processing at FMEF would not be expected to impact geologic and soil resources at Hanford, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.4.2.5 and 4.4.3.1.5. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.4.6.1.6 Ecological Resources

The irradiation of neptunium-237 targets in a CLWR would not result impacts on ecological resources for the reasons described in Section 4.4.4.1.6.

Impacts on ecological resources at Hanford would not result from neptunium-237 storage, target fabrication, and processing at FMEF for the reasons described in Section 4.4.3.1.6.

4.4.6.1.7 Cultural and Paleontological Resources

The irradiation of neptunium-237 targets in a CLWR would not result in impacts on cultural and paleontological resources for the reasons described in Section 4.4.4.1.7.

Impacts on cultural and paleontological resources at Hanford would not result from neptunium-237 storage, target fabrication, and processing at FMEF for the reasons described in Section 4.4.3.1.7.

4.4.6.1.8 Socioeconomics

Reactor operations at a CLWR site would not require additional workers. Target fabrication and processing of plutonium-238 at Hanford would require approximately 62 additional workers (Hoyt et al. 1999). The socioeconomic impacts at Hanford are the same as those addressed in Section 4.4.3.1.8.

4.4.6.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from operations are given in **Table 4–94** for the generic CLWR site and Hanford: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

Target irradiation in a CLWR would not result in any incremental radiological emissions during normal operations or in increased worker exposures. Therefore, the incremental impact of CLWR target irradiation is zero.

As a result of annual operations of the generic CLWR and FMEF, the projected total incremental population dose in the year 2020 would be 4.4×10^{-5} person-rem. The corresponding number of latent cancer fatalities in the populations surrounding the generic CLWR site and Hanford from 35 years of operations would be 7.7×10^{-7}. The total incremental dose to the maximally exposed member of the public from annual generic CLWR operations would be 0 millirem because there would be no increase in radiological releases to the environment from the generic CLWR associated with this option. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would, therefore, be zero. The incremental dose to the maximally exposed member of the public from annual FMEF operations would be 4.7×10^{-7} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 8.2×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–95**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to CLWR workers would be 0 millirem; for FMEF workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities

Table 4–94 Incremental Radiological Impacts on the Public Around the Generic CLWR Site and Hanford from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 6

Receptor	Generic CLWR	Hanford FMEF	Total
Population within 80 kilometers (50 miles) in the year 2020			
Dose (person-rem)	0	4.4×10^{-5}	4.4×10^{-5}
35-year latent cancer fatalities	0	7.7×10^{-7}	7.7×10^{-7}
Maximally exposed individual			
Annual dose (millirem)	0	4.7×10^{-7}	NA[a]
35-year latent cancer fatality risk	0	8.2×10^{-12}	NA[a]
Average exposed individual within 80 kilometers (50 miles)			
Annual dose[b] (millirem)	0	8.9×10^{-8}	NA[a]
35-year latent cancer fatality risk	0	1.6×10^{-12}	NA[a]

a. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FMEF in the year 2020 (494,400).
Key: NA, not applicable.
Source: Model results, using the GENII computer code (Napier et al. 1988).

Table 4–95 Incremental Radiological Impacts on Involved CLWR and Hanford Workers from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 6

Receptor—Involved Workers[a]	Generic CLWR	Hanford FMEF	Total
Total dose (person-rem per year)	0	22[b]	22
35-year latent cancer fatalities	0	0.31	0.31
Average worker dose (millirem per year)	0	290	NA[c]
35-year latent cancer fatality risk	0	0.0041	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with FMEF operations at DOE facilities would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced at all facilities.
b. Based on an estimated 75 badged workers.
c. Values cannot be given for the average worker because the workers would be at two different facilities and sites.
Key: NA, not applicable.
Source: LMER 1997:22; Wham 1999b.

would be 0 and approximately 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–95. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts at the generic CLWR site for this option would be the same as those of current site operations because no new chemicals would be emitted.

Hazardous chemical impacts for this option at Hanford would be the same as those described for Option 3 (Section 4.4.3.1.9).

4.4.6.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with target irradiation in a generic CLWR and FMEF target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual and the offsite population within 80 kilometers (50 miles) of the facility. Consequences to a noninvolved worker are not included for the generic CLWR analysis. Details regarding the exclusion of a noninvolved worker are provided in Appendix I.

Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality for an individual and as the increased number of latent cancer fatalities in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are given in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–96** and **4–97**, respectively. Certain extremely unlikely or incredible severe accidents at commercial nuclear reactors could result in doses sufficiently high to cause early fatalities. The early fatality consequences and risks are presented in **Table 4–98**. The early fatalities shown in Table 4–98 are considered to be conservative estimates based upon the assumption that some individuals very close to the reactor do not evacuate. Because the generic CLWR is currently operating, the consequences and risks are presented for both the current reactor configuration without neptunium-237 targets and for the worst-case neptunium-237 target-loading reactor configuration.

For 35 years of CLWR target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual would be 1.93×10^{-9}. The increased number of latent cancer fatalities in the surrounding population would be 0.00340. The increased risk of an early fatality in the surrounding population would be 4.90×10^{-6}.

For 35 years of FMEF target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed offsite individual and of an early fatality to a noninvolved worker would be 2.88×10^{-6} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.116.

Table 4–96 Generic CLWR and FMEF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 6

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
Generic CLWR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	0.0312	1.56×10^{-5}	173	0.0866	NA[c]	NA
Large-break LOCA with 5 kg/yr plutonium-238 production	0.0313	1.57×10^{-5}	174	0.0869	NA	NA
Early containment failure with 0 kg/yr plutonium-238 production	3,350	1.00[d]	2.05×10^{6}	1,330	NA	NA
Early containment failure with 5 kg/yr plutonium-238 production	3,670	1.00[d]	2.18×10^{6}	1,420	NA	NA
Late containment failure with 0 kg/yr plutonium-238 production	1.11	5.55×10^{-4}	1.00×10^{5}	50.2	NA	NA
Late containment failure with 5 kg/yr plutonium-238 production	1.12	5.60×10^{-4}	1.00×10^{5}	50.2	NA	NA
Containment bypass with 0 kg/yr plutonium-238 production	1,540	1.00[d]	1.57×10^{6}	1,020	NA	NA
Containment bypass with 5 kg/yr plutonium-238 production	1,680	1.00[d]	1.65×10^{6}	1,080	NA	NA
FMEF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.02×10^{-9}	1.01×10^{-12}	7.26×10^{-5}	3.63×10^{-8}	6.65×10^{-10}	2.66×10^{-13}
Target dissolver tank failure during plutonium-238 separation	4.64×10^{-8}	2.32×10^{-11}	0.00169	8.47×10^{-7}	1.95×10^{-8}	7.81×10^{-12}
Ion exchange explosion during plutonium-238 separation	1.24×10^{-5}	6.18×10^{-9}	0.451	2.25×10^{-4}	5.20×10^{-6}	2.08×10^{-9}
Processing facility beyond-design-basis earthquake	16.5	0.0165	6.41×10^{5}	321	921	1.0[d]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Not applicable (refer to Appendix I). Evacuation of noninvolved workers and other noninvolved worker issues are addressed in Appendix I.
d. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident; NA, not applicable.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 2.88×10^{-6} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.116.

Table 4–97 Generic CLWR and FMEF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 6

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual generic CLWR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (4.65×10^{-5})	7.25×10^{-10}	4.03×10^{-6}	NA[c]
Large-break LOCA with 5 kg/yr plutonium-238 production (4.65×10^{-5})	7.30×10^{-10}	4.04×10^{-6}	NA
Early containment failure with 0 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}[(d)]	1.05×10^{-4}	NA
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}[(d)]	1.12×10^{-4}	NA
Late containment failure with 0 kg/yr plutonium-238 production (1.07×10^{-5})	5.94×10^{-9}	5.37×10^{-4}	NA
Late containment failure with 5 kg/yr plutonium-238 production (1.07×10^{-5})	5.99×10^{-9}	5.37×10^{-4}	NA
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}[(d)]	0.00156	NA
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}[(d)]	0.00165	NA
35-year CLWR risk[d]	1.93×10^{-9}	0.00340	NA
Annual FMEF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	3.63×10^{-10}	2.66×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	2.32×10^{-13}	8.47×10^{-9}	7.81×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	6.18×10^{-11}	2.25×10^{-6}	2.08×10^{-11}
Processing facility beyond-design-basis earthquake (1×10^{-5})	8.23×10^{-8}	0.00321	1.00×10^{-5}[(e)]
35-year FMEF risk	2.88×10^{-6}	0.112	3.50×10^{-4}
35-year Option risk	2.88×10^{-6}	0.116	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Not applicable (refer to Appendix i).
d. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.
e. Risk of an early fatality.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident; NA, not applicable.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–98 Generic CLWR Early Fatalities and Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 6

Accident (Frequency)	Population to 80 Kilometers (50 Miles)	
	Early Fatalities[a]	Annual Risk[b]
Annual generic CLWR risks		
Early containment failure with 0 kg/yr plutonium-238 production (7.92×10^{-8})	28.9	2.29×10^{-6}
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	29.4	2.33×10^{-6}
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	7.86	1.20×10^{-5}
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	7.93	1.21×10^{-5}
35-year CLWR risk[c]	NA	4.90×10^{-6}

a. Number of early fatalities assuming that the accident has occurred.
b. Risk of an early fatality.
c. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.

Key: kg/yr, kilograms per year; NA, not applicable.
Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Source: Model results, using the MACCS2 computer code (Chanin and Young 1997).

The irradiation of neptunium-237 targets at the generic CLWR would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of neptunium-237 targets at the generic CLWR.

No chemical processing activities are currently performed at FMEF and no chemicals are stored in this facility. Processing activities in support of plutonium-238 production would require the introduction of hazardous chemicals, specifically nitric acid and nitric oxide. Potential health impacts from accidental releases of nitric acid were assessed by comparing estimated airborne concentrations of the chemicals to ERPG developed by the American Industrial Hygiene Association. The ERPG-1 value (0.5 part per million) is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour, resulting in only mild, transient, and reversible adverse health effects. The ERPG-2 value (10 parts per million) is protective of irreversible or serious health effects or impairment of an individual's ability to take protective action. The ERPG-3 value (25 parts per million) is indicative of potentially life threatening health effects.

The maximum distances, in meters, needed to reach the ERPG values for nitric acid releases at FMEF for Stability Classes D and F are shown in **Table 4–99**. Two separate atmospheric conditions were evaluated, Stability Classes D and F. Stability Class D represents average meteorological conditions, while Stability Class F represents worst-case meteorological conditions. The number of involved and noninvolved workers potentially exposed would vary with a number of factors, such as the time of day and whether they were sheltered within buildings at the time of release. Individuals at the nearest access road (7,100 meters [4.4 miles]) and at the nearest site boundary (7,210 meters [4.5 miles]) from FMEF would be exposed to levels well below ERPG-1.

Table 4–99 ERPG Distances for Nitric Acid Releases at FMEF Under Alternative 2 (Use Only Existing Operational Facilities)—Option 6

Evaluation Parameter	Stability Class D (meters)	Stability Class F (meters)
ERPG-3	375	450
ERPG-2	500	600
ERPG-1	2,000	3,000

Note: To convert from meters to miles, multiply by 6.22×10^{-4}.
Key: ERPG, Emergency Response Planning Guideline.

There are no ERPG values for nitric oxide. For nitric oxide accidents, the level of concern has been estimated by using one-tenth of the "Immediately Dangerous to Life and Health" level published by the National Institute for Occupational Safety and Health. The Immediately Dangerous to Life and Health value for nitric oxide is 100 parts per million. The level of concern value used for this NI PEIS is 10 parts per million. The level of concern is defined as the concentration of an extremely hazardous substance in air above which there may be serious irreversible health effects as a result of a single exposure for a relatively short period of time.

For FMEF, the maximum distances needed to reach the level of concern for nitric oxides releases for Stability Classes D and F are 500 and 2,000 meters (0.31 and 1.24 miles), respectively. The number of involved and noninvolved workers potentially exposed would vary with a number of factors, such as the time of day and whether they were sheltered within buildings at the time of release. Individual at the nearest access road (7,100 meters [4.4 miles]) and the nearest site boundary (7,210 meters [4.5 miles]) from FMEF would be exposed to levels well below the level of concern for nitric oxide.

Potential health impacts from the accidental release of the hazardous chemicals were assessed for offsite individuals who are members of the public located at the nearest site boundary and onsite individuals who are members of the public located at the nearest point of public access on site. Two separate atmospheric conditions were evaluated, Stability Classes D and F. Stability Class D represents average meteorological conditions, while Stability Class F represents worst-case meteorological conditions.

The impacts associated with the accidental release of nitric acid and nitric oxide at FMEF are presented in **Table 4–100**.

Table 4–100 FMEF Hazardous Chemical Accident Impacts Under Alternative 2 (Use Only Existing Operational Facilities)—Option 6

Receptor	Evaluation Parameter	Nitric Acid		Nitric Oxide	
		Stability Class D	Stability Class F	Stability Class D	Stability Class F
Onsite individual	Parts per million Level of concern Potential health effects	0.03 < ERPG-1 None	0.1 ERPG-1 Mild, transient	0.09 < LOC None	0.55 < LOC None
Offsite individual	Parts per million Level of concern Potential health effects	0.03 < ERPG-1 None	0.1 ERPG-1 Mild, transient	0.09 < LOC None	0.53 < LOC None

Note: < means "less than."
Key: ERPG, Emergency Response Planning Guideline; LOC, level of concern.
Source: Model results.

4.4.6.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the FMEF target fabrication facility at Hanford. DOE would transport the unirradiated neptunium-237 targets from FMEF to a CLWR. Following irradiation in the CLWR, the targets would be returned to FMEF for processing. After this processing, the plutonium-238

product would be shipped to LANL. The impact analysis, described in Appendix J, assumes the most distant CLWR is used for target irradiation.

Approximately 868 shipments of radioactive materials would be made by DOE under this option. The total distance traveled on public roads by trucks carrying radioactive materials would be 3.9 million kilometers (2.5 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 23 person-rem; the dose to the public, 439 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.009 latent cancer fatality among transportation workers and 0.22 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 0.0089.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FMEF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 were also evaluated and estimated to have a probability of lower than 1 in 10 million per year.

Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 0.06 person-rem, resulting in 3.0×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.10 traffic fatality.

4.4.6.1.12 Environmental Justice

Under this option, neptunium-237 targets would be irradiated in a CLWR at an unspecified site. Target fabrication and processing would be performed at FMEF located at Hanford. Activities at FMEF were evaluated under other alternatives and options in this NI PEIS (e.g., Section 4.4.3.1.12) and found to pose no significant radiological or other risks to minority and low-income populations. The analysis of accidents at specific sites shows that accidents at the fabrication and target facilities would result in radiological risks to the public that are small, but which are several orders of magnitude larger than those that would result from accidents at specific reactor sites. It is plausible that a similar difference would exist between accident risks at an unspecified CLWR site and the fabrication and processing facilities. However, evaluations of environmental justice are necessarily site specific and cannot be performed for unspecified locations. In the event that this option were selected for implementation and a specific CLWR were selected for irradiation services, additional evaluation of environmental justice at the CLWR site would be performed prior to implementation.

4.4.6.1.13 Waste Management

There would be no change in the amounts of wastes generated as the result of irradiating neptunium-237 targets in the CLWR. Thus, there would be no impact on the CLWR site's waste management systems as the result of target irradiation.

The impacts of managing wastes associated with neptunium-237 target fabrication and processing in FMEF are assumed to be the same as for Option 3 (Section 4.4.3.1.13) because the same amount of plutonium-238 would be produced annually. As shown in that section, the impacts on the waste management systems at Hanford would be minimal.

4.4.6.1.14 Spent Nuclear Fuel Management

No incremental impacts would be associated with the management of spent nuclear fuel (refer to Section 4.4.1.1.14).

4.4.6.2 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.4.7 Alternative 2 (Use Only Existing Operational Facilities)—Option 7

This option involves operating both the High Flux Isotope Reactor (HFIR) at ORR and ATR at INEEL to irradiate neptunium-237 targets, and operating the REDC facility at ORR to both fabricate and process these targets and to store the neptunium-237 transported to ORR from SRS.

The transportation of the neptunium-237 from SRS to ORR for processing and fabrication into neptunium-237 targets in REDC, the transportation of a portion of these targets from ORR to INEEL for irradiation in ATR, the transportation of the irradiated targets back to ORR for postirradiation processing in REDC, and the transportation of the entire plutonium-238 product from ORR to LANL also constitute part of this option.

All options under this alternative include the permanent deactivation of FFTF at Hanford.

4.4.7.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.4.7.1.1 Land Resources

LAND USE. The use of ATR to irradiate neptunium-237 targets would not result in impacts on land use at INEEL for the reasons described in Section 4.4.1.1.1.

The irradiation of neptunium-237 targets would also take place at HFIR. HFIR is an existing facility in the 7900 Area of ORNL. Use of the facility for target irradiation would not involve any new construction. Because no additional land would be disturbed and the target irradiation would be compatible with the present mission of the reactor, there would be no change in impacts on land use at ORR.

There would be no impacts on land use at ORR from neptunium-237 storage, target fabrication, and processing at REDC for the reasons described in Section 4.4.1.1.1.

VISUAL RESOURCES. The use of ATR to irradiate neptunium-237 targets would not result in visual impacts at INEEL for the reasons described in Section 4.4.1.1.1.

The irradiation of neptunium-237 targets would also take place within HFIR at ORR. Because HFIR is an existing facility that would require no external modifications, there would be no change in its appearance.

Therefore, the current Visual Resource Management Class IV rating for the 7900 Area would not change. Because there would be no change in the appearance of HFIR or the 7900 Area, there would be no impact on visual resources.

Neptunium-237 storage, target fabrication, and processing at REDC would not impact visual resources at ORR for the reasons described in Section 4.4.1.1.1.

4.4.7.1.2 Noise

The irradiation of neptunium-237 targets in ATR would not result in noise impacts at INEEL for the reasons described in Section 4.4.1.1.2.

Noise generated during the irradiation of neptunium-237 targets in HFIR would be similar to sound levels associated with current reactor operations, as well as other operations conducted within the 7900 Area. Onsite noise impacts would be expected to be minimal, and changes in offsite noise levels would not be noticeable, because the nearest site boundary is 2.5 kilometers (1.6 miles) to the southeast. Changes in traffic volume going to and from HFIR would be small, and would result in only minor changes to onsite and offsite noise levels. There would be no loud noises associated with neptunium-237 target irradiation that would adversely impact wildlife.

Noise impacts at ORR would not be expected from neptunium-237 storage, target fabrication, and processing at REDC and changes in traffic noise would be small for the reasons described in Section 4.4.1.1.2.

4.4.7.1.3 Air Quality

Impacts for this option at INEEL would be the same as those described for Option 1 (Section 4.4.1.1.3).

Impacts for this option at ORR would be the same as those described for Option 1 (Section 4.4.1.1.3). There would be no measurable nonradiological air pollutant emissions associated with the operation of HFIR.

The air quality impacts of transportation among SRS, INEEL, ORR, and LANL are presented in Section 4.4.7.1.11.

4.4.7.1.4 Water Resources

The irradiation of neptunium-237 targets for plutonium-238 production in ATR at INEEL would have no measurable impact on water resources as previously described for Option 1 (Section 4.4.1.1.4). Under this option, neptunium-237 target irradiation would also be conduced in the HFIR at ORR. Similar to ATR, impacts on water resources associated with the dual operation of HFIR in the 7900 Area of ORR would not be expected to impact water resources as plutonium-238 production would not measurably increase water use or change the quality or quantity of effluents discharged. Both facilities would already be operating for other purposes so dual operation should not have any measurable cumulative impact.

REDC at ORR would be used for neptunium-237 storage, target fabrication, and processing. Impacts on water resources of this activity were determined to be the same as previously described for Option 1 (see Section 4.4.1.1.4). Impacts of this option on water resources are expected to be negligible overall.

4.4.7.1.5 Geology and Soils

The use of ATR to irradiate neptunium-237 targets would not be expected to result in impacts on geologic or soil resources, nor be jeopardized by large-scale geologic conditions, for the reasons described in Section 4.4.1.1.5.

HFIR would also be used to irradiate neptunium-237 targets. Because there would be no construction, there would be no disturbance to either geologic or soil resources in the 7900 Area of ORR. Impacts on geologic and soil resources at ORR would not be expected from neptunium-237 storage, target fabrication, and processing at REDC for the reasons described in Section 4.4.1.1.5. Hazards from large-scale geologic conditions at ORR, such as earthquakes and volcanoes, were evaluated as summarized in Section 4.2.2.2.5. The analysis determined that these hazards present a low risk to specially designed or upgraded facilities (such as HFIR and REDC), and is not revisited here.

As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards will be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.4.7.1.6 Ecological Resources

The irradiation of neptunium-237 targets in ATR would not result in impacts on ecological resources at INEEL for the reasons described in Section 4.4.1.1.6.

The irradiation of neptunium-237 targets would also take place in the existing HFIR facility at ORR. No new construction would occur that could cause direct disturbance to ecological resources, including wetlands. As noted in Section 4.4.7.1.2, there would be no loud noises that would adversely impact wildlife. There would be no change in impacts on aquatic resources because additional water would not be withdrawn from or discharged to site surface waters and effluent chemistry would not measurably change (Section 4.4.1.1.4). Due to the developed nature of the area and because no new construction would take place, impacts on threatened and endangered species would not occur. Consultation to comply with Section 7 of the Endangered Species Act has been initiated with the U.S. Fish and Wildlife Service. Consultations have also been initiated with the State of Tennessee.

There would be no impacts on ecological resources at ORR from neptunium-237 storage, target fabrication, and processing at REDC for the reasons described in Section 4.4.1.1.6.

4.4.7.1.7 Cultural and Paleontological Resources

The use of ATR to irradiate neptunium-237 targets at INEEL would not result in impacts on cultural and paleontological resources for the reasons described in Section 4.4.1.1.7.

The irradiation of neptunium-237 targets would also take place in the existing HFIR facility at ORR. No new construction would take place. Therefore, direct impacts on cultural and paleontological resources would not occur. One structure located within ORNL, the Graphite Reactor, is listed on the National Register of Historic Places as a National Historic Landmark. Additionally, several other structures proposed for listing on the National Register of Historic Places are found within or near ORNL. However, neither the Graphite Reactor nor any of the other structures is located within the 7900 Area, and therefore, their status would not change by the use of HFIR for the irradiation of neptunium-237 targets. Consultation to comply with Section 106 of the National Historic Preservation Act has been initiated with the State Historic Preservation Office.

Impacts on cultural and paleontological resources at ORR would not result from neptunium-237 target fabrication and processing at REDC for the reasons described in Section 4.4.1.1.7.

4.4.7.1.8 Socioeconomics

After facility modifications, startup, and testing of the plutonium-238 reactor operation facilities at INEEL, and reactor operation and target fabrication/processing facilities at ORR, approximately 41 additional workers would be required to operate these facilities (none at INEEL and approximately 41 at ORR) (Wham et al. 1998). The socioeconomic impacts at ORR are the same as those addressed in Section 4.3.1.1.8.

4.4.7.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from operations are given in **Table 4–101** for INEEL and ORR: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual operations of ATR at INEEL and HFIR and REDC at ORR, the projected incremental total population dose in the year 2020 would be 8.8×10^{-5} person-rem. The corresponding number of latent cancer fatalities in the populations surrounding INEEL and ORR from 35 years of operations would be 1.5×10^{-6}. The total incremental dose to the maximally exposed member of the public from annual ATR and HFIR operations would be 0 millirem because there would be no increase in radiological releases to the environment from either of these reactors associated with this option. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would, therefore, be zero. The incremental dose to the maximally exposed member of the public from annual HFIR and REDC operations would be 1.9×10^{-6} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 3.3×10^{-11}.

Incremental doses to involved workers from normal operations are given in **Table 4–102**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to ATR workers would be 0 millirem; for HFIR workers, the incremental annual average dose would also be 0 millirem; for REDC workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0, 0, and approximately 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–102. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–101 Incremental Radiological Impacts on the Public Around INEEL and ORR from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 7

Receptor	INEEL ATR	ORR			Two-Site Total
		HFIR	REDC	Total	
Population within 80 kilometers (50 miles) in the year 2020					
Dose (person-rem)	0	0	8.8×10^{-5}	8.8×10^{-5}	8.8×10^{-5}
35-year latent cancer fatalities	0	0	1.5×10^{-6}	1.5×10^{-6}	1.5×10^{-6}
Maximally exposed individual					
Annual dose (millirem)	0	0	1.9×10^{-6}	1.9×10^{-6}	NA[a]
35-year latent cancer fatality risk	0	0	3.3×10^{-11}	3.3×10^{-11}	NA[a]
Average exposed individual within 80 kilometers (50 miles)					
Annual dose[b] (millirem)	0	0	7.8×10^{-8}	7.8×10^{-8}	NA[a]
35-year latent cancer fatality risk	0	0	1.4×10^{-12}	1.4×10^{-12}	NA[a]

a. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of HFIR and REDC in the year 2020 (1,134,200).
Key: NA, not applicable.
Source: Model results, using the GENII computer code (Napier et al. 1988).

Table 4–102 Incremental Radiological Impacts on Involved INEEL and ORR Workers from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 7

Receptor—Involved Workers[a]	INEEL ATR	ORR		Total
		HFIR	REDC	
Total dose (person-rem per year)	0	0	22[b]	22
35-year latent cancer fatalities	0	0	0.31	0.31
Average worker dose (millirem per year)	0	0	290	NA[c]
35-year latent cancer fatality risk	0	0	0.0041	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 75 badged workers.
c. Values cannot be given for the average worker because the workers would be in three different facilities at two different sites.
Key: NA, not applicable.
Source: LMER 1997:22; Mecham 1999; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. No new hazardous chemicals would be emitted at HFIR. Therefore, impacts for this option at both INEEL and ORR would be the same as those described for Option 1 (Section 4.4.1.1.9).

4.4.7.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with ATR and HFIR target irradiation and REDC target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 mile) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally

exposed offsite individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are given in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–103** and **4–104**, respectively. Because ATR and HFIR are currently operating, the consequences and risks are presented for both the current reactor configurations without neptunium-237 targets and for the worst-case neptunium-237 target-loading reactor configurations. Baseline accident risks attributed to ATR and HFIR operations refer to accidents that could occur under the current ATR and HFIR configurations (without neptunium-237 targets). Baseline accident risks are obtained from the data in Table 4–104 by summing the annual risks for the baseline reactor configuration (0 kilogram per year plutonium-238 production), and then multiplying the sum by 35. The baseline ATR accident risk to the public would be 0.0089 latent cancer fatality. Baseline ATR accident risks to the maximally exposed offsite individual and a noninvolved worker would be 8.2×10^{-7} and 7.2×10^{-6} latent cancer fatalities, respectively. Similarly, the baseline HFIR accident risk to the public would be 0.0052 latent cancer fatality. Baseline HFIR accident risks to the maximally exposed offsite individual and a noninvolved worker would be 4.2×10^{-6} and 2.4×10^{-5} latent cancer fatalities, respectively.

For 35 years of ATR target irradiation, the increased risk of a latent cancer fatality to the maximally exposed offsite individual and to a noninvolved worker would be 1.49×10^{-7} and 1.95×10^{-6}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 7.01×10^{-4}.

For 35 years of HFIR target irradiation, the increased risk of a latent cancer fatality to the maximally exposed offsite individual and to a noninvolved worker would be 5.71×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 4.09×10^{-5}.

For 35 years of REDC target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed offsite individual and of an early fatality to a noninvolved worker would be 5.71×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.157.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 5.71×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.157.

Table 4–103 ATR, HFIR, and REDC Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 7

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
ATR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	0.465	2.33×10^{-4}	5.11×10^{4}	25.5	5.15	0.00206
Large-break LOCA with 3 kg/yr plutonium-238 production	0.549	2.75×10^{-4}	5.15×10^{4}	25.7	6.52	0.00261
Target handling with 0 kg/yr plutonium-238 production[c]	0.0	0.0	0.0	0.0	0.0	0.0
Target handling with 3 kg/yr plutonium-238 production	1.23×10^{-4}	6.15×10^{-8}	0.0786	3.93×10^{-5}	0.00195	7.80×10^{-7}
HFIR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	2.41	0.00121	2,990	1.49	17.2	0.00688
Large-break LOCA with 2 kg/yr plutonium-238 production	2.41	0.00121	3,000	1.50	17.2	0.00688
Target handling with 0 kg/yr plutonium-238 production	0.0	0.0	0.0	0.0	0.0	0.0
Target handling with 2 kg/yr plutonium-238 production	4.96×10^{-4}	2.48×10^{-7}	0.335	1.68×10^{-4}	0.00245	9.80×10^{-7}
REDC accidents						
Ion exchange explosion during neptunium-237 target fabrication	6.13×10^{-9}	3.06×10^{-12}	8.58×10^{-5}	4.29×10^{-8}	5.60×10^{-10}	2.24×10^{-13}
Target dissolver tank failure during plutonium-238 separation	1.76×10^{-7}	8.79×10^{-11}	0.00196	9.82×10^{-7}	1.09×10^{-8}	6.74×10^{-12}
Ion exchange explosion during plutonium-238 separation	4.68×10^{-4}	2.34×10^{-7}	5.23	0.00261	4.49×10^{-5}	1.79×10^{-8}
Processing facility beyond-design-basis earthquake	163	0.163	8.91×10^{5}	445	1,310	1.00[d]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be not associated accident consequences.
d. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–104 ATR, HFIR, and REDC Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 7

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual ATR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (1×10^{-4})	2.33×10^{-8}	0.00255	2.06×10^{-7}
Large-break LOCA with 3 kg/yr plutonium-238 production (1×10^{-4})	2.75×10^{-8}	0.00257	2.61×10^{-7}
Target handling with 0 kg/yr plutonium-238 production[c]	0.0	0.0	0.0
Target handling with 3 kg/yr plutonium-238 production (0.001)	6.15×10^{-11}	3.93×10^{-8}	7.80×10^{-10}
35-year ATR risk[d]	1.49×10^{-7}	7.01×10^{-4}	1.95×10^{-6}
Annual HFIR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (1×10^{-4})	1.21×10^{-7}	1.49×10^{-4}	6.88×10^{-7}
Large-break LOCA with 2 kg/yr plutonium-238 production (1×10^{-4})	1.21×10^{-7}	1.50×10^{-4}	6.88×10^{-7}
Target handling with 0 kg/yr plutonium-238 production	0.0	0.0	0.0
Target handling with 2 kg/yr plutonium-238 production (0.001)	2.48×10^{-10}	1.68×10^{-7}	9.80×10^{-10}
35-year HFIR risk[d]	8.68×10^{-9}	4.09×10^{-5}	3.43×10^{-8}
Annual REDC risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	3.06×10^{-14}	4.29×10^{-10}	2.24×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	8.79×10^{-13}	9.82×10^{-9}	6.74×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	2.34×10^{-9}	2.61×10^{-5}	1.79×10^{-10}
Processing facility beyond-design-basis earthquake (1×10^{-5})	1.63×10^{-6}	0.00445	1.00×10^{-5}[(e)]
35-year REDC risk	5.71×10^{-5}	0.157	3.50×10^{-4}
35-year Option risk	5.71×10^{-5}	0.157	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be no associated accidents risks.
d. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.
e. Risk of an early fatality.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

The irradiation of neptunium-237 targets at ATR and HFIR would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of neptunium-237 targets at ATR and HFIR.

Processing associated with the plutonium-238 production program at REDC, including storage of neptunium-237 and plutonium-238, neptunium-237 target fabrication, postirradiation processing to extract plutonium-238 and to recycle the unconverted neptunium-237 into new targets, would not require the introduction of hazardous chemicals that are not in current use in the facility. The quantities of in-process hazardous chemicals for the plutonium-238 production program are bounded by the quantities of the material currently stored in the facility. The impacts of in-process hazardous chemical accidents associated with the plutonium-238 production are bounded by the impacts of hazardous chemical accidents for existing storage facilities at REDC.

4.4.7.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the REDC target fabrication facility at ORR. DOE would transport the unirradiated neptunium-237 targets from REDC to HFIR, also at ORR, and to ATR at INEEL. Following irradiation in HFIR or ATR, the targets would be returned to REDC for processing. After this processing, the plutonium-238 product would be shipped to LANL. The analysis is described in Appendix J.

Approximately 637 intersite shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 1.8 million kilometers (1.1 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 10 person-rem; the dose to the public, 197 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0041 latent cancer fatality among transportation workers and 0.098 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 0.0056.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to REDC with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 were also evaluated and estimated to have a probability of lower than 1 in 10 million per year.

Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 0.088 person-rem, resulting in 4.4×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.048 traffic fatality.

4.4.7.1.12 Environmental Justice

NORMAL OPERATIONS. For 35 years of normal operations under this option, the radiological risk among the population residing within 80 kilometers (50 miles) of ATR, HFIR, and REDC would be less than 2×10^{-6} latent cancer fatalities. As shown in Sections 4.4.1.1.9 and 4.4.7.1.9, the release of hazardous chemicals at ORR and at INEEL would pose no significant risk of cancer or toxic effects among the public. As discussed in Sections K.5.1 and K.5.2 of Appendix K, the likelihood that a latent cancer fatality would result from the ingestion of food that could be radiologically contaminated due to normal operations would be essentially zero at INEEL and ORR. No credible pattern of food consumption by persons residing in potentially affected areas would result in significant health risks due to radiological contamination of food supplies near INEEL or ORR. As discussed in Section 4.4.7.1.11, no fatalities would be expected to result from incident-free transportation.

ACCIDENTS. The number of latent cancer fatalities among populations at risk due to accidents listed in Table 4–104 would be approximately 0.2. If a radiological accident were to occur at ATR and northwesterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Fort Hall Indian Reservation (see Figure K–2 of Appendix K). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the population or maximally exposed individual residing within the boundary of the Fort Hall Indian Reservation. In the event a radiological accident were to occur at REDC or HFIR and southerly winds prevailed at the time of the accident, radiological contamination would be directed toward the predominately minority population of the Scarboro Community adjacent to the northern boundary of ORR (see Figure K–6 of Appendix K). If the winds were blowing from the west-southwest at the time of the accident, radiological contamination would be directed toward minority populations residing in Knoxville, Tennessee. Accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the minority populations or maximally exposed individuals residing in the Scarboro Community or Knoxville.

As discussed in Section 4.4.7.1.11, no fatalities would be expected to result from transportation accidents.

In summary, the implementation of this option would pose no significant radiological risk to persons residing in potentially affected areas or along representative transportation routes. Under the conservative assumption that all food consumed in potentially affected areas during the 35-year operational period would be radioactively contaminated, no credible pattern of food consumption would pose a significant radiological health risk due to the ingestion of contaminated food supplies. As discussed in other parts of Section 4.4.7.1, the implementation of this option would not result in significant nonradiological impacts on populations at risk. Thus, implementation would not pose significant and adverse environmental risks to persons residing within potentially affected areas, including minority and low-income persons.

4.4.7.1.13 Waste Management

Only very small amounts of additional wastes would be generated as a result of irradiating neptunium-237 targets in ATR and HFIR because these reactors would already be operating for other purposes. The anticipated incremental generation of wastes from ATR operations is discussed in Section 4.4.1.1.13. The operation of HFIR is expected to increase the generation of solid low-level radioactive waste by less than 1 cubic meter (1.3 cubic yards) per year. There would be virtually no impacts on either site's waste management systems as the result of neptunium-237 target irradiation.

The impacts of managing wastes associated with neptunium-237 target fabrication and processing in REDC are assumed to be the same as for Option 1 under Alternative 1 (Section 4.3.1.1.13) because the same amount of plutonium-238 would be produced annually. As shown in that section, the impacts on the waste management systems at ORR would be minimal.

4.4.7.1.14 Spent Nuclear Fuel Management

No incremental impacts would be associated with the management of spent nuclear fuel (refer to Section 4.4.1.1.14).

4.4.7.2 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.4.8 Alternative 2 (Use Only Existing Operational Facilities)—Option 8

This option involves operating both the HFIR at ORR and ATR at INEEL to irradiate neptunium-237 targets, and operating FDPF at INEEL to fabricate and process these targets. This option also includes storage of the neptunium-237 transported to INEEL from SRS, in either Building CPP–651 or FDPF.

The transportation of the neptunium-237 from SRS to INEEL for processing and fabrication into neptunium-237 targets in FDPF, the transportation of a portion of these targets from INEEL to ORR for irradiation in HFIR, the transportation of the irradiated targets back to INEEL for postirradiation processing in FDPF, and the transportation of the entire plutonium-238 product from INEEL to LANL also constitute part of this option.

All options under this alternative include the permanent deactivation of FFTF at Hanford.

4.4.8.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.4.8.1.1 Land Resources

LAND USE. The irradiation of neptunium-237 targets in ATR would not result in impacts on land use at INEEL for the reasons described in Section 4.4.1.1.1.

The irradiation of neptunium-237 targets would also take place in the existing HFIR facility. There would be no impacts on land use at ORR for the reasons described in Section 4.4.7.1.1.

There would be no impacts on land use at INEEL from neptunium-237 storage, target fabrication, and processing for the reasons described in Section 4.4.2.1.1.

VISUAL RESOURCES. The irradiation of neptunium-237 targets in ATR would not result in impacts on visual resources at INEEL for the reasons described in Section 4.4.1.1.1.

The irradiation of neptunium-237 targets would also take place within the existing HFIR facility. There would be no impacts on visual resources at ORR for the reasons described in Section 4.4.7.1.1.

There would be no impacts on visual resources at INEEL from neptunium-237 storage, target fabrication, and processing for the reasons described in Section 4.4.2.1.1.

4.4.8.1.2 Noise

The irradiation of neptunium-237 targets in ATR would not result in noise impacts at INEEL for the reasons described in Section 4.4.1.1.2.

The irradiation of neptunium targets would also take place in HFIR. No change in noise impacts at ORR would be expected for the reasons described in Section 4.4.7.1.2.

Noise impacts at INEEL would not be expected from neptunium-237 storage, target fabrication, and processing and changes in traffic noise would be small for the reasons described in Section 4.4.2.1.2.

4.4.8.1.3 Air Quality

Impacts for this option at INEEL would be the same as those described for Option 2 (Section 4.4.2.1.3).

It is expected that there would be no measurable increases in nonradiological air pollutant emissions at ORR associated with HFIR operations; therefore, no changes in nonradiological air quality impacts would be expected (Wham 1999a).

The air quality impacts of transportation among SRS, INEEL, ORR, and LANL are presented in Section 4.4.8.1.11.

4.4.8.1.4 Water Resources

Impacts for this option at INEEL would be negligible and the same as those described for Option 2 (Section 4.4.2.1.4).

The irradiation of neptunium-237 targets would also take place in the existing HFIR facility at ORR. No measurable impact on water resources at ORR would be expected for the same reasons as described in Section 4.4.7.1.4.

4.4.8.1.5 Geology and Soils

The use of ATR to irradiate neptunium-237 targets at INEEL would not be expected to result in impacts on geologic or soil resources, nor be jeopardized by large-scale geologic conditions, for the reasons described in Section 4.4.1.1.5.

Dual use of HFIR at ORR to irradiate neptunium-237 targets would also not be expected to result in impacts on geologic and soil resources, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.2.2.5 and 4.4.7.1.5.

Neptunium-237 storage, target fabrication, and processing in FDPF would not be expected to impact geologic and soil resources at INEEL, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.3.2.5 and 4.4.2.1.5.

As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards will be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.4.8.1.6 Ecological Resources

The irradiation of neptunium-237 targets in ATR would not result in impacts on ecological resources at INEEL for the reasons described in Section 4.4.1.1.6.

The irradiation of neptunium targets would also take place in HFIR. There would be no impacts on ecological resources at ORR for the reasons described in Section 4.4.7.1.6.

There would be no impacts on ecological resources at INEEL from neptunium-237 storage, target fabrication, and processing for the reasons described in Section 4.4.2.1.6.

4.4.8.1.7 Cultural and Paleontological Resources

The irradiation of neptunium-237 targets in ATR would not result in impacts on cultural and paleontological resources at INEEL for the reasons described in Section 4.4.1.1.7.

The irradiation of neptunium-237 targets would also take place in HFIR. Impacts on cultural and paleontological resources at ORR would not be expected for the reasons described in Section 4.4.7.1.7.

Impacts on cultural and paleontological resources at INEEL would not be expected from neptunium-237 storage, target fabrication, and processing for the reasons described in Section 4.4.2.1.7.

4.4.8.1.8 Socioeconomics

After facility modifications, startup, and testing of the plutonium-238 reactor operation facilities at INEEL and ORR and target fabrication/processing facilities at INEEL, approximately 24 additional workers would be required to operate these facilities (24 at INEEL and none at ORR) (Hill et al. 1999). The socioeconomic impacts at INEEL are the same as those addressed in Section 4.3.2.1.8.

4.4.8.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from operations are given in **Table 4–105** for INEEL and ORR: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual operations of HFIR at ORR and ATR and FDPF at INEEL, the projected incremental total population dose in the year 2020 would be 3.9×10^{-6} person-rem. The corresponding number of latent

Table 4–105 Incremental Radiological Impacts on the Public Around ORR and INEEL from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 8

Receptor	ORR HFIR	INEEL			Two-Site Total
		ATR	FDPF	Total	
Population within 80 kilometers (50 miles) in the year 2020					
Dose (person-rem)	0	0	3.9×10^{-6}	3.9×10^{-6}	3.9×10^{-6}
35-year latent cancer fatalities	0	0	6.8×10^{-8}	6.8×10^{-8}	6.8×10^{-8}
Maximally exposed individual					
Annual dose (millirem)	0	0	2.6×10^{-7}	2.6×10^{-7}	NA[a]
35-year latent cancer fatality risk	0	0	4.6×10^{-12}	4.6×10^{-12}	NA[a]
Average exposed individual within 80 kilometers (50 miles)					
Annual dose[b] (millirem)	0	0	2.1×10^{-8}	2.1×10^{-8}	NA[a]
35-year latent cancer fatality risk	0	0	3.7×10^{-13}	3.7×10^{-13}	NA[a]

a. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FDPF in the year 2020 (188,400).
Key: NA, not applicable.
Source: Model results, using the GENII computer code (Napier et al. 1988).

cancer fatalities in the populations surrounding INEEL and ORR from 35 years of operations would be 6.8×10^{-8}. The incremental total dose to the maximally exposed member of the public from annual ATR and HFIR operations would be 0 millirem because there would be no increase in radiological releases to the environment from either of these reactors associated with this option. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would, therefore, be zero. The total incremental dose to the maximally exposed member of the public from annual ATR and FDPF operations would be 2.6×10^{-7} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 4.6×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–106**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to ATR workers would be 0 millirem; for HFIR workers, the incremental annual average dose would also be 0 millirem; for FDPF workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0, 0, and approximately 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–106. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts for this option at INEEL would be the same as those described for Option 2 (Section 4.4.2.1.9).

Hazardous chemical impacts at ORR would be the same as those of ongoing site operations because no new chemicals are expected to be emitted from operating HFIR.

4.4.8.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with ATR and HFIR target irradiation and FDPF target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Table 4–106 Incremental Radiological Impacts on Involved ORR and INEEL Workers from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 8

Receptor—Involved Workers[a]	ORR HFIR	INEEL ATR	INEEL FDPF	Total
Total dose (person-rem per year)	0	0	22[b]	22
35-year latent cancer fatalities	0	0	0.31	0.31
Average worker dose (millirem per year)	0	0	290	NA[c]
35-year latent cancer fatality risk	0	0	0.0041	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 75 badged workers.
c. Values cannot be given for the average worker because the workers would be in three different facilities at two different sites.
Key: NA, not applicable.
Source: LMER 1997:22; Mecham 1999; Wham 1999b.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 mile) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed offsite individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are given in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–107** and **4–108**, respectively. Because ATR and HFIR are currently operating, the consequences and risks are presented for both the current reactor configurations without neptunium-237 targets and for the worst-case neptunium-237 target-loading reactor configurations.

For 35 years of ATR target irradiation, the increased risk of a latent cancer fatality to the maximally exposed offsite individual and to a noninvolved worker would be 1.49×10^{-7} and 1.95×10^{-6}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 7.01×10^{-4}.

For 35 years of HFIR target irradiation, the increased risk of a latent cancer fatality to the maximally exposed offsite individual and to a noninvolved worker would be 8.68×10^{-4} and 3.43×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 4.09×10^{-5}.

For 35 years of FDPF target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed offsite individual and an early fatality to a noninvolved worker would be 1.49×10^{-5} and

3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0287.

Table 4–107 ATR, HFIR, and FDPF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 8

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
ATR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	0.465	2.33×10^{-4}	5.11×10^{4}	25.5	5.15	0.00206
Large-break LOCA with 3 kg/yr plutonium-238 production	0.549	2.75×10^{-4}	5.15×10^{4}	25.7	6.52	0.00261
Target handling with 0 kg/yr plutonium-238 production[c]	0.0	0.0	0.0	0.0	0.0	0.0
Target handling with 3 kg/yr plutonium-238 production	1.23×10^{-4}	6.15×10^{-8}	0.0786	3.93×10^{-5}	0.00195	7.80×10^{-7}
HFIR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	2.41	0.00121	2,990	1.49	17.2	0.00688
Large-break LOCA with 2 kg/yr plutonium-238 production	2.41	0.00121	3,000	1.50	17.2	0.00688
Target handling with 0 kg/yr plutonium-238 production	0.0	0.0	0.0	0.0	0.0	0.0
Target handling with 2 kg/yr plutonium-238 production	4.96×10^{-4}	2.48×10^{-7}	0.335	1.68×10^{-4}	0.00245	9.80×10^{-7}
FDPF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.01×10^{-9}	1.01×10^{-12}	2.49×10^{-5}	1.24×10^{-8}	7.26×10^{-9}	2.91×10^{-12}
Target dissolver tank failure during plutonium-238 separation	6.11×10^{-8}	3.05×10^{-11}	5.65×10^{-4}	2.82×10^{-7}	2.17×10^{-7}	8.69×10^{-11}
Ion exchange explosion during plutonium-238 separation	1.63×10^{-5}	8.13×10^{-9}	0.150	7.51×10^{-5}	5.79×10^{-5}	2.31×10^{-8}
Processing facility beyond-design-basis earthquake	42.5	0.0425	1.64×10^{5}	82.0	1,200	1.0[d]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be no associated accident consequences.
d. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 1.50×10^{-5} and 3.52×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0295.

Table 4–108 ATR, HFIR, and FDPF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 8

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual ATR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (1×10^{-4})	2.33×10^{-8}	0.00255	2.06×10^{-7}
Large-break LOCA with 3 kg/yr plutonium-238 production (1×10^{-4})	2.75×10^{-8}	0.00257	2.61×10^{-7}
Target handling with 0 kg/yr plutonium-238 production[c]	0.0	0.0	0.0
Target handling with 3 kg/yr plutonium-238 production (0.001)	6.15×10^{-11}	3.93×10^{-8}	7.80×10^{-10}
35-year ATR risk[d]	1.49×10^{-7}	7.01×10^{-4}	1.95×10^{-6}
Annual HFIR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (1×10^{-4})	1.21×10^{-7}	1.49×10^{-4}	6.88×10^{-7}
Large-break LOCA with 2 kg/yr plutonium-238 production (1×10^{-4})	1.21×10^{-7}	1.50×10^{-4}	6.88×10^{-7}
Target handling with 0 kg/yr plutonium-238 production	0.0	0.0	0.0
Target handling with 2 kg/yr plutonium-238 production (0.001)	2.48×10^{-10}	1.68×10^{-7}	9.80×10^{-10}
35-year HFIR risk[d]	8.68×10^{-9}	4.09×10^{-5}	3.43×10^{-8}
Annual FDPF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	1.24×10^{-10}	2.91×10^{-14}
Target dissolver tank failure during plutonium-238 separation (0.01)	3.05×10^{-13}	2.82×10^{-9}	8.69×10^{-13}
Ion exchange explosion during plutonium-238 separation (0.01)	8.13×10^{-11}	7.51×10^{-7}	2.31×10^{-10}
Processing facility beyond-design-basis earthquake (1×10^{-5})	4.25×10^{-7}	8.20×10^{-4}	1.00×10^{-5}[e]
35-year FDPF risk	1.49×10^{-5}	0.0287	3.50×10^{-4}
35-year Option risk	1.50×10^{-5}	0.00295	3.52×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be no associated accident risks.
d. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.
e. Risk of an early fatality.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

The irradiation of neptunium-237 targets at ATR and HFIR would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of neptunium-237 targets at ATR and HFIR.

No chemical processing activities are currently performed at FDPF and no chemicals are stored in this facility. Processing activities in support of plutonium-238 production would require the introduction of hazardous chemicals, specifically nitric acid and nitric oxide. Potential health impacts from accidental releases of nitric

acid were assessed by comparing estimated airborne concentrations of the chemicals to Emergency Response Planning Guidelines (ERPG) developed by the American Industrial Hygiene Association. The ERPG-1 value (0.5 part per million) is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour, resulting in only mild, transient, and reversible adverse health effects. The ERPG-2 value (10 parts per million) is protective of irreversible or serious health effects or impairment of an individual's ability to take protective action. The ERPG-3 value (25 parts per million) is indicative of potentially life threatening health effects.

The maximum distances, in meters, needed to reach the ERPG values for nitric acid releases at FDPF for Stability Classes D and F are shown in **Table 4–109**. Two separate atmospheric conditions were evaluated, Stability Classes D and F. Stability Class D represents average meteorological conditions while Stability Class F represents worst-case meteorological conditions. The number of involved and noninvolved workers potentially exposed would vary with a number of factors, such as the time of day and whether they were sheltered within buildings at the time of release. Individuals at the nearest access road (5,800 meters [3.6 miles]) and at the nearest site boundary (13,952 meters [8.7 miles]) from FDPF would be exposed to levels well below ERPG-1.

Table 4–109 ERPG Distances for Nitric Acid Releases at FDPF Under Alternative 2 (Use Only Existing Operational Facilities)—Option 8

Evaluation Parameter	Stability Class D (meters)	Stability Class F (meters)
ERPG-3	375	450
ERPG-2	500	600
ERPG-1	2,000	3,000

Key: ERPG, Emergency Response Planning Guideline.
Note: To convert from meters to miles, multiply by 6.22×10^{-4}.

There are no ERPG values for nitric oxide. For nitric oxide accidents, the level of concern has been estimated by using one-tenth of the "Immediately Dangerous to Life and Health" level published by the National Institute for Occupational Safety and Health. The Immediately Dangerous to Life and Health value for nitric oxide is 100 parts per million. The level of concern value used for this NI PEIS is 10 parts per million. The level of concern is defined as the concentration of an extremely hazardous substance in air above which there may be serious irreversible health effects as a result of a single exposure for a relatively short period of time.

For FDPF, the maximum distances needed to reach the level of concern for nitric oxides releases for Stability Classes D and F are 500 and 2,000 meters (0.31 and 1.24 miles), respectively. The number of involved and noninvolved workers potentially exposed would vary with a number of factors, such as the time of day and whether they were sheltered within buildings at the time of release. Individual at the nearest access road (5,800 meters [3.6 miles]) and the nearest site boundary (13,952 meters [8.7 miles]) from FDPF would be exposed to levels well below the level of concern for nitric oxide.

Potential health impacts from the accidental release of the hazardous chemicals were assessed for offsite individuals who are members of the public located at the nearest site boundary and onsite individuals who are members of the public located at the nearest point of public access on site.

The impacts associated with the accidental release of nitric acid and nitric oxide at FDPF are presented in **Table 4–110**.

Table 4–110 FDPF Hazardous Chemical Accident Impacts Under Alternative 2 (Use Only Existing Operational Facilities)—Option 8

Receptor	Evaluation Parameter	Nitric Acid		Nitric Oxide	
		Stability Class D	Stability Class F	Stability Class D	Stability Class F
Onsite individual	Parts per million Level of concern Potential health effects	0.05 < ERPG-1 None	0.15 ERPG-1 Mild, transient	0.09 < LOC None	0.87 < LOC None
Offsite individual	Parts per million Level of concern Potential health effects	<<0.05 < ERPG-1 None	<<0.15 ERPG-1 Mild, transient	<<0.09 < LOC None	<<0.87 < LOC None

Key: ERPG, Emergency Response Planning Guideline; LOC, level of concern.
Note: < means "less than"; << means "much less than."
Source: Model results.

4.4.8.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the FDPF target fabrication facility at INEEL. DOE would transport the unirradiated neptunium-237 targets from FDPF to HFIR at ORR, and to ATR at INEEL. Following irradiation in HFIR or ATR, the targets would be returned to FDPF for processing. After this processing, the plutonium-238 product would be shipped to LANL. The analysis is described in Appendix J.

Approximately 385 intersite shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 1.3 million kilometers (0.79 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 8 person-rem; the dose to the public, 128 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0033 latent cancer fatality among transportation workers and 0.064 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 0.0043.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FDPF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 were also evaluated and estimated to have a probability of lower than 1 in 10 million per year.

Estimates of the total ground transportation accident risks are as follows: a radiological dose to the population of 0.0878 person-rem, resulting in 4.4×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.025 traffic fatality.

4.4.8.1.12 Environmental Justice

NORMAL OPERATIONS. For 35 years of normal operations under this option, the likelihood of an incremental latent cancer fatality among the population residing within 80 kilometers (50 miles) of HFIR, ATR, and FDPF would be essentially zero (derived from information in Table 4–105). As shown in Sections 4.4.2.1.9 and 4.4.8.1.9, the release of hazardous chemicals at INEEL would pose no significant risk of cancer or toxic effects among the public. As discussed in Sections K.5.1 and K.5.2, the likelihood that a latent cancer fatality would result from the ingestion of food that could be radiologically contaminated due to normal operations would be essentially zero at INEEL and ORR. No credible pattern of food consumption by persons residing in potentially affected areas would result in significant health risks due to radiological contamination of food supplies near INEEL or ORR. The likelihood of a latent cancer fatality among the public due to incident-free transportation during the 35-year project would be approximately 1 in 16, and the likelihood of a nonradiological fatality due to vehicular emissions would be approximately 1 in 200 (derived from information in Section 4.4.8.1.11).

ACCIDENTS. The likelihood of a latent cancer fatality among the populations at risk due to accidents listed in Table 4–108 would be approximately 1 in 35. If a radiological accident were to occur at ATR or FDPF and northwesterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Fort Hall Indian Reservation (see Figure K–2). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the population or maximally exposed individual residing within the boundary of the Fort Hall Indian Reservation. In the event a radiological accident were to occur at HFIR and southerly winds prevailed at the time of the accident, radiological contamination would be directed toward the predominately minority population of the Scarboro Community adjacent to the northern boundary of ORR (see Figure K–6). If the winds were blowing from the west-southwest at the time of the accident, radiological contamination would be directed toward minority populations residing in Knoxville, Tennessee. Accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the minority populations or maximally exposed individuals residing in the Scarboro Community or Knoxville.

The radiological risk of a public fatality due to incident-free transportation of radioactive material would be approximately 0.064 latent cancer fatality and the risk of a fatal traffic collision during 35 years of shipments would be approximately 0.025 latent cancer fatality (Section 4.4.8.1.11).

In summary, the implementation of this option would pose no significant radiological risk to persons residing in potentially affected areas or along representative transportation routes. Under the conservative assumption that all food consumed in potentially affected areas during the 35-year operational period would be radioactively contaminated, no credible pattern of food consumption would pose a significant radiological health risk due to the ingestion of contaminated food supplies. As discussed in other parts of Section 4.4.8.1, the implementation of this option would not result in significant nonradiological impacts on populations at risk. Thus, implementation would not pose significant and adverse environmental risks to persons residing within potentially affected areas, including minority and low-income persons.

4.4.8.1.13 Waste Management

Only very small amounts of additional wastes would be generated as a result of irradiating neptunium-237 targets in ATR and HFIR because these reactors would already be operating for other purposes. The anticipated incremental generation of wastes from ATR operations is discussed in Section 4.4.1.1.13. The anticipated incremental generation of wastes from HFIR operations is discussed in Section 4.4.7.1.13. There would be virtually no impacts on either site's waste management system as the result of neptunium-237 target irradiation.

The impacts of managing wastes associated with neptunium-237 target fabrication and processing in FDPF are assumed to be the same as for Option 2 under Alternative 1 (Section 4.3.2.1.13) because the same amount of plutonium-238 would be produced annually. As shown in that section, the impacts on the waste management systems at INEEL would be minimal.

4.4.8.1.14 Spent Nuclear Fuel Management

No incremental impacts would be associated with the management of spent nuclear fuel (refer to Section 4.4.1.1.14).

4.4.8.2 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.4.9 Alternative 2 (Use Only Existing Operational Facilities)—Option 9

This option involves operating HFIR at ORR and ATR at INEEL to irradiate neptunium-237 targets, and operating FMEF at Hanford to both fabricate and process these targets and to store the neptunium-237 transported to Hanford from SRS.

The transportation of the neptunium-237 from SRS to Hanford for processing and fabrication into neptunium-237 targets in FMEF, the transportation of targets from Hanford to both INEEL and ORR for irradiation in ATR and HFIR, respectively, the transportation of the irradiated targets back to Hanford for postirradiation processing in FMEF, and the transportation of the plutonium-238 product from Hanford to LANL also constitute part of this option.

All options under this alternative include the permanent deactivation of FFTF at Hanford.

4.4.9.1 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.4.9.1.1 Land Resources

LAND USE. The irradiation of neptunium-237 targets in ATR would not result in impacts on land use at INEEL for the reasons described in Section 4.4.1.1.1.

The irradiation of neptunium-237 targets would also take place within the existing HFIR facility at ORR. Impacts on land use at ORR would not result for the reasons described in Section 4.4.7.1.1.

Impacts on land use at Hanford from neptunium-237 storage, target fabrication, and processing at FMEF would be expected to be minimal for the reasons described in Section 4.4.3.1.1.

VISUAL RESOURCES. The irradiation of neptunium-237 targets in ATR would not result in impacts on visual resources at INEEL for the reasons described in Section 4.4.1.1.1.

The irradiation of neptunium-237 targets would also take place within the existing HFIR facility at ORR. There would be no impacts on visual resources at ORR for the reasons described in Section 4.4.7.1.1.

Impacts on visual resources at Hanford from neptunium-237 storage, target fabrication, and processing at FMEF would be expected to be minimal for the reasons described in Section 4.4.3.1.1.

4.4.9.1.2 Noise

The irradiation of neptunium-237 targets in ATR would not result in a change in noise impacts at INEEL for the reasons described in Section 4.4.1.1.2.

The irradiation of neptunium targets would also take place in HFIR. No change in noise impacts at ORR would be expected for the reasons described in Section 4.4.7.1.2.

Noise impacts at Hanford would be expected to be minimal from neptunium-237 storage, target fabrication, and processing at FMEF and changes in traffic noise would be small for the reasons described in Section 4.4.3.1.2.

4.4.9.1.3 Air Quality

Impacts for this option at INEEL would be the same as those described for Option 3 (Section 4.4.3.1.3).

Impacts for this option at ORR would be the same as those described for Option 8 (Section 4.4.8.1.3).

Impacts for this option at Hanford would be the same as those described for Option 3 (Section 4.4.3.1.3).

The air quality impacts of transportation among SRS, INEEL, ORR, Hanford, and LANL are presented in Section 4.4.9.1.11.

4.4.9.1.4 Water Resources

Impacts for this option at INEEL would be negligible and similar to those described for Option 1 (Section 4.4.1.1.4).

Impacts for this option at ORR would be negligible and similar to those described for Option 7 (Section 4.4.7.1.4).

Impacts for this option at Hanford would be the same as those described for Option 3 (Section 4.4.3.1.4).

4.4.9.1.5 Geology and Soils

The use of ATR to irradiate neptunium-237 targets at INEEL would not be expected to result in impacts on geologic or soil resources, nor be jeopardized by large-scale geologic conditions, for the reasons described in Section 4.4.1.1.5.

Dual use of HFIR at ORR to irradiate neptunium-237 targets would also not be expected to result in impacts on geologic and soil resources, nor be jeopardized by large-scale geologic conditions, for the reasons described in Sections 4.2.2.2.5 and 4.4.7.1.5.

Impacts on geologic and soil resources at Hanford would not be expected from neptunium-237 storage, target fabrication, and processing at FMEF for the reasons described in Sections 4.3.3.1.5 and 4.4.3.1.5. Large-scale geologic conditions also present a low risk to FMEF operations, as further discussed in Section 4.2.4.2.5. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards will be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.4.9.1.6 Ecological Resources

The irradiation of neptunium-237 targets in ATR would not result in impacts on ecological resources at INEEL for the reasons described in Section 4.4.1.1.6.

The irradiation of neptunium targets would also take place in HFIR. There would be no impacts on ecological resources at ORR for the reasons described in Section 4.4.7.1.6.

There would be no impacts on ecological resources at Hanford from neptunium-237 storage, target fabrication, and processing at FMEF for the reasons described in Section 4.4.3.1.6.

4.4.9.1.7 Cultural and Paleontological Resources

The irradiation of neptunium-237 targets in ATR would not result in impacts on cultural and paleontological resources at INEEL for the reasons described in Section 4.4.1.1.7.

The irradiation of neptunium targets would also take place in HFIR. There would be no impacts on cultural and paleontological resources at ORR for the reasons described in Section 4.4.7.1.7.

There would be no impacts on cultural and paleontological resources at Hanford from neptunium-237 target fabrication and processing at FMEF for the reasons described in Section 4.4.3.1.7.

4.4.9.1.8 Socioeconomics

After facility modifications, startup, and testing of the plutonium-238 reactor operation facilities at INEEL and ORR and target fabrication/processing facilities at Hanford, approximately 62 additional workers would be required to operate these facilities (none at INEEL and ORR and 62 at Hanford) (Hoyt et al. 1999). The socioeconomic impacts at Hanford are the same as those addressed in Section 4.3.3.1.8.

4.4.9.1.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from operations are given in **Table 4–111** for INEEL, ORR, and Hanford: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

Table 4–111 Incremental Radiological Impacts on the Public Around INEEL, ORR, and Hanford from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 9

Receptor	INEEL ATR	ORR HFIR	Hanford FMEF	Three-Site Total
Population within 80 kilometers (50 miles) in the year 2020				
Dose (person-rem)	0	0	4.4×10^{-5}	4.4×10^{-5}
35-year latent cancer fatalities	0	0	7.7×10^{-7}	7.7×10^{-7}
Maximally exposed individual				
Annual dose (millirem)	0	0	4.7×10^{-7}	NA[a]
35-year latent cancer fatality risk	0	0	8.2×10^{-12}	NA[a]
Average exposed individual within 80 kilometers (50 miles)				
Annual dose[b] (millirem)	0	0	8.9×10^{-8}	NA[a]
35-year latent cancer fatality risk	0	0	1.6×10^{-12}	NA[a]

a. A "Total" cannot be given in this case because the same individual cannot be located at three different sites simultaneously.
b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FMEF in the year 2020 (494,400).
Key: NA, not applicable.
Source: Model results, using the GENII computer code (Napier et al. 1988).

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual operations of ATR at INEEL, HFIR at ORR, and FMEF at Hanford, the projected incremental total population dose in the year 2020 would be 4.4×10^{-5} person-rem. The corresponding number of latent cancer fatalities in the populations surrounding INEEL, ORR, and Hanford from 35 years of operations would be 7.7×10^{-7}. The total incremental dose to the maximally exposed members of the public from annual ATR and HFIR operations would be 0 millirem because there would be no increase in radiological releases to the environment from either of these reactors associated with this option. From 35 years of operations, the corresponding risk of a latent cancer fatality to these individuals would, therefore, be zero. The incremental dose to the maximally exposed member of the public from annual FMEF operations would be 4.7×10^{-7} millirem. From 35 years of operations, the corresponding risk of a latent fatal cancer to this individual would be 8.2×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–112**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to ATR and HFIR workers would be 0 millirem; for FMEF workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0, 0, and approximately 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–112. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–112 Incremental Radiological Impacts on Involved INEEL, ORR, and Hanford Workers from Operational Facilities Under Alternative 2 (Use Only Existing Operational Facilities)—Option 9

Receptor—Involved Workers[a]	INEEL ATR	ORR HFIR	Hanford FMEF	Three-Site Total
Total dose (person-rem per year)	0	0	22[b]	22
35-year latent cancer fatalities	0	0	0.31	0.31
Average worker dose (millirem per year)	0	0	290	NA[c]
35-year latent cancer fatality risk	0	0	0.0041	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 75 badged workers.
c. Values cannot be given for the average worker because the workers would be at three different facilities and sites.
Key: NA, not applicable.
Source: LMER 1997:22; Mecham 1999; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts for this option at INEEL would be the same as those of ongoing site operations because no new chemicals are expected to be emitted at ATR.

Hazardous chemical impacts for this option at ORR were determined to be the same as those of ongoing site operations because no new chemicals are expected to be emitted at HFIR.

Hazardous chemical impacts for this option at Hanford would be the same as those described for Option 3 (Section 4.4.3.1.9).

4.4.9.1.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with ATR and HFIR target irradiation and FMEF target processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Estimates of radiological consequences have been developed for the maximally exposed offsite individual, the offsite population within 80 kilometers (50 miles) of the facility, and a noninvolved worker at a distance of 640 meters (0.4 mile) from the release point. Consequences are presented in terms of radiological dose (in rem) and the probability that the dose would result in a latent cancer fatality. Accident risk is defined as the product of the accident probability (i.e., accident frequency) and the accident consequence. In this NI PEIS, risk is expressed as the increased likelihood of a latent cancer fatality per year for an individual (the maximally exposed offsite individual or a noninvolved worker), and as the increased number of latent cancer fatalities per year in the offsite population. The probability coefficients for determining the likelihood of a latent cancer fatality, given a dose, are given in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

To provide a better indication of risks from the postulated accidents, the risks are summed for each facility and also for each option. Although the summation provides the combined risk for the spectrum of accidents analyzed, it does not indicate total risk. To determine total risk from accidents, a full-scope probabilistic risk analysis would be required for each facility. Since full-scope probabilistic risk analyses are not available to incorporate in this NI PEIS, the summation of the spectrum of accident risks was considered appropriate for the purposes of this NI PEIS. Details of the risk summation calculations are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–113** and **4–114**, respectively. Because ATR and HFIR are currently operating, the consequences and risks are presented for both the current reactor configurations without neptunium-237 targets and for the worst-case neptunium-237 target-loading reactor configurations.

Table 4–113 ATR, HFIR, and FMEF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 9

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
ATR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	0.465	2.33×10^{-4}	5.11×10^{4}	25.5	5.15	0.00206
Large-break LOCA with 3 kg/yr plutonium-238 production	0.549	2.75×10^{-4}	5.15×10^{4}	25.7	6.52	0.00261
Target handling with 0 kg/yr plutonium-238 production[c]	0.0	0.0	0.0	0.0	0.0	0.0
Target handling with 3 kg/yr plutonium-238 production	1.23×10^{-4}	6.15×10^{-8}	0.0786	3.93×10^{-5}	0.00195	7.80×10^{-7}
HFIR accidents						
Large-break LOCA with 0 kg/yr plutonium-238 production	2.41	0.00121	2,990	1.49	17.2	0.00688
Large-break LOCA with 2 kg/yr plutonium-238 production	2.41	0.00121	3,000	1.50	17.2	0.00688
Target handling with 0 kg/yr plutonium-238 production	0.0	0.0	0.0	0.0	0.0	0.0
Target handling with 2 kg/yr plutonium-238 production	4.96×10^{-4}	2.48×10^{-7}	0.335	1.68×10^{-4}	0.00245	9.80×10^{-7}
FMEF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.02×10^{-9}	1.01×10^{-12}	7.26×10^{-5}	3.63×10^{-8}	6.65×10^{-10}	2.66×10^{-13}
Target dissolver tank failure during plutonium-238 separation	4.64×10^{-8}	2.32×10^{-11}	0.00169	8.47×10^{-7}	1.95×10^{-8}	7.81×10^{-12}
Ion exchange explosion during plutonium-238 separation	1.24×10^{-5}	6.18×10^{-9}	0.451	2.25×10^{-4}	5.20×10^{-6}	2.08×10^{-9}
Processing facility beyond-design-basis earthquake	16.5	0.0165	6.41×10^{5}	321	921	1.0[d]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be no associated accident consequences.
d. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–114 ATR, HFIR, and FMEF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 9

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual ATR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (1×10^{-4})	2.33×10^{-8}	0.00255	2.06×10^{-7}
Large-break LOCA with 3 kg/yr plutonium-238 production (1×10^{-4})	2.75×10^{-8}	0.00257	2.61×10^{-7}
Target handling with 0 kg/yr plutonium-238 production[c]	0.0	0.0	0.0
Target handling with 3 kg/yr plutonium-238 production (0.001)	6.15×10^{-11}	3.93×10^{-8}	7.80×10^{-10}
35-year ATR risk[d]	1.49×10^{-7}	7.01×10^{-4}	1.95×10^{-6}
Annual HFIR risks			
Large-break LOCA with 0 kg/yr plutonium-238 production (1×10^{-4})	1.21×10^{-7}	1.49×10^{-4}	6.88×10^{-7}
Large-break LOCA with 2 kg/yr plutonium-238 production (1×10^{-4})	1.21×10^{-7}	1.50×10^{-4}	6.88×10^{-7}
Target handling with 0 kg/yr plutonium-238 production	0.0	0.0	0.0
Target handling with 2 kg/yr plutonium-238 production (0.001)	2.48×10^{-10}	1.68×10^{-7}	9.80×10^{-10}
35-year HFIR risk[d]	8.68×10^{-9}	4.09×10^{-5}	3.43×10^{-8}
FMEF accidents			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	3.63×10^{-10}	2.66×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	2.32×10^{-13}	8.47×10^{-9}	7.81×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	6.18×10^{-11}	2.25×10^{-6}	2.08×10^{-11}
Processing facility beyond-design-basis earthquake (1×10^{-5})	8.23×10^{-8}	0.00321	1.00×10^{-5}[(e)]
35-year FMEF risk	2.88×10^{-6}	0.112	3.50×10^{-4}
35-year Option risk	2.88×10^{-6}	0.113	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. There would be no neptunium-237 targets for this zero-production case. Thus, there would be no associated accident risks.
d. The increased risk from irradiation of neptunium-237 targets in a currently operating reactor is determined by subtracting the risk of operating without targets from the risk of operating with targets.
e. Risk of an early fatality.

Note: To convert from kilograms per year to pounds per year, multiply by 2.20.
Key: kg/yr, kilograms per year; LOCA, loss-of-coolant accident.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years of ATR target irradiation, the increased risk of a latent cancer fatality to the maximally exposed offsite individual and to a noninvolved worker would be 1.49×10^{-7} and 1.95×10^{-6}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 7.01×10^{-4}.

For 35 years of HFIR target irradiation, the increased risk of a latent cancer fatality to the maximally exposed offsite individual and to a noninvolved worker would be 8.68×10^{-9} and 3.43×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 4.09×10^{-5}.

For 35 years of FMEF target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed offsite individual and of an early fatality to a noninvolved worker would be 2.88×10^{-6} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.112.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 3.04×10^{-6} and 3.52×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.113.

The irradiation of neptunium-237 targets at ATR and HFIR would not introduce any additional operations that require the use of hazardous chemicals. Thus, there are no postulated hazardous chemical accidents attributable to the irradiation of neptunium-237 targets at ATR and HFIR.

No chemical processing activities are currently performed at FMEF and no chemicals are stored in this facility. Processing activities in support of plutonium-238 production would require the introduction of hazardous chemicals, specifically nitric acid and nitric oxide. Potential health impacts from accidental releases of nitric acid were assessed by comparing estimated airborne concentrations of the chemicals to ERPG developed by the American Industrial Hygiene Association. The ERPG-1 value (0.5 part per million) is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour, resulting in only mild, transient, and reversible adverse health effects. The ERPG-2 value (10 parts per million) is protective of irreversible or serious health effects or impairment of an individual's ability to take protective action. The ERPG-3 value (25 parts per million) is indicative of potentially life threatening health effects.

The maximum distances, in meters, needed to reach the ERPG values for nitric acid releases at FMEF for Stability Classes D and F are shown in **Table 4–115**. Two separate atmospheric conditions were evaluated, Stability Classes D and F. Stability Class D represents average meteorological conditions while Stability Class F represents worst-case meteorological conditions. The number of involved and noninvolved workers potentially exposed would vary with a number of factors, such as the time of day and whether they were sheltered within buildings at the time of release. Individuals at the nearest access road (7,100 meters [4.4 miles]) and at the nearest site boundary (7,210 meters [4.5 miles]) from FDPF would be exposed to levels well below ERPG-1.

Table 4–115 ERPG Distances for Nitric Acid Releases at FMEF Under Alternative 2 (Use Only Existing Operational Facilities)—Option 9

Evaluation Parameter	Stability Class D (meters)	Stability Class F (meters)
ERPG-3	375	450
ERPG-2	500	600
ERPG-1	2,000	3,000

Note: To convert from meters to miles, multiply by 6.22×10^{-4}.
Key: ERPG, Emergency Response Planning Guideline.

There are no ERPG values for nitric oxide. For nitric oxide accidents, the level of concern has been estimated by using one-tenth of the "Immediately Dangerous to Life and Health" level published by the National Institute for Occupational Safety and Health. The Immediately Dangerous to Life and Health value for nitric oxide is 100 parts per million. The level of concern value used for this NI PEIS is 10 parts per million. The level of concern is defined as the concentration of an extremely hazardous substance in air above which there may be serious irreversible health effects as a result of a single exposure for a relatively short period of time.

For FMEF, the maximum distances needed to reach the level of concern for nitric oxides releases for Stability Classes D and F are 500 and 2,000 meters (0.31 and 1.24 miles), respectively. The number of involved and noninvolved workers potentially exposed would vary with a number of factors, such as the time of day and whether they were sheltered within buildings at the time of release. Individual at the nearest access road (7,100 meters [4.4 miles]) and the nearest site boundary (7,210 meters [4.5 miles]) from FMEF would be exposed to levels well below the level of concern for nitric oxide.

Potential health impacts from the accidental release of the hazardous chemicals were assessed for offsite individuals who are members of the public located at the nearest site boundary and onsite individuals who are members of the public located at the nearest point of public access on site.

The impacts associated with the accidental release of nitric acid and nitric oxide at FMEF are presented in **Table 4–116**.

Table 4–116 FMEF Hazardous Chemical Accident Impacts Under Alternative 2 (Use Only Existing Operational Facilities)—Option 9

Receptor	Evaluation Parameter	Nitric Acid		Nitric Oxide	
		Stability Class D	Stability Class F	Stability Class D	Stability Class F
Onsite individual	Parts per million Level of concern Potential health effects	0.03 < ERPG-1 None	0.1 ERPG-1 Mild, transient	0.09 < LOC None	0.55 < LOC None
Offsite individual	Parts per million Level of concern Potential health effects	0.03 < ERPG-1 None	0.1 ERPG-1 Mild, transient	0.09 < LOC None	0.53 < LOC None

Note: < means "less than."
Key: ERPG, Emergency Response Planning Guideline; LOC, level of concern.
Source: Model results.

4.4.9.1.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the FMEF target fabrication facility at Hanford. DOE would transport the unirradiated neptunium-237 targets from FMEF to HFIR at ORR, and to ATR at INEEL. Following irradiation in HFIR or ATR, the targets would be returned to FMEF for processing. After this processing, the plutonium-238 product would be shipped to LANL. The analysis is described in Appendix J.

Approximately 763 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 1.9 million kilometers (1.2 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 12 person-rem; the dose to the public, 196 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0047 latent cancer fatality among transportation workers and 0.098 latent cancer fatality in the total affected

population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option is 0.0051.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FMEF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 were also evaluated and estimated to have a probability of lower than 1 in 10 million per year.

Estimates of the total ground transportation accident risks are as follows: a radiological dose to the population of 0.06 person-rem, resulting in 3.0×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.04 traffic fatality.

4.4.9.1.12 Environmental Justice

NORMAL OPERATIONS. For 35 years of normal operations under this option, the likelihood of an incremental latent cancer fatality among the population residing within 80 kilometers (50 miles) of HFIR, ATR, and FMEF would be essentially zero (derived from information in Table 4–111). As shown in Sections 4.4.3.1.9 and 4.4.9.1.9, the release of hazardous chemicals at Hanford would pose no significant risk of cancer or toxic effects among the public. As discussed in Sections K.5.1, K.5.2, and K.5.3 of Appendix K, the risk that would result from the ingestion of food that could be radiologically contaminated due to normal operations would be essentially zero at INEEL and ORR, and approximately 0.001 latent cancer fatality at Hanford. No credible pattern of food consumption by persons residing in potentially affected areas would result in significant health risks due to radiological contamination of food supplies near INEEL, ORR, and Hanford. As discussed in Section 4.4.9.1.11, no fatalities would be expected to result from incident-free transportation activities.

ACCIDENTS. The number of latent cancer fatalities among populations at risk due to accidents listed in Table 4–114 would be approximately 0.11. If a radiological accident were to occur at ATR or FMEF and northwesterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Fort Hall Indian Reservation (see Figure K–2). In the event a radiological accident were to occur at HFIR and southerly winds prevailed at the time of the accident, radiological contamination would be directed toward the predominately minority population of the Scarboro Community adjacent to the northern boundary of ORR (see Figure K–6). If the winds were blowing from the west-southwest at the time of the accident, radiological contamination would be directed toward minority populations residing in Knoxville, Tennessee. If a radiological accident were to occur at FMEF and northeasterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Yakama Indian Reservation (see Figure K–11). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the populations or maximally exposed individuals residing near or within the boundaries of the Fort Hall Indian Reservation, the Scarboro Community, Knoxville, or the Yakama Indian Reservation.

As discussed in Section 4.4.9.1.11, no fatalities would be expected to result from transportation accidents.

In summary, the implementation of this option would pose no significant radiological risk to persons residing in potentially affected areas or along representative transportation routes. Under the conservative assumption that all food consumed in potentially affected areas during the 35-year operational period would be

radioactively contaminated, no credible pattern of food consumption would pose a significant radiological health risk due to the ingestion of contaminated food supplies. As discussed in other parts of Section 4.4.9.1, the implementation of this option would not result in significant nonradiological impacts on populations at risk. Thus, implementation would not pose significant and adverse environmental risks to persons residing within potentially affected areas, including minority and low-income persons.

4.4.9.1.13 Waste Management

Only very small amounts of additional wastes would be generated as a result of irradiating neptunium-237 targets in ATR and HFIR because these reactors would already be operating for other purposes. The anticipated incremental generation of wastes from ATR operations is discussed in Section 4.4.1.1.13. The anticipated incremental generation of wastes from HFIR operations is discussed in Section 4.4.7.1.13. There would be virtually no impacts on either site's waste management systems as the result of neptunium-237 target irradiation.

The impacts of managing wastes associated with neptunium-237 target fabrication and processing in FMEF are assumed to be the same as for Option 3 (Section 4.4.3.1.13) because the same amount of plutonium-238 would be produced annually. As shown in that section, the impacts on the waste management systems at Hanford would be minimal.

4.4.9.1.14 Spent Nuclear Fuel Management

No incremental impacts would be associated with the management of spent nuclear fuel (refer to Section 4.4.1.1.14).

4.4.9.2 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.5 ALTERNATIVE 3—CONSTRUCT NEW ACCELERATOR(S)

Under Alternative 3, one or two new accelerators would be used for target irradiation for the evaluation period of 35 years. The new accelerator(s) which would be constructed at an existing DOE site, would be used to irradiate all of the targets (i.e., for production of plutonium-238, isotopes for medical and industrial uses, and materials testing for research and development). Ongoing operations at existing facilities as described in Chapter 3, Affected Environment, would continue.

The targets for plutonium-238 production would be fabricated in one of the three candidate facilities at ORNL, INEEL, or Hanford. The material needed for the target fabrication (neptunium-237) would be transported from SRS to the fabrication facilities. The targets would be irradiated at the new high-energy accelerator facility and transported back to the target fabrication facilities for postirradiation processing.

Targets for medical and industrial isotope production would be fabricated in a new support facility located at the same site as the low-energy accelerator. The targets would be irradiated in the low-energy accelerator and returned to the new support facility for postirradiation processing. Site selection for Alternative 3 is not evaluated as part of this NI PEIS. Because Alternative 3 is evaluated at a generic DOE site, no credit was taken for any support infrastructure existing at the site and it was postulated that a new support facility would be required to support operation of the low-energy accelerator and its missions and the high-energy accelerator nuclear research and development missions if both accelerators are located on the same site. While this approach bounds the environmental impact assessment for the implementation of Alternative 3, it overstates the impacts because this NI PEIS integrates the impacts associated with constructing new support facilities and infrastructure that may be available at the existing DOE site. In the event that Alternative 3 or the low-energy accelerator alone is selected by the Record of Decision for subsequent consideration, follow-on NEPA assessments would evaluate potential locations for either both accelerators or one of the accelerators. It is highly unlikely that DOE would consider locating the new low-energy or high-energy accelerator on a DOE site that does not have existing infrastructure capable of supporting all or most of the proposed mission requirements.

DOE can select any alternative or combination of alternatives or elements of alternatives in the NI PEIS Record of Decision associated with this NI PEIS. Alternative 3 is a prime example of an alternative that could be split and combined with another alternative. DOE could select Alternative 2 in combination with the new low-energy accelerator element of Alternative 3. This combination of alternative elements would provide the plutonium-238 production requirements, enhanced nuclear research and development capability, and enhanced medical and industrial isotope production capability.

Under Alternative 3, nonirradiated targets, irradiated targets, and processed materials would be transported between the locations selected for storage, target fabrication, target irradiation, postirradiation processing, and the final destination of the plutonium-238. Alternative 3 also would include decontamination and decommissioning of the accelerator(s) and the support facility when the missions are over, as well as deactivation of FFTF at Hanford.

The low-energy accelerator would serve as a dedicated isotope production facility. Due to the nature of this type of accelerator, it could only produce a limited number of isotopes (listed in Table 1–1), has no ability to satisfy the plutonium-238 needs, and a very limited ability to support the proposed nuclear-based research and development needs. The preconceptual design of the high-energy accelerator presented in Appendix F focused on supporting the plutonium-238 production mission. The design of the high-energy accelerator could be refined and expanded to perform additional missions such as the production of a select set of medical and industrial radioisotopes. In addition, DOE is aware of longer-term concepts that would apply high-energy accelerators to produce “tuneable” neutrons in a subcritical assembly. Such a facility could be used to address

some of the missions more familiar to reactor facilities and may hold considerable promise for future science and technology research. A facility of this nature could provide unique capabilities in areas such as the testing of many different nuclear system coolant, fuel, and material interactions. The changes required to add additional capability to the high-energy accelerator could be provided, but they would increase the size of the facility, add complexity to the facility design and operation, increase the cost of construction and operation, and potentially require more time for design and construction.

The three options under this alternative and their associated target fabrication, postirradiation processing, and transportation activities are discussed below.

- **Option 1.** REDC at ORNL would be used to fabricate and process the neptunium-237 targets required for plutonium-238 production. The neptunium-237 transported from SRS to ORNL would be stored at REDC. The plutonium-238 product would be transported from ORNL to LANL for use in radioisotope power systems for future U.S. space missions. A new support facility at an existing DOE site would be used to fabricate and process the targets required for the production of medical and industrial and research isotopes and to store the materials needed for target fabrication.

- **Option 2.** FDPF at INEEL would be used to fabricate and process the neptunium-237 targets associated with plutonium-238 production. The neptunium-237 transported from SRS to INEEL would be stored in FDPF or Building CPP–651 at INEEL. The plutonium-238 product would be transported from INEEL to LANL for use in radioisotope power systems for future U.S. space missions. A new support facility at an existing DOE site would be used to fabricate and process the targets required to produce medical and industrial and research isotopes and to store the materials needed for target fabrication.

- **Option 3.** FMEF at Hanford would be used to fabricate and process the neptunium-237 targets for plutonium-238 production. The neptunium-237 transported from SRS to Hanford would be stored in FMEF. The plutonium-238 product would be transported from Hanford to LANL. A new support facility at an existing DOE site would be used to fabricate and process the targets required for the production of medical and industrial and research isotopes and to store the materials needed for target fabrication.

The incremental environmental impacts associated with each option are presented separately for the high-energy accelerator, the low-energy accelerator, and the support facility because combinations of these facilities may be selected for implementation. This segmentation assists in the selection of facilities from any of the possible combinations.

The baseline operational impacts at ORR, INEEL, and Hanford are presented in Table 4–1. These are the sites at which plutonium-238 production activities would take place under this alternative. The other activities associated with this alternative would take place at a DOE site not yet selected and, therefore, baseline impacts cannot be presented. The incremental impacts associated with each option for the identified sites can be added to the baselines to provide total site impacts.

4.5.1 Alternative 3 (Construct New Accelerator[s])—Option 1

Option 1 involves constructing and operating one or two accelerators to irradiate all targets associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating REDC at ORR to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and conducting and operating the support facility to fabricate and process the other targets and materials and to process the associated products. This option includes storage in REDC of the neptunium-237 transported to

ORR from SRS and storage in the new support facility of the other target materials transported to the generic site from other offsite facilities.

The transportation of the neptunium-237 from SRS to ORR and then to the generic site, the transportation of the other target materials to the generic site, and the transportation of plutonium-238 and other product materials following irradiation and postirradiation processing constitute part of this option.

All options under this alternative include the decontamination and decommissioning of the accelerator(s) and support facility at the generic site following their operational lifetimes, and also the permanent deactivation of FFTF at Hanford.

4.5.1.1 Construction of the New Accelerator(s) and Support Facility

The environmental impacts associated with the construction of one or two new accelerators and a support facility at the generic DOE site are assessed in this section.

4.5.1.1.1 Land Resources

LAND USE. The construction of a low-energy accelerator, a high-energy accelerator, and a support facility would require 4 hectares (10 acres), 20.2 hectares (50 acres), and 2.4 hectares (6 acres), respectively (TechSource 2000; SAIC 2000). Since the exact nature of the construction site for any of these facilities is not known at this time (e.g., whether it has been previously disturbed or not), potential effects on land use cannot be determined. In general, if a location in a previously developed portion of a generic DOE site were selected, impacts on land use would be minimal. However, if an undisturbed location were chosen, land use would change from its present designation to industrial. If the accelerator(s) alternative were selected, tiered NEPA documentation would permit an exact determination of impacts on land use.

VISUAL RESOURCES. Impacts from construction of one or two accelerators and a support facility to visual resources at a generic DOE site would depend on the specific location selected. Impacts could include a change in the present Visual Resource Management rating of the site and/or increase in visibility of the site from offsite locations due to the presence of new structures. If construction took place on undeveloped land, the Visual Resource Management rating could change from Class II or III (ratings typical of undeveloped portions of many DOE sites) to Class IV. If a previously developed location were chosen for the accelerator(s), the Visual Resource Management rating would remain Class IV. In either case, new facilities may impact the view from offsite locations by increasing the industrial nature of the viewshed. This impact would be more likely at a western site due to the generally level terrain and sparse vegetation. Specific impacts on visual resources would be determined in tiered NEPA documentation if the accelerator(s) alternative were selected.

4.5.1.1.2 Noise

The construction of high-energy and/or low-energy accelerators would result in some increase in noise levels from the use of earthmoving, materials handling, and impact equipment; employee vehicles; and truck traffic. Noise from construction activities, especially impulsive noise, would be expected to disturb wildlife in the immediate area of the construction site. The change in noise levels in areas outside the DOE site would be dependent on the location selected and the exact nature of the construction location and activities required. However, generally if the location selected were within one of the larger DOE sites and more centrally located within the site, offsite noise impacts from construction activities would be small. Construction employee vehicles and truck traffic would result in an increase in traffic noise along roads used to access the site. However, this increase in traffic noise would be small unless the construction traffic volume were as large as

the existing site traffic. Site-specific analysis would be conducted in tiered NEPA documentation if the accelerator(s) alternative were selected.

The construction of a support facility for the high-energy and/or low-energy accelerators would result in some increase in noise levels from the use of earthmoving, materials handling, and impact equipment; employee vehicles; and truck traffic. Noise from construction activities, especially impulsive noise, would be expected to disturb wildlife in the immediate area of the construction site. The change in noise levels in areas outside the DOE site would be dependent on the location selected and the exact nature of the construction location and activities required. However, generally if the location selected were within one of the larger DOE sites and more centrally located within the site, offsite noise impacts from construction activities would be small. Construction employee vehicles and truck traffic would result in an increase in traffic noise along roads used to access the site. However, this increase in traffic noise would be small unless the construction traffic volume were as large as the existing site traffic. Site-specific analysis would be conducted in tiered NEPA documentation if the accelerator(s) alternative were selected.

4.5.1.1.3 Air Quality

High-Energy Accelerator. Construction of the high-energy accelerator would result in an increase in air quality impacts from employee vehicles, trucks, and construction equipment. Criteria pollutant concentrations for construction of the high-energy accelerator were modeled and compared to the most stringent standards (**Table 4–117**). The maximum ground-level concentrations that would result from high-energy accelerator construction would be well below the ambient air quality standards, although concentrations of some pollutants (i.e., PM_{10} and NO_x) would be relatively high. Therefore, if the accelerator were in an area that already had high background pollutant concentrations, resultant pollutant concentrations could approach or exceed the ambient standards. As a result, regulatory compliance would need to be assessed on a case-by-case basis. No hazardous chemical emissions have been identified from construction activities.

Modeling was based on a construction area of 100,000 square meters (1,080,000 square feet). The site was modeled as an area source with emissions occurring at a height of 3 meters (9.8 feet). A boundary limit of 3,200 meters (2 miles) was assumed for a generic site.

Table 4–117 Incremental Concentrations Associated with High-Energy Accelerator Construction Under All Options of Alternative 3 (Construct New Accelerator[s])

Pollutant	Averaging Time	Most Stringent Standard or Guideline (microgram per cubic meter)[a]	Modeled Increment (microgram per cubic meter)
Carbon monoxide	8 hours 1 hour	10,000 40,000	436 623
Nitrogen oxide	Annual	100	42
PM_{10}	Annual 24 hours	50 150	3 69
Sulfur dioxide	Annual 24 hours 3 hours	80 365 1,300	3 64 143

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

Source: Modeled increments are based on SCREEN 3 computer code (EPA 1995); data from TechSource 2000.

Low-Energy Accelerator. Given the small size of the low-energy accelerator (about 3 percent of the construction size of the high-energy accelerator), emissions of air pollutants from construction would be very small in comparison with the high-energy accelerator. The maximum ground level concentrations that would result from low-energy accelerator construction would be well below the ambient air quality standards. Nevertheless, regulatory compliance would need to be assessed on a case-by-case basis.

Support Facility for High-Energy Accelerator. Given the small size of the support facility in comparison with the high-energy accelerator (assumed about 10 percent of the construction size of the high-energy accelerator), emissions of air pollutants from construction would be very small in comparison with the high-energy accelerator construction. The maximum ground level concentrations that would result from accelerator support facility construction would be 10 percent of the values given in Table 4–117.

Support Facility for Low-Energy Accelerator. Given the small size of the low-energy accelerator and its support facility in comparison with the high-energy accelerator, emissions of air pollutants from construction would be very small in comparison with the high-energy accelerator's support facility construction. No significant impact would result from construction of the support facility.

4.5.1.1.4 Water Resources

It is estimated that construction of the high-energy accelerator would require approximately 22.7 million liters (6 million gallons) of water per year. Construction of the low-energy accelerator would require about 11.4 million liters (3 million gallons) of water annually (TechSource 2000). Construction of the support facility would require an estimated 16.5 million liters (4.36 million gallons) of water per year (SAIC 2000).

Water would be expected to be required for such uses as mixing concrete, dust control, washing activities, and for potable and sanitary needs. These are annual average values over the forecasted construction periods; these values do not include dewatering of excavations that could be required at some sites. The exact impact of these withdrawals on the resource would depend on the water source (surface water or groundwater) and its relative abundance. These factors would be used to determine the impact on the local and/or regional availability of the resource. Impacts would be expected to be small to negligible due to the relatively small volumes of water required for construction compared to expected site availability.

Construction of the high-energy accelerator is projected to generate approximately 11.4 million liters (3 million gallons) of sanitary wastewater per year. Construction of the low-energy accelerator would generate an estimated 5.7 million liters (1.5 million gallons) of sanitary wastewater annually (TechSource 2000). Construction of the support facility would generate about 4 million liters (1.06 million gallons) of sanitary wastewater per year (SAIC 2000). Process wastewater could also be generated during construction, associated with facility cold-startup and testing of auxiliary systems as construction progresses (e.g., cooling towers). The site selected would use existing infrastructure; nearby wastewater treatment facilities would be used to the extent possible, supplemented by portable or temporary facilities during construction, as necessary. The potential impact on water resources would depend on the availability and capacity of appropriate treatment facilities. All wastewater would be disposed of in accordance with applicable regulatory requirements with discharges to surface waters in accordance with National Pollutant Discharge Elimination System (NPDES) effluent limitations.

Ground disturbance and runoff from denuded areas could potentially impact surface water quality near construction areas (Section 4.5.1.1.6). However, appropriate spill prevention practices and soil erosion and sediment control measures (e.g., silt fences, mulching disturbed areas) would be employed during construction to minimize water quality impacts.

Some locations on a generic DOE site could potentially be affected by flooding requiring appropriate siting decisions (Section 3.6.4). Applicable regulatory requirements would be followed in siting facilities including Executive Order 11988, *Floodplain Management*.

Although specific impacts on water resources cannot be determined at this time, site-specific analysis would be conducted in tiered NEPA documentation if the accelerator(s) alternative were selected.

4.5.1.1.5 Geology and Soils

Construction of the high-energy accelerator would disturb a total of approximately 20.2 hectares (50 acres) of land, with construction of the low-energy accelerator disturbing about 4 hectares (10 acres) of land (TechSource 2000). Construction of the support facility would disturb an additional 2.4 hectares (6 acres) of land (SAIC 2000). Construction impacts on geologic and soil resources cannot be determined at this time since they are site specific in nature. However, impacts would be expected to be less if previously disturbed land were used than if an undeveloped area were selected for construction.

In general, construction activities would likely require appreciable quantities of sand and gravel and possibly other geologic materials and, depending on the site chosen, could temporarily deplete local deposits or stockpiles of these materials. Soil erosion potential is also closely related to the amount of land disturbed.

As discussed in Section 3.6.5, the proposed facilities could be located at a generic DOE site with seismic activity ranging from low to moderate. Known capable faults could be located within 19 kilometers (12 miles). However, no known large-scale geologic conditions are present at any generic DOE site that would preclude the construction and operation of properly designed facilities. Appropriate activities and subsurface investigations would be conducted to identify geologic hazards including seismic and volcanic features and other natural hazards (landslide areas, sinkholes, unstable soils) as part of the site selection process. As stated in DOE Order 420.1, DOE requires that nuclear or nonnuclear facilities be designed, constructed, and operated so that the public, the workers, and the environment are protected from the adverse impacts of natural phenomena hazards, including earthquakes. DOE Order 420.1, Section 4.4, as supplemented by DOE Guide 420.1-2, stipulates the natural phenomena hazards mitigation requirements for DOE facilities. Further, the natural phenomena hazards mitigation requirements of DOE Order 420.1 are consistent with the guidance for seismic design and construction contained in the National Earthquake Hazards Reduction Program 1997 provisions (BSSC 1997). In addition, DOE Guide 420.1-2 was recently issued to recognize the consolidation of the three previous U.S. model building codes, including the Uniform Building Code, into the *International Building Code* (ICC 2000). The DOE requirements for seismic engineering have followed the Uniform Building Code, unless the importance of achieving a high level of protection warrants the use of more demanding methods and criteria (DOE Guide 420.1-2). Thus, new facilities would be designed and sited in accordance with DOE Order 420.1.

Site-specific analysis would be conducted in tiered NEPA documentation if the accelerator(s) alternative were selected.

4.5.1.1.6 Ecological Resources

If the accelerator(s) alternative were selected, tiered NEPA documentation would be undertaken to determine the exact nature of construction impacts on ecological resources. During that process, impacts on individual species and habitats that are sensitive to disturbance would be determined. This would include consideration of wetlands and threatened and endangered species. Wetland delineations and consultation with the U.S. Fish and Wildlife Service and state wildlife agency would take place, as necessary, to ensure that these resources would be protected.

Construction impacts on ecological resources are site specific. The nature of these impacts would be expected to vary depending on whether the site was located in the eastern or western portion of the United States. In fact, depending on the site location, impacts on some resources may not occur. Additionally, construction impacts on ecological resources would depend on whether the selected location was within an already disturbed portion of the site. In general impacts on terrestrial resources, wetlands, aquatic resources, and threatened and endangered species described below are applicable to an undeveloped site.

Terrestrial Resources. The construction of a low-energy accelerator, a high-energy accelerator, and a support facility would require 4 hectares (10 acres), 20.2 hectares (50 acres), and 2.4 hectares (6 acres), respectively (TechSource 2000; SAIC 2000). If these facilities were constructed at an undeveloped location, it is likely that woodland habitat would be lost at an eastern generic DOE site and shrubland would be disturbed at a western site. Land clearing activities would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would not be expected to survive. Construction activities and noise would cause larger mammals and birds in the construction and adjacent areas to move to similar habitat nearby. If the area to which they moved was below its carrying capacity, these animals would be expected to survive. However, if the area were already supporting the maximum number of individuals, the additional animals would compete for limited resources that could lead to habitat degradation and eventual loss of the excess population. Nests and young animals living within the disturbed area may not survive.

Wetlands. Clearing and grading operations could result in the direct loss of wetlands, although proper placement of the accelerator(s) and support facility within the overall generic DOE site would eliminate or reduce the potential for such loss. Indirect impacts could also result from stormwater runoff carrying sediments to wetlands located adjacent to the site. Changes in hydrology, water quality, and soils could occur as a result of alterations in water levels, runoff, and the buildup of sediments. These changes could, in turn, alter the vegetative composition of the wetland. In general, both direct and indirect impacts would be more likely to occur at an eastern site due to the greater abundance of wetlands. If preliminary analysis determined that wetlands could be impacted by development, a wetland delineation would be required. Impacts on wetlands could also lead to the implementation of mitigation measures.

Aquatic Resources. During construction of the accelerator(s) and a support facility, impacts on aquatic resources could result from stormwater runoff. Runoff could alter flow rates, increase turbidity, and lead to sedimentation of streambeds. These impacts could, in turn, cause temporary and permanent changes in species composition and density, and alter breeding habitats. The implementation of erosion and sediment control procedures would lessen construction impacts.

Threatened and Endangered Species. The construction of one or two accelerators and a support facility would have the potential to impact threatened and endangered species. Sources of impacts would be similar to those discussed above for terrestrial resources, wetlands, and aquatic resources. The primary difference is that the resource of concern involves individual species that are sensitive to disturbance and whose existence may be threatened by development. Consultations with the U.S. Fish and Wildlife Service and appropriate state agency would be conducted at the site-specific level, as appropriate.

4.5.1.1.7 Cultural and Paleontological Resources

The construction of a low-energy accelerator, a high-energy accelerator, and a support facility would require 4 hectares (10 acres), 20.2 hectares (50 acres), and 2.4 hectares (6 acres), respectively (TechSource 2000; SAIC 2000). Since the exact nature of the construction site for any of these facilities is not known at this time (e.g., whether it has previously been disturbed or not), potential effects on cultural resources cannot be determined. In general, if a location in a previously developed portion of a DOE generic site were selected, impacts on cultural resources may not occur. However, if an undisturbed location were chosen, cultural

resources could be impacted. If the accelerator(s) alternative were selected, prehistoric and historic resources, including those that are or may be eligible for listing on the National Register of Historic Places, would be identified. These resources would be identified through site surveys and consultation with the State Historic Preservation Officer. Specific concerns about the presence, type, and location of Native American resources would be addressed through consultation with the potentially affected tribes in accordance with the *National Historic Preservation Act*, the *Native American Graves Protection and Repatriation Act*, and the *American Indian Religious Freedom Act*.

4.5.1.1.8 Socioeconomics

It is estimated that 410 workers would be needed to construct the new accelerator(s) and a support facility at a generic DOE site during the peak year of construction. The impact from this influx of workers upon the site's region of influence and regional economic area would depend on whether the site were located near a large urbanized area or in a remote rural area. Since the population for the region of influence for a generic site could range from nearly 2.0 million people for a site in a large metropolitan area, to less than 200,000 for a site in a small rural community, the socioeconomic impacts of constructing new accelerator(s) and a support facility would vary greatly. Therefore, if DOE were to select the new accelerator(s) alternative, additional NEPA documentation would be required to select the specific DOE site to locate the new accelerator(s) and support facility. In that document, DOE would perform a thorough evaluation of the socioeconomic impacts of the sites under consideration.

4.5.1.1.9 Public and Occupational Health and Safety—Normal Construction Activities

Assessments of incremental radiological and chemical impacts associated with the construction of the new accelerator(s) and support facility are presented in this section. Supplemental information is provided in Appendix H.

RADIOLOGICAL IMPACTS. During construction operations, it is not anticipated that there would be any resulting radiological releases to the environment; therefore no additional dose to the public is expected. Furthermore, construction workers are not expected to receive exposures above natural background levels which exist within the construction areas. However, as a precautionary measure, workers would be badged as deemed appropriate.

HAZARDOUS CHEMICAL IMPACTS. No hazardous chemical releases have been identified for construction activities. The painting activities would result in very small emissions of noncarcinogenic chemicals, which would produce minimal impact. Therefore, minimal hazardous chemical impacts are associated with construction.

4.5.1.1.10 Public and Occupational Health and Safety—Construction Accidents

There are no radiological or hazardous chemical accidents postulated during the construction phases of the new accelerator(s) or the support facility. Workers could experience industrial accidents commonly associated with the construction large facilities.

4.5.1.1.11 Environmental Justice

Environmental effects due to construction activities that would be expected to occur at an unspecified accelerator(s) and support facility site are addressed in Section 4.5.1.1. The analysis shows that radiological and nonradiological risks to persons residing in the (hypothetical) potentially affected areas would not be significant. Unless there are patterns of food consumption among minority or low-income residents

surrounding the actual site (yet to be determined) that would result in a significant ingestion of radiologically contaminated food, it is plausible that construction activities would pose no significant risks to minority and low-income persons. However, evaluations of environmental justice are necessarily site specific and cannot be performed in detail for unspecified locations. In the event that this option were selected for implementation and a specific site selected for the new accelerator(s) and support facility, an additional evaluation of environmental justice at the accelerator(s) and support facility site during construction would be performed prior to implementation.

4.5.1.1.12 Waste Management

The expected generation rates of wastes at a generic DOE site that would be associated with the construction of new accelerator(s) to irradiate targets and a support facility to fabricate and process medical and industrial isotope targets and to meet research and development needs are provided in **Table 4–118**. These estimates represent the total amount of wastes generated during the construction period. These generation rates cannot be compared at this time with site treatment, storage, and disposal capacities because a DOE site has not yet been chosen for these facilities. Site-specific analyses would be conducted if this alterative were chosen, and appropriate NEPA documentation would be prepared.

Table 4–118 Estimated Waste Generation Associated with Constructing New Accelerator(s) and Support Facility Under All Options of Alternative 3 (Construct New Accelerator[s])

Waste Type[a]	Estimated Waste Generation for New Accelerator(s) (total cubic meters)		Estimated Waste Generation for New Support Facility (total cubic meters)
	Low-Energy	High-Energy	
Transuranic	0	0	0
Low-level radioactive			
Liquid	0	2	0
Solid	0	115	0
Mixed low-level radioactive	0	6	0
Hazardous			
Liquid	0	4	1
Solid	0	7	3
Nonhazardous			
Process wastewater	0	0	0
Sanitary wastewater	4,500	51,000	16,000
Solid	500	3,900	650

a. See definitions in Appendix G.9.
Note: To convert from cubic meters to cubic yards, multiply by 1.308.
Source: SAIC 2000; TechSource 2000.

Section 3.6.11.1 provides DOE site ranges for each waste type that include volume currently stored, projected generation, and for some wastes, disposal volume. Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.5.1.1.9 through 4.5.1.1.10.

4.5.1.2 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.5.1.2.1 Land Resources

LAND USE. The operation of one or two accelerators and a support facility at a generic DOE site would not be expected to affect land use. This is because none of the anticipated operational impacts (e.g., air emissions) are expected to affect this resource.

REDC would be used for neptunium-237 storage, target fabrication, and processing. The use of REDC for this purpose would not change land use at the site since REDC is currently operating and its proposed use would be compatible with its present mission.

VISUAL RESOURCES. The primary source of impacts on visual resources from the operation of one or two accelerators and a support facility would be air emissions. Releases from stacks associated with this alternative would be controlled and, therefore, would be unlikely to exceed Bureau of Land Management Visual Resource Management objectives. However, the operation of cooling towers could result in a visible plume. The extent and visibility of the plume would depend on site meteorological conditions and terrain features. While plume formation would be favored by meteorological conditions at an eastern generic DOE site, terrain features would tend to mask it from offsite locations; the opposite would tend to be true at a western site. If the accelerator(s) alternative were selected, the visual impact of the cooling tower plume would be determined in tiered NEPA documentation.

All activities associated with neptunium-237 storage, target fabrication, and processing would take place within REDC. Operations associated with the proposed mission would not result in any impact on visual resources or change in the current Visual Resource Management Class IV rating of the 7900 Area. This is because none of the anticipated operational impacts (e.g., air emissions) would be expected to affect this resource.

4.5.1.2.2 Noise

The operation of high-energy and/or low-energy accelerators at a generic DOE site would result in some increase in noise levels from equipment (e.g., cooling systems, vents, motors, generators, compressors, pumps, and material-handling equipment), employee vehicles, and truck traffic. Noise from operation activities could disturb wildlife outside the facility fence line. The change in noise levels in areas outside the DOE site would be dependent on the location selected and the equipment. However, generally if the location selected were within one of the larger DOE sites and were more centrally located within the site, offsite noise impacts from operation would be expected to be small. Operation employee vehicles and truck traffic would result in an increase in traffic noise along roads used to access the site. However, this increase in traffic noise would be small unless the operation traffic volume were as large as the existing site traffic. Site-specific analysis would be conducted in tiered NEPA documentation if the accelerator(s) alternative were selected.

The operation of a support facility for the high-energy and/or low-energy accelerators at a generic DOE site would result in some increase in noise levels from equipment (e.g., cooling systems, vents, motors, generators, compressors, pumps, and material-handling equipment), employee vehicles, and truck traffic. Noise from operation activities could disturb wildlife outside the facility fence line. The change in noise levels in areas outside the DOE site would be dependent on the location selected and the equipment. However, generally if the location selected were within one of the larger DOE sites and were more centrally located within the site, offsite noise impacts from operation would be expected to be small. Operation employee vehicles and truck traffic would result in an increase in traffic noise along roads used to access the site. However, this increase in traffic noise would be small unless the operation traffic volume were as large as the existing site traffic. Site-specific analysis would be conducted in tiered NEPA documentation if the accelerator(s) alternative were selected.

This option also involves using REDC for neptunium-237 target material storage, target fabrication, and processing. Interior modifications of these facilities in the 7900 Area of ORNL would be expected to result in little change in noise impacts on wildlife around this area. The operation of REDC would not result in any change in noise impacts on wildlife around the 7900 Area and offsite noise impacts would be small because the nearest site boundary is 2.5 kilometers (1.6 miles) to the southeast. Operation would be expected to result in a minimal change in noise impacts on people near the ORR as a result of changes in employee and truck traffic levels.

4.5.1.2.3 Air Quality

High-Energy Accelerator. The operation of a new high-energy accelerator would result in some increase in air quality impacts due to the operation of emergency diesel generators. Criteria pollutants were modeled and compared to the most stringent standards (**Table 4–119**). The maximum ground-level pollutant concentrations that would result from high-energy accelerator operation would be well below the ambient air quality standards. However, if the accelerator is in an area that already had high background pollutant concentrations, resultant pollutant concentrations could approach or exceed the ambient standards for some pollutants. As a result, regulatory compliance would need to be assessed on case-by-case basis. Hazardous chemical impacts are addressed in Section 4.5.1.2.9.

Table 4–119 Incremental Concentrations Associated with High-Energy Accelerator Diesel Generator Operation Under Alternative 3 (Construct New Accelerator[s])—Option 1

Pollutant	Averaging Time	Most Stringent Standard or Guideline (microgram per cubic meter)[a]	Modeled Increment (microgram per cubic meter)
Carbon monoxide	8 hours 1 hour	10,000 40,000	94 135
Nitrogen oxide	Annual	100	0.47
PM_{10}	Annual 24 hours	50 150	0.03 17.7
Sulfur dioxide	Annual 24 hours 3 hours	80 365 1,300	0.03 16.5 37.2

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995); TechSource 2000.

Modeling was based on design consideration of two emergency diesel generators. These were modeled as a point source with emissions occurring at a stack height of 3 meters (9.8 feet). A boundary limit of 3,200 meters (2 miles) was assumed for a generic site.

Air quality impacts at ORR from target fabrication and processing associated with this option were determined to be the same as described for Alternative 2, Option 1 (Section 4.4.1.1.3).

Low-Energy Accelerator. The operation of a low-energy accelerator would not require emergency diesel generators. Thus, there would be no increase in air quality impacts due to the operation of the low-energy accelerator.

Support Facility for High-Energy Accelerator. The operation of the support facility would result in air pollutant emissions similar to the FMEF facility operating in support of the FFTF. Thus, there would be an

increase in air quality impacts that would be assessed and appropriate NEPA document prepared if this option were selected for implementation.

Support Facility for Low-Energy Accelerator. The operation of the support facility would result in minimal air quality impacts given the small size of the accelerator. Air quality would be assessed and appropriate NEPA document prepared if this option were selected for implementation.

4.5.1.2.4 Water Resources

It is estimated that the operation of the high-energy accelerator at a generic DOE site would require 1,904 million liters (503 million gallons) of water per year. The operation of the low-energy accelerator would require about 1.29 million liters (0.34 million gallons) of water annually (TechSource 2000). The operation of the support facility would require an estimated 11.9 million liters (3.14 million gallons) of water per year (SAIC 2000). In general, water would be required to support such uses as process cooling, material processing, potable, and sanitary needs with the relatively high water use of the high-energy accelerator attributable to cooling tower operation. The exact impact of these withdrawals on the resource would depend on the water source (surface water or groundwater) and its relative abundance. These factors would be used to determine the impact on the local and/or regional availability of the resource. For surface water, a dedicated surface water intake may have to be constructed if the generic site's existing distribution system is inadequate to meet the increased demands of the facilities. For groundwater, additional wells may have to be developed to supply the facilities (particularly the high-energy accelerator) directly or to provide increased production capacity for the generic site's existing supply system.

The operation of the high-energy accelerator is projected to generate approximately 284 million liters (75 million gallons) of process wastewater per year. The operation of the low-energy accelerator would not generate process wastewater as process cooling water would be recirculated within a closed-loop system. It is expected that process effluent from the high-energy accelerator would mainly consist of cooling tower blowdown. The support facility would generate an estimated 3.6 million liters (0.95 million gallons) of process wastewater per year as a result of material processing. There would be no radiological liquid effluent discharge to the environment under normal operations. Approximately 11.4 million liters (3 million gallons) of sanitary wastewater would also be generated annually as a result of high-energy accelerator operations. The operation of the low-energy accelerator would generate about 0.9 million liters (0.24 million gallons) of sanitary wastewater per year. The operation of the support facility would generate an estimated 8.3 million liters (2.2 million gallons) of sanitary wastewater per year (SAIC 2000; TechSource 2000). Waste management activities and their effects are further detailed in Section 4.5.1.2.13. The potential impact on water resources would depend on the availability and capacity of appropriate treatment facilities. Process and sanitary wastewater would be discharged to either existing site wastewater treatment facilities or to new facilities constructed specifically to serve the proposed facilities. All wastewater would be disposed of in accordance with applicable regulatory requirements with discharges to surface waters in accordance with National Pollutant Discharge Elimination System (NPDES) effluent limitations.

Although specific impacts on water resources cannot be determined at this time, site-specific analysis would be conducted in tiered NEPA documentation if the accelerator(s) alternative is selected.

REDC, an existing facility in the 7900 Area of ORNL, would be used for neptunium-237 storage, target fabrication, and processing in support of plutonium-238 production; these activities would be similar to the current mission of REDC. As existing facilities would be used, there would be no construction-related impacts on water bodies, floodplains, or on surface or groundwater quality. In addition, no additional measurable increase in water use is anticipated to support target fabrication for plutonium-238 production. The only measurable increase would be an additional 23,000 liters (6,100 gallons) per year of process wastewater

associated with target processing (Wham 1999c). Any change in the quantity or quality of process and sanitary wastewater discharges would be negligible compared to that of other activities, with no radiological liquid effluent discharge to the environment under normal operations (Wham 1999a; LMER 1997). Specifically, the anticipated additional 23,000 liters (6,100 gallons) of process wastewater generated per year would be negligible relative to the total volume of process wastewater generated and treated at ORNL daily, approximately 2.08 million liters (550,000 gallons) per day. Overall, no measurable impact on water resources at ORR is expected.

4.5.1.2.5 Geology and Soils

The operation of the accelerator(s) and support facility would not be expected to result in impacts on geologic and soils resources at a generic DOE site. If cooling towers are used, the potential exists for salt deposition to alter soil chemistry. While high rainfall at an eastern site would tend to keep salt from accumulating in the soil, the potential exists that salt could accumulate at a western site where rainfall is sparse. If the accelerator(s) alternative were selected, impacts on geology and soils would be determined in tiered NEPA documentation. As discussed in Section 4.5.1.1.5, the proposed facilities would be designed and constructed in accordance with DOE Order 420.1 and sited to minimize the risk from geologic hazards. Thus, site geologic conditions would be unlikely to affect the facilities.

The use of REDC for neptunium-237 storage, target fabrication, and processing would not be expected to impact either geologic or soil resources, nor be jeopardized by large-scale geologic conditions. Hazards from large-scale geologic conditions at ORR, such as earthquakes, volcanoes, and sinkholes, were previously evaluated in the *Storage and Disposition PEIS* (DOE 1996a:4-260) as discussed in Section 4.2.2.2.5. The analysis determined that these hazards present a low risk to long-term storage facilities. Further review of the data and analyses presented in that document and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions likewise present a low risk to REDC operations.

As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards will be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.5.1.2.6 Ecological Resources

If the accelerator(s) alternative were selected, tiered NEPA documentation would be undertaken to determine the exact nature of operational impacts on ecological resources. During this process, impacts on individual species and habitats that are sensitive to disturbance would be determined. This would include consideration of wetlands and threatened and endangered species.

While the exact nature of operational impacts on ecological resources cannot be determined until a specific site is selected, certain general types of impacts are possible. The nature and extent of these impacts would be expected to vary depending on whether the selected site was located in the eastern or western portion of the United States.

Terrestrial Resources. Activities associated with operations, such as noise and human presence, could affect wildlife living adjacent to the accelerator(s) and support facility. These disturbances could cause some species to move from the area. Preventing workers from entering undisturbed areas would minimize impacts on wildlife living adjacent to the facilities. Emissions to the air and water, both nonradiological and radiological, could impact both plants and animals. Plants and animals could be exposed to pollutants via a number of pathways including direct exposure, contact with contaminated soil, ingestion, and inhalation. Further, bioaccumulation could affect species that consume exposed plants or animals. While regulatory limits would

act to limit the effects of air emissions and effluent discharges, impacts would be analyzed once site and facility specific information became available.

Wetlands. Impacts from the operation of one or two accelerators and a support facility at a western generic DOE site would not be expected to affect wetlands since discharges would be to an evaporation pond. At an eastern site, wastewater and cooling tower blowdown would be discharged to an onsite water body. While these discharges would be through permitted outfalls, the potential exists that wetlands could be affected. Potential impacts, such as changes in water levels and plant species composition, would depend on outfall location, water volume, discharge temperature, and water chemistry. Since these factors depend on site location and facility engineering design, operational impacts on onsite wetlands would have to be analyzed once these factors are known.

Aquatic Resources. Operational impacts on aquatic resources at a western site would not be expected because groundwater would be used and wastewater and cooling tower blowdown would be discharged to an evaporation pond. At an eastern site, potential impacts on aquatic resources could occur as a result of water withdrawal and discharge. Water withdrawal could lead to the loss of aquatic organisms through impingement and entrainment. The discharge of cooling water could result in alterations in aquatic communities. Alterations could include changes in aquatic vegetation and the loss of fish and benthic macroinvertebrates. Additionally, radionuclides and chemicals in the discharge water have the potential to impact aquatic organisms. The extent of potential impacts on the aquatic environment would depend on site and facility specific information.

Threatened and Endangered Species. The operation of one or two accelerators and a support facility would have the potential to impact threatened and endangered species. Sources of impacts would be similar to those discussed above for terrestrial resources, wetlands, and aquatic resources. The primary difference is that the resources of concern involve individual species that are sensitive to disturbance and whose existence may be threatened by development.

REDC would be used for neptunium-237 storage, target fabrication, and processing. As noted in Section 4.5.1.2.2, wildlife would not be adversely affected by noise associated with facility operation. There would be no change in impacts on wetlands or aquatic resources since additional water would not be withdrawn from or discharged to site surface waters. Further, this option would not result in any new contaminants in existing discharges (Section 4.5.1.2.4). No threatened and endangered species have been identified within the 7900 Area; therefore, operational impacts on this resource are not expected.

4.5.1.2.7 Cultural and Paleontological Resources

Impacts on cultural and paleontological resources from the operation of one or two accelerators and a support facility at a generic DOE site would depend on the relative location of such resources to the site and/or transportation routes. While impacts would be expected to be nonexistent or small, they cannot be ruled out. For example, noise related to plant operation or traffic to and from the facility or alterations in the viewshed could adversely affect visitor enjoyment of an historic site. Since impacts on cultural resources are site dependent, specific operational impacts cannot be determined until a site were selected. The operation of the accelerator(s) and support facility would not be expected to impact paleontological resources.

The operation of REDC for neptunium-237 storage, target fabrication, and processing would not affect the status of cultural and paleontological resources at ORR. The Graphite Reactor, which is located within ORNL, is listed on the National Register of Historic Places as a National Historic Landmark. Additionally, several other structures proposed for listing on the National Register of Historic Places are found within or near

ORNL. However, neither the Graphite Reactor nor any of the other structures is located within the 7900 Area, thus, the use of REDC for target fabrication and processing would not change their status.

4.5.1.2.8 Socioeconomics

It is estimated that 225 workers would be needed to operate the new accelerator(s) and support facility at a generic DOE site. The impact from this influx of workers upon the site's region of influence and regional economic area would depend on whether the site were located near a large urbanized area or in a remote rural area. Since the population for the region of influence for a generic site could range from nearly 2.0 million people for a site in a large metropolitan area, to less than 200,000 for a site in a small rural community, the socioeconomic impacts of operating a new accelerator and support facility would vary greatly. Therefore, if DOE were to select this option, additional NEPA documentation would be required to determine the specific socioeconomic impacts.

The socioeconomic impacts associated with neptunium-237 target fabrication and processing at ORR are addressed in Section 4.3.1.1.8.

4.5.1.2.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup and operations are given in **Table 4–120** for the generic DOE site and ORR: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual operations of the accelerator facilities (a high-energy accelerator, a low-energy accelerator, and an accelerator support facility) and REDC, the projected incremental total population dose in the year 2020 would be 0.20 person-rem; the corresponding number of latent cancer fatalities in the populations surrounding the generic DOE site and ORR from 35 years of operations would be 0.0035. The incremental total dose to the maximally exposed member of the public from annual operations of the accelerator(s) and support facility at the generic site would be 0.0034 millirem; from 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 6.0×10^{-8}. Estimated annual risks are also presented for preoperational testing and startup phase activities anticipated for the accelerator(s) and support facility. The incremental dose to the maximally exposed member of the public from annual REDC operations would be 1.9×10^{-6} millirem; from 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 3.3×10^{-11}.

Table 4–120 Incremental Radiological Impacts on the Public Around the Generic DOE Site and ORR from Operational Facilities Under Alternative 3 (Construct New Accelerator[s])—Option 1

Receptor	ORR REDC	Accelerators Preoperational Startup[a]		Generic Site Operations				Two-Site Total
				Accelerators		Accelerator(s) Support Facility	Total	
		Low-Energy	High-Energy	Low-Energy	High-Energy			
Population within 80 kilometers (50 miles) in the year 2020								
Dose (person-rem)	8.8×10^{-5}	0.0024	0.035	0.0036	0.055	0.14	0.20	0.20
35-year latent cancer fatalities	1.5×10^{-6}	2.4×10^{-6}[b]	3.5×10^{-5}[b]	6.3×10^{-5}	9.6×10^{-4}	0.0025	0.0035	0.0035
Maximally exposed individual								
Annual dose (millirem)	1.9×10^{-6}	1.4×10^{-5}	1.8×10^{-4}	7.8×10^{-5}	8.7×10^{-4}	0.0025	0.0034	NA[c]
35-year latent cancer fatality risk	3.3×10^{-11}	1.4×10^{-11}[b]	1.8×10^{-10}[b]	1.4×10^{-9}	1.5×10^{-8}	4.4×10^{-8}	6.0×10^{-8}	NA[c]
Average exposed individual within 80 kilometers (50 miles)								
Annual dose[d] (millirem)	7.8×10^{-8}	1.6×10^{-6}	2.3×10^{-5}	2.3×10^{-6}	3.6×10^{-5}	9.1×10^{-5}	1.3×10^{-4}	NA[c]
35-year latent cancer fatality risk	1.4×10^{-12}	1.6×10^{-12}[b]	2.3×10^{-11}[b]	4.0×10^{-11}	6.3×10^{-10}	1.6×10^{-9}	2.3×10^{-9}	NA[c]

a. For conservatism as well as consistency with other radiological impacts evaluated in this NI PEIS, these values were assessed for the year 2020 even though these activities would commence prior to that year.
b. Preoperational activities last 2 years. Number is a 2-year latent cancer fatality risk.
c. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
d. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of REDC or the generic site in the year 2020 (1,134,200 and 1,538,100, respectively).

Key: NA, not applicable.

Source: SAIC 2000; TechSource 2000; model results, using the GENII computer code (Napier et al. 1988).

Incremental doses to involved workers from normal operations are given in **Table 4–121**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to the high-energy and low-energy accelerator workers during startup and operations would be 150 millirem; for support facility workers, the incremental annual average dose operations would be 102 millirem for REDC workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities is estimated to be 30 (high-energy accelerator startup and operation), 15 (low-energy accelerator startup and operation), 12 (support facility operation), and 22 person-rem (REDC operation). The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–121. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

HAZARDOUS CHEMICALS IMPACTS

High-Energy Accelerator. The operation of a high-energy accelerator would result in some increase in emissions of hazardous chemicals from diesel fuel burning equipment used for operation. The operation of the accelerator would require the emergency diesel generators to be tested approximately 1 hour each month and 12 hours once a year to ensure operability. Chemical releases were modeled based on 48 hours of operation. The source was modeled as a point source with emissions occurring at a stack height of 3 meters (9.8 feet). A boundary limit of 3,200 meters (2 miles) was assumed for a generic site. Resulting concentrations were determined to be very small and would have no incremental impact on the site current conditions (**Table 4–122**). Cancer risk values for carcinogenic compounds are well below acceptable risk values and Hazard Indexes for the toxic chemicals were far below one, and, thus, there will be minimal nonradiological hazardous chemical impacts from the operation of the high-energy accelerator.

Hazardous chemical impacts at ORR from target fabrication and processing associated with this option were determined to be the same as described in Option 1 under Alternative 2 (Section 4.4.1.1.9).

Table 4–121 Incremental Radiological Impacts on Involved Workers at the Generic DOE Site and ORR from Operational Facilities Under Alternative 3 (Construct New Accelerator[s])—Option 1

Receptor—Involved Workers[a]	ORR REDC	Accelerators Preoperational Startup		Generic Site Operations			Two-Site Total
				Accelerators		Accelerator(s) Support Facility	
		Low-Energy	High-Energy	Low-Energy	High-Energy		
Total dose (person-rem per year)	22[b]	15[b]	30[b]	15[b]	30[b]	12[b]	79
35-year latent cancer fatalities	0.31	0.012[c]	0.024[c]	0.21	0.42	0.17	1.1
Average worker dose (millirem per year)	290	150	150	150	150	102	NA[d]
35-year latent cancer fatality risk	0.0041	1.2×10^{-4}[(c)]	1.2×10^{-4}[(c)]	0.0021	0.0021	0.0014	NA[d]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 75 badged workers at ORR REDC, 97 radiological workers (and 120 total workers) at the accelerator(s) support facility, 200 workers at the high-energy accelerator, and 100 workers at the low-energy accelerator.
c. Preoperational startup testing lasts 2 years. Number is a 2-year latent cancer fatality risk.
d. Values cannot be given for the average worker because the workers would be in three different facilities at two different sites.
Key: NA, not applicable.
Source: DOE 1999b; Nielsen 1999; LMER 1997:22; Wham 1999b.

Table 4–122 Incremental Hazardous Chemical Impacts on the Public Around a Generic Site from High-Energy Accelerator Operation Under Alternative 3 (Construct New Accelerator[s])—Option 1

Chemicals	Modeled Annual Increment (microgram per cubic meter)	RfC (microgram per cubic meter)	Unit Cancer Risk (Risk per Microgram per cubic meter)	Hazard Quotient	Cancer Risk
Acetaldehyde	0.0000811	NA	2.20×10^{-6}	NA	1.79×10^{-10}
Benzene	0.0000987	NA	7.80×10^{-6}	NA	7.70×10^{-10}
Formaldehyde	0.000125	NA	1.30×10^{-5}	NA	1.62×10^{-9}
Toluene	0.0000433	400	NA	1.08×10^{-7}	NA
Propylene	0.000273	NA	3.70×10^{-6}	NA	1.01×10^{-9}

Note: Propylene oxide cancer unit was used for propylene.
Key: RfC, Reference concentration; NA, not applicable; The chemical is not a known carcinogen, or it is a carcinogen and only unit cancer will apply.
Source: Data from TechSource 2000; EPA 1999; modeled increments are based on the SCREEN 3 computer code (EPA 1995).

Low-Energy Accelerator. The operation of a low-energy accelerator would not require emergency diesel generators. Thus, there would be no increase in hazardous chemical impacts due to the operation of the low-energy accelerator.

Support Facility for High-Energy Accelerator. The operation of the support facility would result in air pollutant emissions similar to the FMEF facility operating in support of the FFTF. Thus, there would be an increase in hazardous chemical impacts that would be assessed and appropriate NEPA document prepared if this option were selected for implementation.

Support Facility for Low-Energy Accelerator. The operation of the support facility would result in minimal hazardous chemical impacts. Thus, there would be no increase in hazardous chemical emissions due to operation.

4.5.1.2.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with accelerator target irradiation; support facility fabrication and processing of medical, industrial, and research and development isotopes; and REDC target fabrication and processing of neptunium-237 targets are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–123** and **4–124**, respectively.

For 35 years of high-energy accelerator target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.07×10^{-6} and 2.60×10^{-5}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00833.

For 35 years of low-energy accelerator target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.45×10^{-9} and 3.07×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 3.28×10^{-5}.

For 35 years of medical, industrial, and research and development target fabrication and processing at the support facility, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 3.26×10^{-5} and 9.85×10^{-5}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.056.

For 35 years of neptunium-237 target fabrication and processing at REDC, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 5.71×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.157.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 9.18×10^{-5} and 4.75×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.221.

There are no hazardous chemical accidents associated with the new accelerator(s) or new support facility. The irradiation of neptunium-237, medical, industrial, and research and development isotopes in the new accelerator(s) would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The fabrication and processing of medical, industrial, and research and development isotopes at the new support facility would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The hazardous chemical accident impacts at REDC are the same as those presented in Section 4.4.4.1.10.

Table 4–123 New Accelerator(s), Support Facility, and REDC Accident Consequences Under Alternative 3 (Construct New Accelerator[s])—Option 1

Accident	Maximally Exposed Offsite Individual		Population to 80 kilometers (50 miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
High-energy accelerator accidents						
Design-basis target accident	2.92×10^{-6}	1.46×10^{-9}	8.75×10^{-3}	4.37×10^{-6}	4.60×10^{-5}	1.84×10^{-8}
Beyond-design-basis earthquake	1.81×10^{1}	5.90×10^{-3}	3.56×10^{4}	2.38×10^{1}	1.86	7.44×10^{-2}
Low-energy accelerator accidents						
Design-basis target accident	8.05×10^{-5}	4.03×10^{-8}	14.8	7.39×10^{-3}	1.12×10^{-3}	4.48×10^{-7}
Beyond-design-basis earthquake	1.32×10^{-2}	6.60×10^{-6}	3.94×10^{1}	1.97×10^{-2}	2.08×10^{-1}	8.32×10^{-5}
Support facility accidents						
Medical and industrial isotopes localized solvent fire	0.0194	9.72×10^{-6}	31.1	0.0156	0.00530	2.12×10^{-6}
Medical and industrial isotopes unlikely seismic event	0.0750	3.75×10^{-5}	136	0.0680	0.510	2.04×10^{-4}
Medical and industrial isotopes glovebox explosion	2.50	0.00125	4,600	2.30	17.0	0.00680
REDC accidents						
Ion exchange explosion during neptunium-237 target fabrication	6.13×10^{-9}	3.06×10^{-12}	8.58×10^{-5}	4.29×10^{-8}	5.60×10^{-10}	$2.24x0^{-13}$
Target dissolver tank failure during plutonium-238 separation	1.76×10^{-7}	8.79×10^{-11}	0.00196	9.82×10^{-7}	1.09×10^{-8}	6.74×10^{-12}
Ion exchange explosion during plutonium-238 separation	4.68×10^{-4}	2.34×10^{-7}	5.23	0.00261	4.49×10^{-5}	1.79×10^{-8}
Processing facility beyond-design-basis earthquake	163	0.163	8.91×10^{5}	445	1,310	1.00[c]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–124 New Accelerator(s), Support Facility, and REDC Accident Risks Under Alternative 3 (Construct New Accelerator[s])—Option 1

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual high-energy accelerator risks			
Design basis target accident (1×10^{-4})	1.46×10^{-13}	4.37×10^{-10}	1.84×10^{-12}
Beyond-design-basis earthquake (1×10^{-5})	5.90×10^{-8}	2.38×10^{-4}	7.44×10^{-7}
35-year high-energy accelerator risk	2.07×10^{-6}	0.00833	2.60×10^{-5}
Annual low-energy accelerator risks			
Design basis target accident (1×10^{-4})	4.03×10^{-12}	7.39×10^{-7}	4.48×10^{-11}
Beyond-design-basis earthquake (1×10^{-5})	6.60×10^{-11}	1.97×10^{-7}	8.32×10^{-10}
35-year low-energy accelerator risk	2.45×10^{-9}	3.28×10^{-5}	3.07×10^{-8}
Annual support facility risks			
Medical and industrial isotopes localized solvent fire (0.044)	4.32×10^{-7}	6.91×10^{-4}	9.41×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	3.75×10^{-7}	6.80×10^{-4}	2.04×10^{-6}
Medical and industrial isotopes glovebox explosion (1.00×10^{-4})	1.25×10^{-7}	2.30×10^{-4}	6.80×10^{-7}
35-year support facility risk	3.26×10^{-5}	0.056	9.85×10^{-5}
Annual REDC risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	3.06×10^{-14}	4.29×10^{-10}	2.24×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	8.79×10^{-13}	9.82×10^{-9}	6.74×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	2.34×10^{-9}	2.61×10^{-5}	1.79×10^{-10}
Processing facility beyond-design-basis earthquake (1×10^{-5})	1.63×10^{-6}	0.00445	1.00×10^{-5}[c]
35-year REDC risk	5.71×10^{-5}	0.157	3.50×10^{-4}[c]
35-year Option risk	9.18×10^{-5}	0.221	4.75×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

4.5.1.2.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the REDC target fabrication facility at ORR. DOE would transport the unirradiated neptunium-237 targets from REDC to the accelerator(s) site. Following irradiation in the accelerator(s), the targets would be returned to REDC for processing. After this processing, the plutonium-238 product would be shipped to LANL. Additionally, medical and industrial isotopes would be shipped from the accelerator(s) site to a local airport, and from there to locations throughout the country.

Approximately 37,000 shipments of radioactive materials would be made by DOE in support of the low-energy accelerator. The total distance traveled on public roads by trucks carrying radioactive materials would be 4.8 million kilometers (3.0 million miles); and in the air carrying medical and industrial isotopes, 23 million kilometers (14 million miles).

Approximately 343 shipments of radioactive materials would be made by DOE in support of the high-energy accelerator. The total distance traveled on public roads by trucks carrying radioactive materials would be 0.98 million kilometers (0.61 million miles).

The transportation impact analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION FOR THE LOW-ENERGY ACCELERATOR. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 15 person-rem; the dose to the public, 7 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0059 latent cancer fatality among transportation workers and 0.0037 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.02.

IMPACTS OF INCIDENT-FREE TRANSPORTATION FOR THE HIGH-ENERGY ACCELERATOR. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 5 person-rem; the dose to the public, 105 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0022 latent cancer fatality among transportation workers and 0.053 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.0026.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION FOR THE LOW-ENERGY ACCELERATOR. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: more than 1 in 10 million per year) would not breach the transportation package. The consequences of more severe accidents that could breach the transportation package and release radioactive material were evaluated and estimated to have probabilities of less than 1 in 10 million per year.

Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting 0.11 traffic fatality.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION FOR THE HIGH-ENERGY ACCELERATOR. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FDPF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 0.16 person-rem, resulting in 8.1×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.025 traffic fatality.

4.5.1.2.12 Environmental Justice

Under this option, neptunium-237 targets would be irradiated in one or two new accelerators that would be constructed at a site yet to be specified. Fabrication and processing of neptunium-237 targets for

plutonium-238 production would be performed at REDC located at ORR. A new support facility would be constructed at the same unspecified site for fabrication and processing targets not used for plutonium-238 production.

Activities at REDC were evaluated under other alternatives and options in this NI PEIS (e.g., Section 4.4.1.1.12) and found to pose no significant radiological or other risks to minority and low-income populations. The environmental analysis of operations at the new accelerator(s) and support facility site shows that radiological and nonradiological risks to persons residing in the (hypothetical) potentially affected area would not be significant. Unless there are patterns of food consumption among minority or low-income residents surrounding the actual site (yet to be determined) that would result in a significant ingestion of radiologically contaminated food, it is plausible that operations at the site would pose no significant risks to minority and low-income persons. However, evaluations of environmental justice are necessarily site-specific and cannot be performed in detail for unspecified locations. In the event that this option were selected for implementation and a specified site selected for the new accelerator(s) and support facility, an additional evaluation of environmental justice at the accelerator(s) and support facility site during operation would be performed prior to implementation.

4.5.1.2.13 Waste Management

The expected annual generation of wastes that would be associated with the operation of new accelerator(s) to irradiate targets and a support facility to fabricate and process medical and industrial isotope targets and to meet research and development needs are provided in **Table 4–125**. These generation rates cannot be compared at this time with site treatment, storage, and disposal capacities because a DOE site has not yet been chosen for these facilities. Section 3.6.11.1 provides DOE site ranges for each waste type that include volume currently stored, projected generation, and for some wastes, disposal volume. Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.5.1.2.9 through 4.5.1.2.11.

Table 4–125 Estimated Waste Generation Rates of Operating New Accelerator(s) and Support Facility Under Alternative 3 (Construct New Accelerator[s])—Option 1

Waste Type[a]	Estimated Waste Generation for New Accelerator(s) (cubic meters per year)		Estimated Waste Generation for New Support Facility (cubic meters per year)
	Low-Energy	High-Energy	
Transuranic	0	0	0
Low-level radioactive			
Liquid	0	1	0
Solid	5	54	20
Mixed low-level radioactive	0.20	3	4
Hazardous	0.10	2	<1
Nonhazardous			
Process waste water	0	280,000	16[b]
Sanitary wastewater	910	11,300	8,300
Solid	8	31	80

a. See definitions in Appendix G.9.
b. Assume process wastewater generated at the same rate as the Hanford 300 Area facilities (RPL/306–E).
Note: To convert from cubic meters to cubic yards, multiply by 1.308, < mean “less than.”
Source: SAIC 2000; TechSource 2000.

In accordance with the Records of Decision for the *Waste Management PEIS* (DOE 1997a), wastes could be treated and disposed of on site or at other DOE sites or commercial facilities. It is also assumed that transuranic waste, low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous waste would be treated, stored, and disposed of in accordance with current and developing site practices. No high-level radioactive waste would be associated with irradiating targets in the new accelerator(s), with target fabrication or processing in the new support facility, or with neptunium-237 target fabrication and processing in REDC. No transuranic waste would be associated with irradiating targets in the accelerator(s) or with target fabrication and processing in the new support facility.

Currently, DOE sites that manage low-level radioactive waste treat and/or dispose of the waste on site or off site, either at another DOE facility or a commercial facility. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision issued on February 18, 2000 (65 FR 10061), states that for the management of low-level radioactive waste, minimal treatment will be performed at all sites, and disposal will continue, to the extent practicable, on site at INEEL, LANL, ORR, and SRS. In addition, Hanford and the Nevada Test Site will be available to all DOE sites for low-level radioactive waste disposal. An estimated 35 cubic meters (46 cubic yards) of liquid low-level radioactive waste and 2,100 cubic meters (2,750 cubic yards) of solid low-level radioactive waste would be generated over a 35-year period as a result of target irradiation at the new accelerator(s). Target fabrication and processing at the new support facility would generate about 700 cubic meters (920 cubic yards) of solid low-level radioactive waste. The minor amounts of low-level radioactive waste (less than 10 cubic meters [13.1 cubic yards]) (Brunson 1999b) generated from the decontamination of the shipping containers used to transport neptunium-237 from SRS to REDC (or FDPF or FMEF, depending on the option) for storage could easily be managed under the existing waste management practices and are not included in the table.

Most of DOE's mixed low-level radioactive waste is being stored on site awaiting the development of treatment methods. DOE is subject to the requirements mandated by the Federal Facility Compliance Act of 1992, and most DOE facilities that currently store or generate mixed low-level radioactive waste have either a state-approved or EPA region-approved site treatment plan or another type of agreement. Each site treatment plan or agreement requires the treatment of mixed waste, including mixed low-level radioactive waste, in accordance with its provisions. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision, issued on February 18, 2000 (65 FR 10061), states that mixed low-level radioactive waste will be treated at Hanford, INEEL, ORR, and SRS and disposed of at Hanford and the Nevada Test Site. Over the 35-year operational period, an estimated 110 cubic meters (140 cubic yards) of mixed low-level radioactive waste would be generated as a result of target irradiation at the new accelerator(s). Target fabrication and processing at the new support facility would generate about 140 cubic meters (180 cubic yards) of mixed low-level radioactive waste.

The hazardous waste Record of Decision, issued on August 5, 1998 (63 FR 41810), states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of nonwastewater hazardous waste, with ORR and SRS continuing to treat some of their own nonwastewater hazardous waste on site in existing facilities where this is economically favorable. Wastewater, which is about 99 percent of DOE's hazardous waste, is treated on site. An estimated 74 cubic meters (97 cubic yards) of hazardous waste would be generated during the 35-year operational period at the accelerator(s) and less than 35 cubic meters (46 cubic yards) at the new support facility.

DOE currently manages sanitary and industrial waste on a site-by-site basis. Some DOE sites dispose of this waste in onsite landfills that have permits issued by appropriate state agencies, while other sites use commercial landfills (DOE 1997a:1-29). Solid waste such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent off site for that purpose. Over the 35-year operational period, an estimated 9.8 million cubic meters (12.8 million cubic yards) of process wastewater, 427,000 cubic meters

(558,000 cubic yards) of sanitary wastewater, and 1,400 cubic meters (1,800 cubic yards) of solid nonhazardous waste would be generated as a result of target irradiation at the new accelerator(s). Target fabrication and processing at the new support facility would generate about 560 cubic meters (730 cubic yards) of process wastewater, 291,000 cubic meters (381,000 cubic yards) of sanitary wastewater, and 2,800 cubic meters (3,700 cubic yards) of solid nonhazardous waste.

The impacts of managing wastes associated with fabricating and processing neptunium-237 targets for plutonium-238 production in REDC at ORR are assumed to be the same as for Option 1 under Alternative 1 (Section 4.3.1.1.13). As shown in that section, the impacts on the waste management systems at ORR would be small.

4.5.1.3 Decontamination and Decommissioning of the Accelerator(s) and Support Facility

The environmental impacts associated with the decontamination and decommissioning of the accelerator(s) and support facility at the generic DOE site are assessed in this section.

4.5.1.3.1 Land Resources

LAND USE. Decontamination and decommissioning of the accelerator(s) and a support facility would not involve the removal of any major structures, although some smaller facilities and pieces of equipment could be removed. Thus, the industrial nature of the land would not change.

VISUAL RESOURCES. Decontamination and decommissioning of the accelerator(s) and a support facility would not impact visual resources since no major structures would be removed. Thus, the Visual Resource Management Class IV rating of the site would remain unchanged.

4.5.1.3.2 Noise

Decontamination and decommissioning of the high-energy and/or low-energy accelerators and support facility would result in some increase in noise levels from the use of construction type equipment, materials handling and impact equipment, employee vehicles, and truck traffic. Actual noise levels would depend on the decontamination and decommissioning activities selected. Noise from these activities, especially impulsive noise, would be expected to disturb wildlife in the immediate area of the facilities. The change in noise levels in areas outside the DOE site would depend on the location selected and the exact nature of the activities required. However, generally if the accelerator(s) and support facility location were within one of the large DOE sites and were more centrally located within the site, offsite noise impacts from decontamination and decommissioning would be expected to be small. Employee vehicles and truck traffic would result in an increase in traffic noise along roads used to access the site. However, this increase in traffic noise would be small unless the decontamination and decommissioning traffic volume were as large as the traffic from facility operation and other site activities. Site-specific analysis would be conducted in tiered NEPA documentation if the accelerator(s) alternative were selected.

4.5.1.3.3 Air Quality

The potential for air quality impacts due to decommissioning and deactivation of the accelerator(s) and support facility would not be expected to be any higher than those associated with their construction and operation. Some decrease in air quality impacts may occur when generators and pumps supporting operations of the accelerator(s) are shut down.

4.5.1.3.4 Water Resources

Decontamination and decommissioning of the accelerator(s) and support facility would involve permanent shutdown, stabilization, and monitoring of the deactivated facilities. As a result, processing and auxiliary systems would be shutdown and process and sanitary wastewater discharges would cease from the vacated facilities. This would eliminate the annual discharge of approximately 284 million liters (75 million gallons) of nonradioactive process wastewater from the high-energy accelerator and 3.6 million liters (0.95 million gallons) from the support facility to onsite treatment facilities. Also, the discharge of sanitary wastewater to onsite treatment facilities would be eliminated including 11.4 million liters (3 million gallons) per year from the high-energy accelerator, 0.9 million liters (0.24 million gallons) from the low-energy accelerator and 8.3 million liters (2.2 million gallons) annually from the support facility. The effects of decontamination and decommissioning on waste management are further detailed in Section 4.5.1.3.13. Site water withdrawals to supply the facilities would also be reduced by an estimated 1,904 million liters (503 million gallons) per year for the high-energy accelerator, 1.29 million liters (0.34 million gallons) for the low-energy accelerator, and 11.9 million liters (3.14 million gallons) annually for the support facility (SAIC 2000; TechSource 2000).

4.5.1.3.5 Geology and Soils

No major structures would be demolished to effect decontamination and decommissioning of the accelerator(s) and support facility. Some ground disturbance could occur associated with removal of some smaller facilities and pieces of equipment. However, ground disturbance would be confined to previously disturbed areas immediately adjacent to the accelerator(s) and support facility, with the impact on geologic and soil resources expected to be negligible overall.

4.5.1.3.6 Ecological Resources

Since no major structures would be demolished during the decontamination and decommissioning of the accelerator(s) and a support facility, the area would continue to be of limited value to wildlife. Noise from decontamination and decommissioning activities would be expected to disturb wildlife in the immediate area; however, this disturbance would be of limited duration. Water use would decrease at the generic site with the decommissioning of the accelerator(s) and support facility. This would result in a decrease in impingement and entrainment of aquatic organisms, as well as a decrease in impacts from effluent discharge at a site where surface water bodies are used. At a site where water is withdrawn from groundwater and discharged to an evaporation pond, the cessation of discharge from the accelerator(s) and support facility could result in a reduction in the size of the pond or its possible elimination. This could, in turn, result in the loss (or elimination) of associated aquatic and terrestrial wildlife, as well as wetland habitat. The response of any threatened or endangered species to decontamination and decommissioning of the accelerator(s) and support facility could vary from positive (e.g., due to a decrease in human presence and emissions) to negative (e.g., due to the elimination of aquatic or wetland habitat), depending on the species involved.

4.5.1.3.7 Cultural and Paleontological Resources

Decontamination and decommissioning of the accelerator(s) and a support facility would not change the status of cultural and paleontological resources. This is because any required ground disturbance would be confined to previously disturbed areas immediately adjacent to the accelerator(s) and support facility.

4.5.1.3.8 Socioeconomics

Decommissioning of the accelerator(s) and support facility would result in a negative impact on the socioeconomic characteristics of the DOE site at which they were located. This impact would depend on

whether the candidate site was located near a large urbanized area or in a remote rural area. Since the population for the region of influence for a generic DOE site could range from nearly 2.0 million people for a site in a large metropolitan area, to less than 200,000 for a site in a small rural community, the socioeconomic impacts of decommissioning would vary greatly. Therefore, if DOE were to select the new accelerator(s) alternative, additional NEPA documentation would be required to evaluate the specific socioeconomic impacts of decommissioning.

4.5.1.3.9 Public and Occupational Health and Safety—Normal Decontamination and Decommissioning Activities

Assessments of incremental radiological and chemical impacts associated with the decontamination and decommissioning of the accelerator(s) and support facility are presented in this section. Supplemental information is provided in Appendix H.

During decontamination and decommissioning operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers are described below.

RADIOLOGICAL IMPACTS. In the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG-0586 (NRC 1988), NRC determined that the health impact to the public from the decommissioning of research reactors was "negligible." In the same NUREG, NRC also concluded that the public health impact from radiological releases associated with the decommissioning and decontamination of the research reactor support facility was also "negligible." Decommissioning and decontamination of the accelerator(s) and support facility would involve less radioactive materials and thus less radioactive emissions, than those associated with the research reactor and support facility. Based on these conclusions, the environmental impact on the public health and safety from the routine release of radionuclides during the decontamination and decommissioning of the accelerator(s) and support facility addressed in this NI PEIS are deemed to be negligible.

A probability coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991).

Incremental doses to involved workers from decontamination and decommissioning operations are given in **Table 4–126**; these workers are defined as those directly associated with all decontamination and decommissioning activities. The incremental annual average dose to involved workers during decontamination and decommissioning operations at the accelerator(s) would be 160 millirem; for support facility workers, the incremental annual average dose during decontamination and decommissioning operations would be 100 millirem. The incremental annual dose received by the total site workforce for each of these facilities is estimated to be 17 (total for both accelerators) and 4 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from annual decontamination and decommissioning operations are included in Table 4–126. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–126 Incremental Radiological Impacts on Involved Workers at the Generic DOE Site from Accelerator(s) and Support Facility Decontamination and Decommissioning Activities Under All Options of Alternative 3 (Construct New Accelerator[s])

Receptor—Involved Workers[a]	Generic Site Decontamination and Decommissioning Activities			
	Accelerators		Accelerator(s) Support Facility	Total
	Low-Energy	High-Energy		
Total dose (person-rem per year)	5.6[b]	11[b]	4[b]	21
1-year latent cancer fatalities	0.0022	0.0045	0.0016	0.0083
Average worker dose (millirem per year)	160	160	100	143
1-year latent cancer fatality risk	6.5×10^{-5}	6.5×10^{-5}	0.0004	5.7×10^{-5}

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.

b. Based on 105 badged workers at the accelerator(s) (35 at low-energy and 70 at high-energy) and 40 badged workers at the support facility.

Source: Calculational results.

HAZARDOUS CHEMICAL IMPACTS. No additional hazardous chemical release is expected from activities associated with decontamination and decommissioning the accelerator(s) and its support facility.

4.5.1.3.10 Public and Occupational Health and Safety—Decontamination and Decommissioning Accidents

There are no radiological or hazardous chemical accidents postulated during the decontamination and decommissioning phases of the new accelerator(s) or the new support facility. Involved workers could experience industrial accidents commonly associated with these types of activities.

4.5.1.3.11 Environmental Justice

Environmental effects due to decontamination and decommissioning activities that would be expected to occur at an unspecified accelerator(s) and support facility site are addressed in Section 4.5.1.3. The environmental analysis of decontamination and decommissioning activities at the new accelerator(s) and support facility site shows that radiological and nonradiological risks to persons residing in the (hypothetical) potentially affected areas would not be significant. Unless there are patterns of food consumption among minority or low-income residents surrounding the actual site (yet to be determined) that would result in a significant ingestion of radiologically contaminated food, it is plausible that decontamination and decommissioning activities at the site would pose no significant risks to minority and low-income persons. However, evaluations of environmental justice are necessarily site specific and cannot be performed in detail for unspecified locations. In the event that this option were selected for implementation and a specific site selected for the new accelerator(s) and support facility, an additional evaluation of environmental justice at the accelerator(s) and support facility site during decontamination and decommissioning would be performed prior to implementation.

4.5.1.3.12 Waste Management

The decontamination and decommissioning of the new accelerator(s) and support facility could generate numerous types of wastes. The materials that may be removed or stabilized as a result of decontamination and decommissioning would be managed and reused, recycled, or disposed of in accordance with applicable Federal and state regulations. No analysis of waste management impacts, however, can be formulated at this

time. Once proposals concerning decontamination and decommissioning activities were developed, DOE would undertake any additional NEPA analysis that may be necessary or appropriate.

4.5.1.4 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.5.2 Alternative 3 (Construct New Accelerator[s])—Option 2

Option 2 involves constructing and operating one or two accelerators to irradiate all targets associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating FDPF at INEEL to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and conducting and operating the support facility to fabricate and process the other targets and materials and to process the associated products. This option includes storage in Building CPP–651 or FDPF of the neptunium-237 transported to INEEL from SRS and storage in the new support facility of the other target materials transported to the generic site from other offsite facilities.

The transportation of the neptunium-237 from SRS to INEEL and then to the generic site, the transportation of the other target materials to the generic site, and the transportation of plutonium-238 and other product materials following irradiation and postirradiation processing constitute part of this option.

All options under this alternative include the decontamination and decommissioning of the accelerator(s) and support facility at the generic DOE site following their operating lifetimes, and also the permanent deactivation of FFTF at Hanford.

4.5.2.1 Construction of the New Accelerator(s) and Support Facility

The environmental impacts associated with the construction of one or two new accelerators and a support facility at the generic DOE site are assessed in Section 4.5.1.1.3.

4.5.2.2 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.5.2.2.1 Land Resources

LAND USE. Impacts on land use associated with the operation of one or two accelerators and a support facility are addressed in Section 4.5.1.2.1.

Building CPP–651 and/or FDPF, which are located at INTEC, would be used for neptunium-237 storage, and FDPF would be used for target fabrication and processing. Use of these facilities would not change land use at the site since both are currently operating and their proposed use would be compatible with their present mission.

VISUAL RESOURCES. Impacts on visual resources associated with the operation of one or two accelerators and a support facility are addressed in Section 4.5.1.2.1.

All activities associated with neptunium-237 storage would take place within Building CPP–651 and/or FDPF, and target fabrication and processing would be in FDPF. Operations associated with the proposed mission

would not result in any impact on visual resources or change in the current Visual Resource Management Class IV designation of INTEC. This is because none of the anticipated operational impacts (e.g., air emissions) would be expected to affect this resource.

4.5.2.2.2 Noise

Noise impacts associated with the operation of the accelerator(s) and support facility are addressed in Section 4.5.1.2.2.

This option also involves using Building CPP–651 and/or FDPF, both in the INTEC area of INEEL, for neptunium-237 target material storage, and FDPF for target fabrication and processing. Interior modifications of these facilities would be expected to result in little change in noise impacts on wildlife around this area. The operation of these facilities would not be expected to result in any change in noise impacts on wildlife around the INTEC area and offsite noise impacts would be small because the nearest site boundary is 12 kilometers (7.5 miles) to the south. Operation would result in a minimal change in noise impacts on people near the INEEL as a result of changes in employee and truck traffic levels.

4.5.2.2.3 Air Quality

Air quality impacts associated with the operation of the accelerator(s) and support facility are addressed in Section 4.5.1.2.3.

Impacts associated with this option at INEEL were determined to be the same as under Option 2 of Alternative 2 (Section 4.4.2.1.3).

The air quality impacts of transportation are presented in Section 4.5.2.2.11.

4.5.2.2.4 Water Resources

Impacts on water resources associated with the operation of the accelerator(s) and support facility are addressed in Section 4.5.1.2.4.

Building CPP–651 and/or the FDPF, which are both in the INTEC area of INEEL, would be used for neptunium-237 storage, with target fabrication and processing in support of plutonium-238 production conducted in FDPF. As existing facilities would be used, there would be no construction-related impacts on water bodies, floodplains, or on surface or groundwater quality. In addition, no measurable increase in water use is anticipated to support target fabrication for plutonium-238 production (Moor 1999). The only measurable increase would be an additional 23,000 liters (6,100 gallons) per year of process wastewater associated with target processing in FDPF (Kirkham 1999; Wham 1999c). There would be no radiological liquid effluent discharge to the environment under normal operations, and no measurable impact on water resources at INEEL is expected.

4.5.2.2.5 Geology and Soils

Impacts on geology and soils associated with the operation of the accelerator(s) and support facility are addressed in Section 4.5.1.2.5. As discussed in Section 4.5.1.1.5, the proposed facilities would be designed and constructed in accordance with DOE Order 420.1 and sited to minimize the risk from geologic hazards. Thus, site geologic conditions would be unlikely to affect the facilities.

The use of Building CPP–651 and/or FDPF for neptunium-237 storage, and FDPF for target fabrication and processing would not be expected to impact geologic resources, nor be jeopardized by large-scale geologic conditions, at INEEL. Hazards from large-scale geologic conditions at INEEL, such as earthquakes and volcanoes, were previously evaluated in the *Storage and Disposition PEIS* (DOE 1996a:4-148) as discussed in Section 4.2.3.2.5. The analysis determined that these hazards present a low risk to long-term storage facilities. That analysis was reviewed in the SPD EIS (DOE 1999a:4-267-268). Further review of the data and analyses presented in these referenced documents and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions likewise present a low risk to the proposed use of the INTEC facilities. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards will be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.5.2.2.6 Ecological Resources

Impacts on ecological resources associated with the operation of one or two accelerators and a support facility are addressed in Section 4.5.1.2.6.

Building CPP–651 and/or FDPF would be used for neptunium-237 storage, and FDPF for target fabrication and processing. As noted in Section 4.5.2.2.2, there would be little change in noise impacts on wildlife. Because water usage and wastewater discharge would be small fractions of current values, there would be no impact on aquatic resources (Section 4.5.2.2.4). Threatened and endangered species would not be affected by operation because an existing facility(s) within an already developed area would be used.

4.5.2.2.7 Cultural and Paleontological Resources

Impacts on cultural and paleontological resources associated with the operation of one or two accelerators and a support facility are addressed in Section 4.5.1.2.7.

Although six historic structures are associated with INTEC, their status would not be affected by the operation of Building CPP–651 and/or FDPF for neptunium-237 storage, and FDPF for target fabrication and processing. Also, the status of Native American and paleontological resources occurring in the vicinity of INTEC would not be affected by operation of these facilities.

4.5.2.2.8 Socioeconomics

The socioeconomic impacts associated with the operation of the accelerator(s) and support facility at a generic DOE site are addressed in Section 4.5.1.2.8.

The socioeconomic impacts associated with neptunium-237 target fabrication and processing at INEEL are addressed in Section 4.3.2.1.8.

4.5.2.2.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup and operations are given in **Table 4–127** for the generic DOE accelerator(s) site and INEEL: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

Table 4–127 Incremental Radiological Impacts on the Public Around the Generic DOE Site and INEEL from Operational Facilities Under Alternative 3 (Construct New Accelerator[s])—Option 2

Receptor	INEEL FDPF	Accelerators Preoperational Startup[a]		Generic Site Operations				Two-Site Total
				Accelerators		Accelerator(s) Support Facility	Total	
		Low-Energy	High-Energy	Low-Energy	High-Energy			
Population within 80 kilometers (50 miles) in the year 2020								
Dose (person-rem)	3.9×10^{-6}	0.0024	0.035	0.0036	0.055	0.14	0.20	0.20
35-year latent cancer fatalities	6.7×10^{-8}	2.4×10^{-6}[b]	3.5×10^{-5}[b]	6.3×10^{-5}	9.6×10^{-4}	0.0025	0.0035	0.0035
Maximally exposed individual								
Annual dose (millirem)	2.6×10^{-7}	1.4×10^{-5}	1.8×10^{-4}	7.8×10^{-5}	8.7×10^{-4}	0.0025	0.0034	NA[c]
35-year latent cancer fatality risk	4.6×10^{-12}	1.4×10^{-11}[b]	1.8×10^{-10}[b]	1.4×10^{-9}	1.5×10^{-8}	4.4×10^{-8}	6.0×10^{-8}	NA[c]
Average exposed individual within 80 kilometers (50 miles)								
Annual dose[d] (millirem)	2.0×10^{-8}	1.6×10^{-6}	2.3×10^{-5}	2.3×10^{-6}	3.6×10^{-5}	9.1×10^{-5}	1.3×10^{-4}	NA[c]
35-year latent cancer fatality risk	3.6×10^{-13}	1.6×10^{-12}[b]	2.3×10^{-11}[b]	4.0×10^{-11}	6.3×10^{-10}	1.6×10^{-9}	2.3×10^{-9}	NA[c]

a. For conservatism as well as consistency with other radiological impacts evaluated in this NI PEIS, these values were assessed for the year 2020 even though these activities would commence prior to that year.
b. Preoperational activities last 2 years. Number is a 2-year latent cancer fatality risk.
c. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
d. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FDPF or the generic site in the year 2020 (188,400 and 1,538,100, respectively).

Key: NA, not applicable.

Source: SAIC 2000; TechSource 2000; model results, using the GENII computer code (Napier et al. 1988).

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual operations of the accelerator facilities (a high-energy accelerator, a low-energy accelerator, and a support facility) and FDPF, the projected incremental total population dose in the year 2020 would be 0.20 person-rem; the corresponding number of latent cancer fatalities in the populations surrounding the generic DOE site and INEEL from 35 years of operations would be 0.0035. The incremental total dose to the maximally exposed member of the public from annual operations of the accelerator(s) and support facility at the generic DOE site would be 0.0034 millirem; from 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 6.0×10^{-8}. Estimated annual risks are also presented for pre-operational testing/startup phase activities anticipated for the accelerator(s) and support facility. The incremental dose to the maximally exposed member of the public from annual FDPF operations would be 2.6×10^{-7} millirem; from 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 4.6×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–128**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to the high-energy and low-energy accelerator workers during startup and operations would be 150 millirem; for

support facility workers, the incremental annual average dose during operations would be 102 millirem; for FDPF workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities is estimated to be 30 (high-energy accelerator startup and operation), 15 (low-energy accelerator startup and operation), 12 (support facility operation), and 22 person-rem (FDPF operation). The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–128. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–128 Incremental Radiological Impacts on Involved Workers at the Generic DOE Site and INEEL from Operational Facilities Under Alternative 3 (Construct New Accelerator[s])—Option 2

Receptor—Involved Workers[a]	INEEL FDPF	Accelerators Preoperational Startup		Generic Site Operations			Two-Site Total
				Accelerators		Accelerator(s) Support Facility	
		Low-Energy	High-Energy	Low-Energy	High-Energy		
Total dose (person-rem per year)	22[b]	15[b]	30[b]	15[b]	30[b]	12[b]	79
35-year latent cancer fatalities	0.31	0.012[c]	0.024[c]	0.21	0.42	0.17	1.1
Average worker dose (millirem per year)	290	150	150	150	150	102	NA[d]
35-year latent cancer fatality risk	0.0041	1.2×10^{-4}[(c)]	1.2×10^{-4}[(c)]	0.0021	0.0021	0.0014	NA[d]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 75 badged workers at INEEL FDPF, 200 at the high-energy accelerator, 100 at the low-energy accelerator, and 120 total workers at the accelerator(s) support facility.
c. Preoperational startup testing lasts 2 years. Number is a 2-year latent cancer fatality risk.
d. Values cannot be given for the average worker because the workers would be in three different facilities at two different sites.
Key: NA, not applicable.
Source: DOE 1999b; LMER 1997:22; Nielsen 1999; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts associated with the operation of the accelerator(s) and support facility are addressed in Section 4.5.1.2.9.

Impacts from hazardous chemicals at INEEL were determined to be the same as under Option 2 of Alternative 2 (Section 4.4.2.1.9).

4.5.2.2.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with accelerator target irradiation; support facility fabrication and processing of medical, industrial, and research and development isotopes; and FDPF target fabrication and processing of neptunium-237 targets are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–129** and **4–130**, respectively.

For 35 years of high-energy accelerator target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.07×10^{-6} and 2.60×10^{-5}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00833.

For 35 years of low-energy accelerator target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.45×10^{-9} and 3.07×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be $3.28\times10^{-5.}$

Table 4–129 New Accelerator(s), Support Facility, and FDPF Accident Consequences Under Alternative 3 (Construct New Accelerator[s])—Option 2

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
High-energy accelerator accidents						
Design-basis target accident	2.92×10^{-6}	1.46×10^{-9}	8.75×10^{-3}	4.37×10^{-6}	4.60×10^{-5}	1.84×10^{-8}
Beyond-design-basis earthquake	1.81×10^{1}	5.90×10^{-3}	3.56×10^{4}	2.38×10^{1}	1.86	7.44×10^{-2}
Low-energy accelerator accidents						
Design-basis target accident	8.05×10^{-5}	4.03×10^{-8}	14.8	7.39×10^{-3}	1.12×10^{-3}	4.48×10^{-7}
Beyond-design-basis earthquake	1.32×10^{-2}	6.60×10^{-6}	3.94×10^{1}	1.97×10^{-2}	2.08×10^{-1}	8.32×10^{-5}
Support facility accidents						
Medical and industrial isotopes localized solvent fire	0.0194	9.72×10^{-6}	31.1	0.0156	0.00530	2.12×10^{-6}
Medical and industrial isotopes unlikely seismic event	0.0750	3.75×10^{-5}	136	0.0680	0.510	2.04×10^{-4}
Medical and industrial isotopes glovebox explosion	2.50	0.00125	4,600	2.30	17.0	0.00680
FDPF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.01×10^{-9}	1.01×10^{-12}	2.49×10^{-5}	1.24×10^{-8}	7.26×10^{-9}	2.91×0^{-12}
Target dissolver tank failure during plutonium-238 separation	6.11×10^{-8}	3.05×10^{-11}	5.65×10^{-4}	2.82×10^{-7}	2.17×10^{-7}	8.69×10^{-11}
Ion exchange explosion during plutonium-238 separation	1.63×10^{-5}	8.13×10^{-9}	0.150	7.51×10^{-5}	5.79×10^{-5}	2.31×10^{-8}
Processing facility beyond-design-basis earthquake	42.5	0.0425	1.64×10^{5}	82.0	1,200	1.00[c]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years of medical, industrial, and research and development target fabrication and processing at the support facility, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 3.26×10^{-5} and 9.85×10^{-5}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.056.

For 35 years of neptunium-237 target fabrication and processing at FDPF, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 1.49×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0287.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 4.96×10^{-5} and 4.75×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0931.

Table 4–130 New Accelerator(s), Support Facility, and FDPF Accident Risks Under Alternative 3 (Construct New Accelerator[s])—Option 2

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual high-energy accelerator risks			
Design-basis target accident (1×10^{-4})	1.46×10^{-13}	4.37×10^{-10}	1.84×10^{-12}
Beyond-design-basis earthquake (1×10^{-5})	5.90×10^{-8}	2.38×10^{-4}	7.44×10^{-7}
35-year high-energy accelerator risk	2.07×10^{-6}	0.00833	2.60×10^{-5}
Annual low-energy accelerator risks			
Design-basis target accident (1×10^{-4})	4.03×10^{-12}	7.39×10^{-7}	4.48×10^{-11}
Beyond-design-basis earthquake (1×10^{-5})	6.60×10^{-11}	1.97×10^{-7}	8.32×10^{-10}
35-year low-energy accelerator risk	2.45×10^{-9}	3.28×10^{-5}	3.07×10^{-8}
Annual support facility risks			
Medical and industrial isotopes localized solvent fire (0.044)	4.32×10^{-7}	6.91×10^{-4}	9.41×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	3.75×10^{-7}	6.80×10^{-4}	2.04×10^{-6}
Medical and industrial isotopes glovebox explosion (1.00×10^{-4})	1.25×10^{-7}	2.30×10^{-4}	6.80×10^{-7}
35-year support facility risk	3.26×10^{-5}	0.056	9.85×10^{-5}
Annual FDPF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	1.24×10^{-10}	2.91×10^{-14}
Target dissolver tank failure during plutonium-238 separation (0.01)	3.05×10^{-13}	2.82×10^{-9}	8.69×10^{-13}
Ion exchange explosion during plutonium-238 separation (0.01)	8.13×10^{-11}	7.51×10^{-7}	2.31×10^{-10}
Processing facility beyond-design-basis earthquake (1×10^{-5})	4.25×10^{-7}	8.20×10^{-4}	1.00×10^{-5}[c]
35-year FDPF risk	1.49×10^{-5}	0.0287	3.50×10^{-4}[c]
35-year Option risk	4.96×10^{-5}	0.0931	4.75×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

There are no hazardous chemical accidents associated with the new accelerator(s) or new support facility. The irradiation of neptunium-237, medical, industrial, and research and development isotopes in the new accelerator(s) would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The fabrication and processing of medical, industrial, and research and development isotopes at the new support facility would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The hazardous chemical accident impacts at FDPF are the same as those presented in Section 4.4.5.1.10.

4.5.2.2.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the REDC target fabrication facility at ORR. DOE would transport the unirradiated neptunium-237 targets from REDC to the accelerator(s) site. Following

irradiation in the accelerator(s), the targets would be returned to REDC for processing. After this processing, the plutonium-238 product would be shipped to LANL. Additionally, medical and industrial isotopes would be shipped from the accelerator(s) site to a local airport, and from there to locations throughout the country.

Approximately 37,000 shipments of radioactive materials would be made by DOE in support of the low-energy accelerator. The total distance traveled on public roads by trucks carrying radioactive materials would be 4.8 million kilometers (3.0 million miles); and in the air carrying medical and industrial isotopes, 23 million kilometers (14 million miles).

Approximately 343 shipments of radioactive materials would be made by DOE in support of the high-energy accelerator. The total distance traveled on public roads by trucks carrying radioactive materials would be 1.3 million kilometers (0.79 million miles).

The transportation impact analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION FOR THE LOW-ENERGY ACCELERATOR. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 15 person-rem; the dose to the public, 7 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0059 latent cancer fatality among transportation workers and 0.0037 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.02.

IMPACTS OF INCIDENT-FREE TRANSPORTATION FOR THE HIGH-ENERGY ACCELERATOR. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 8 person-rem; the dose to the public, 132 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0032 latent cancer fatality among transportation workers and 0.066 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.0036.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION FOR THE LOW-ENERGY ACCELERATOR. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: more than 1 in 10 million per year) would not breach the transportation package. The consequences of more severe accidents that could breach the transportation package and release radioactive material were evaluated and estimated to have probabilities of less than 1 in 10 million per year.

Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting 0.11 traffic fatality.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION FOR THE HIGH-ENERGY ACCELERATOR. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FDPF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 0.16 person-rem, resulting in 8.2×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.026 traffic fatality.

4.5.2.2.12 Environmental Justice

Under this option, neptunium-237 targets would be irradiated in one or two new accelerators that would be constructed at a site yet to be specified. Fabrication and processing of neptunium-237 targets for plutonium-238 production would be performed at FDPF located at INEEL. A new support facility would be constructed at the same site for fabrication and processing targets not used for plutonium-238 production.

Activities at FDPF were evaluated under other alternatives and options in this NI PEIS (e.g., Section 4.4.2.1.12) and found to pose no significant radiological or other risks to minority and low-income populations. The environmental analysis of operations at the new accelerator(s) and support facility site shows that radiological and nonradiological risks to persons residing in the (hypothetical) potentially affected areas would not be significant. Unless there are patterns of food consumption among minority or low-income residents surrounding the actual site (yet to be determined) that would result in a significant ingestion of radiologically contaminated food, it is plausible that operations at the site would pose no significant risks to minority and low-income persons. However, evaluations of environmental justice are necessarily site specific and cannot be performed in detail for unspecified locations. In the event that this option were selected for implementation and a specific site selected for the new accelerator(s) and support facility, an additional evaluation of environmental justice at the accelerator(s) and support facility site during operation would be performed prior to implementation.

4.5.2.2.13 Waste Management

The impacts of managing wastes associated with the operation of new accelerator(s) to irradiate targets and a support facility to fabricate and process medical and industrial isotope targets and to meet research and development needs are assumed to be the same as for Option 1 (Section 4.5.1.2.13). Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.5.2.2.9 through 4.5.2.2.11.

The impacts of managing wastes associated with fabricating and processing neptunium-237 targets for plutonium-238 production in FDPF at INEEL are assumed to be the same as for Option 2 under Alternative 1 (Section 4.3.2.1.13). As shown in that section, the impacts on the waste management systems at INEEL would be small.

4.5.2.3 Decontamination and Decommissioning of the Accelerator(s) and Support Facility

The environmental impacts associated with the decontamination and decommissioning of the accelerator(s) and support facility at the generic DOE site are assessed in Section 4.5.1.3.

4.5.2.4 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.5.3 Alternative 3 (Construct New Accelerator[s])—Option 3

Option 3 involves constructing and operating one or two accelerators to irradiate all targets associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating FMEF at Hanford to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and conducting and operating the support facility to fabricate and process the other targets and materials and to process the associated products. This option includes storage in FMEF of the neptunium-237 transported to Hanford from SRS and storage in the new support facility of the other target materials transported to the generic site from other offsite facilities.

The transportation of the neptunium-237 from SRS to Hanford and then to the generic site, the transportation of the other target materials to the generic site, and the transportation of plutonium-238 and other product materials following irradiation and postirradiation processing constitute part of this option.

All options under this alternative include the decontamination and decommissioning of the accelerator(s) and support facility at the generic site following their operating lifetimes, and also the permanent deactivation of FFTF at Hanford.

4.5.3.1 Construction of the New Accelerator(s) and Support Facility

Environmental impacts associated with the construction of one or two new accelerators and support facility at the generic DOE site are assessed in Section 4.5.1.1.

4.5.3.2 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.5.3.2.1 Land Resources

LAND USE. Impacts on land use associated with the operation of the accelerator(s) and a support facility are addressed in Section 4.5.1.2.1.

FMEF would be used for neptunium-237 storage, target fabrication, and processing. Land use within the 400 Area would not change since the use of FMEF would be compatible with the mission for which it was designed.

VISUAL RESOURCES. Impacts on visual resources associated with the operation of the accelerator(s) and support facility are addressed in Section 4.5.1.2.1.

All activities associated with neptunium-237 storage, target fabrication, and processing would take place within FMEF. Operations associated with the proposed mission would not result in any change to visual resources; thus, the current Visual Resource Management Class IV rating of the 400 Area. This is because none of the anticipated operational impacts (e.g., air emissions) would be expected to affect this resource.

4.5.3.2.2 Noise

Noise impacts associated with the operation of the accelerator(s) and support facility are addressed in Section 4.5.1.2.2.

This option also involves using FMEF for target material storage, target fabrication, and processing. Activities associated with construction of a new stack would be typical of small construction projects and would result in some temporary increase in noise. Noise sources associated with this construction would not be expected to be loud impulsive sources and are not expected to result in disturbance of wildlife around the 400 Area. The operation of FMEF would not be expected to result in any change in noise impacts on wildlife around the 400 Area and offsite noise impacts would also be minor because the nearest site boundary is 7 kilometers (4.3 miles) to the east. Operation would be expected to result in a minimal change in noise impacts on people near the Hanford site as a result of changes in employee and truck traffic levels.

4.5.3.2.3 Air Quality

Air quality impacts associated with the operation of the accelerator(s) and support facility are addressed in Section 4.5.1.2.3.

Air quality impacts at Hanford associated with this option were determined to be the same as under Option 3 of Alternative 2 (Section 4.4.3.1.3).

The air quality impacts of transportation are presented in Section 4.5.3.2.11.

4.5.3.2.4 Water Resources

Impacts on water resources associated with the operation of the accelerator(s) and support facility are addressed in Section 4.5.1.2.4.

FMEF in the 400 Area of Hanford would be used for neptunium-237 storage, target fabrication, and processing in support of plutonium-238 production. The operation of FMEF for this purpose would be likely to increase groundwater withdrawals in the 400 Area by approximately 19 million liters (5 million gallons). This includes approximately 15 million liters (4 million gallons) per year to support FMEF cooling needs and an additional 3.8 million liters (1 million gallons) per year for potable and sanitary water demands due to increased staffing. However, no impact on regional groundwater levels would be expected from increased withdrawals. FMEF groundwater usage would constitute an increase of about 10 percent over the 197 million liters (52 million gallons) withdrawn annually in the 400 Area during standby operations. Sanitary wastewater discharges from FMEF would also increase by roughly 3.8 million liters (1 million gallons) per year to the Energy Northwest treatment system, which has sufficient capacity. Also, the operation of FMEF for target fabrication and processing would generate approximately 15 million liters (4 million gallons) per year of process wastewater. This wastewater would be discharged to the 400 Area process sewer system and ultimately to the 400 Area Pond (i.e., 4608 B/C percolation ponds) (Chapin 2000; Nielsen 1999:38, 39, 41). As discharges to the pond are regulated under State Waste Discharge Permit No. ST-4501 and there are no radiological liquid effluent pathways to the environment from FMEF, the impact on groundwater quality would be negligible.

Waste management aspects of this option and their effects are further discussed in Section 4.5.3.2.13.

4.5.3.2.5 Geology and Soils

Impacts on geology and soils associated with the operation of the accelerator(s) and support facility are addressed in Section 4.5.1.2.5. As discussed in Section 4.5.1.1.5, the proposed facilities would be designed and constructed in accordance with DOE Order 420.1 and sited to minimize the risk from geologic hazards. Thus, site geologic conditions would be unlikely to affect the facilities.

The use of FMEF for neptunium-237 storage, target fabrication, and processing would not be expected to impact geologic resources, nor be jeopardized by large-scale geologic conditions. Hazards from large-scale geologic conditions at Hanford, such as earthquakes and volcanoes, were previously evaluated in the *Storage and Disposition PEIS* (DOE 1996a:4-45) as discussed in Section 4.2.4.2.5. The analysis determined that these hazards present a low risk to long-term storage facilities. That analysis was reviewed in the SPD EIS (DOE 1999a:4-260). Further review of the data and analyses presented in these referenced documents and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions likewise present a low risk to FMEF operations. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards will be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.5.3.2.6 Ecological Resources

Impacts on ecological resources associated with the operation of the accelerator(s) and a support facility are addressed in Section 4.5.1.2.6.

This option also involves using FMEF for neptunium-237 storage, target fabrication, and processing. As noted in Section 4.5.3.2.2, there would be no change in noise impacts on wildlife. Because water usage and wastewater discharge would be small fractions of current values, there would be no change in impacts on aquatic habitat or wetlands associated with the Columbia River (Section 4.5.3.2.4). Threatened and endangered species would not be affected by operation because an existing facility within an already developed area would be used.

4.5.3.2.7 Cultural and Paleontological Resources

Impacts on cultural and paleontological resources associated with the operation of the accelerator(s) and a support facility are addressed in Section 4.5.1.2.7.

Neptunium-237 storage, target fabrication, and processing would take place at FMEF, which is in the 400 Area. No prehistoric, historic, or paleontological sites have been identified either within the 400 Area or within 2 kilometers (1.2 miles) of the 400 Area. Six buildings located within the 400 Area, including two FFTF structures (the Reactor Containment Building and FFTF Control Building), have been determined to be eligible for the National Register as contributing properties within the Historic District recommended for mitigation. The operation of FMEF would not affect the status of these structures. No Native American resources are known to occur within the 400 Area.

4.5.3.2.8 Socioeconomics

The socioeconomic impacts associated with the operation of the new accelerator(s) and support facility at a generic DOE site are addressed in Section 4.5.1.2.8.

Target fabrication and processing of neptunium-237 targets at FMEF at Hanford would require about 62 additional workers (Hoyt et al. 1999). The socioeconomic impacts at Hanford are the same as those addressed in Section 4.4.3.1.8.

4.5.3.2.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup and operations are given in **Table 4–131** for the generic DOE site and Hanford: the population within 80 kilometers (50 miles)in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

Table 4–131 Incremental Radiological Impacts on the Public Around the Generic DOE Site and Hanford from Operational Facilities Under Alternative 3 (Construct New Accelerator[s])—Option 3

Receptor	Hanford FMEF	Accelerators Preoperational Startup[a]		Generic Site Operations				Two-Site Total
				Accelerators		Accelerator(s) Support Facility	Total	
		Low-Energy	High-Energy	Low-Energy	High-Energy			
Population within 80 kilometers (50 miles) in the year 2020								
Dose (person-rem)	4.4×10^{-5}	0.0024	0.035	0.0036	0.055	0.14	0.20	0.20
35-year latent cancer fatalities	7.7×10^{-7}	2.4×10^{-6}[b]	3.5×10^{-5}[b]	6.3×10^{-5}	9.6×10^{-4}	0.0025	0.0035	0.0035
Maximally exposed individual								
Annual dose (millirem)	4.7×10^{-7}	1.4×10^{-5}	1.8×10^{-4}	7.8×10^{-5}	8.7×10^{-4}	0.0025	0.0034	NA[c]
35-year latent cancer fatality risk	8.2×10^{-12}	1.4×10^{-11}[b]	1.8×10^{-10}[b]	1.4×10^{-9}	1.5×10^{-8}	4.4×10^{-8}	6.0×10^{-8}	NA[c]
Average exposed individual within 80 kilometers (50 miles)								
Annual dose[d] (millirem)	8.9×10^{-8}	1.6×10^{-6}	2.3×10^{-5}	2.3×10^{-6}	3.6×10^{-5}	9.1×10^{-5}	1.3×10^{-4}	NA[c]
35-year latent cancer fatality risk	1.6×10^{-12}	1.6×10^{-12}[b]	2.3×10^{-11}[b]	4.0×10^{-11}	6.3×10^{-10}	1.6×10^{-9}	2.3×10^{-9}	NA[c]

a. For conservatism as well as consistency with other radiological impacts evaluated in this NI PEIS, these values were assessed for the year 2020 even though these activities would commence prior to that year.
b. Preoperational activities last 2 years. Number is a 2-year latent cancer fatality risk.
c. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
d. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FMEF or the generic site in the year 2020 (494,400 and 1,538,100, respectively).

Key: NA, not applicable.

Source: SAIC 2000; TechSource 2000; model results, using the GENII computer code (Napier et al. 1988)

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual operations of the accelerator facilities (the high- and low-energy accelerators and the support facility) and FMEF, the projected incremental total population dose in the year 2020 would be 0.20 person-rem; the corresponding number of latent cancer fatalities in the populations surrounding the generic DOE site and Hanford from 35 years of operations would be 0.0035. The incremental total dose to the maximally exposed member of the public from annual operations of the accelerator(s) and support facility at the generic DOE site would be 0.0034 millirem; from 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 6.0×10^{-8}. Estimated annual risks are also presented for pre-operational testing/startup phase activities anticipated for the accelerator(s) and support facility. The incremental dose to the maximally exposed member of the public from annual FMEF operations would be 4.7×10^{-7} millirem; from 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 8.2×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–132**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to the high-energy and low-energy accelerator workers during startup and operations would be 150 millirem; for support facility workers, the incremental annual average dose during operations would be 102 millirem; for FMEF workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities is estimated to be 45 (total for both accelerators), 12, and 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–132. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–132 Incremental Radiological Impacts on Involved Workers at the Generic DOE Site and Hanford from Operational Facilities Under Alternative 3 (Construct New Accelerator[s])—Option 3

Receptor—Involved Workers[a]	Hanford FMEF	Accelerators Preoperational Startup		Generic Site Operations			Two-Site Total
				Accelerators		Accelerator(s) Support Facility	
		Low-Energy	High-Energy	Low-Energy	High-Energy		
Total dose (person-rem per year)	22[b]	15[b]	30[b]	15[b]	30[b]	12[b]	79
35-year latent cancer fatalities	0.31	0.012[c]	0.024[c]	0.21	0.42	0.17	1.1
Average worker dose (millirem per year)	290	150	150	150	150	102	NA[d]
35-year latent cancer fatality risk	0.0041	1.2×10^{-4}[(c)]	1.2×10^{-4}[(c)]	0.0021	0.0021	0.0014	NA[d]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 75 badged workers at FMEF, 200 at the high-energy accelerator, 100 at the low-energy accelerator, and 120 at the accelerator(s) support facility.
c. Preoperational startup testing lasts 2 years. Number is a 2-year latent cancer fatality risk.
d. Values cannot be given for the average worker because the workers would be in three different facilities at two different sites.
Key: NA, not applicable.
Source: LMER 1997:22; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts associated with the operation of the accelerator(s) and support facility are addressed in Section 4.5.1.2.9.

Impacts from hazardous chemicals at Hanford were determined to be the same as under Option 3 of Alternative 2 (Section 4.4.3.1.9).

4.5.3.2.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with accelerator target irradiation; support facility fabrication and processing of medical, industrial, and research and development isotopes; and FMEF target fabrication and processing of neptunium-237 targets are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–133** and **4–134**, respectively.

Table 4–133 New Accelerator(s), Support Facility, and FMEF Accident Consequences Under Alternative 3 (Construct New Accelerator[s])—Option 3

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
High-energy accelerator accidents						
Design-basis target accident	2.92×10^{-6}	1.46×10^{-9}	8.75×10^{-3}	4.37×10^{-6}	4.60×10^{-5}	1.84×10^{-8}
Beyond-design-basis earthquake	1.81×10^{1}	5.90×10^{-3}	3.56×10^{4}	2.38×10^{1}	1.86	7.44×10^{-2}
Low-energy accelerator accidents						
Design-basis target accident	8.05×10^{-5}	4.03×10^{-8}	14.8	7.39×10^{-3}	1.12×10^{-3}	4.48×10^{-7}
Beyond-design-basis earthquake	1.32×10^{-2}	6.60×10^{-6}	3.94×10^{1}	1.97×10^{-2}	2.08×10^{-1}	8.32×10^{-5}
Support facility accidents						
Medical and industrial isotopes localized solvent fire	0.0194	9.72×10^{-6}	31.1	0.0156	0.00530	2.12×10^{-6}
Medical and industrial isotopes unlikely seismic event	0.0750	3.75×10^{-5}	136	0.0680	0.510	2.04×10^{-4}
Medical and industrial isotopes glovebox explosion	2.50	0.00125	4,600	2.30	17.0	0.00680
FMEF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.02×10^{-9}	1.01×10^{-12}	7.26×10^{-5}	3.63×10^{-8}	6.65×10^{-10}	2.66×10^{-13}
Target dissolver tank failure during plutonium-238 separation	4.64×10^{-8}	2.32×10^{-11}	0.00169	8.47×10^{-7}	1.95×10^{-8}	7.81×10^{-12}
Ion exchange explosion during plutonium-238 separation	1.24×10^{-5}	6.18×10^{-9}	0.451	2.25×10^{-4}	5.20×10^{-6}	2.08×10^{-9}
Processing facility beyond-design-basis earthquake	16.5	0.0165	6.41×10^{5}	321	921	1.00[c]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years of high-energy accelerator target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.07×10^{-6} and 2.60×10^{-5}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00833.

For 35 years of low-energy accelerator target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.45×10^{-9} and 3.07×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be $3.28\times10^{-5.}$

For 35 years of medical, industrial, and research and development target fabrication and processing at the support facility, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 3.26×10^{-5} and 9.85×10^{-5}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.056.

For 35 years of neptunium-237 target fabrication and processing at FMEF, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be

2.88×10^{-6} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.112.

Table 4–134 New Accelerator(s), Support Facility, and FMEF Accident Risks Under Alternative 3 (Construct New Accelerator[s])—Option 3

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual high-energy accelerator risks			
Design-basis target accident (1×10^{-4})	1.46×10^{-13}	4.37×10^{-10}	1.84×10^{-12}
Beyond-design-basis earthquake (1×10^{-5})	5.90×10^{-8}	2.38×10^{-4}	7.44×10^{-7}
35-year high-energy accelerator risk	2.07×10^{-6}	0.00833	2.60×10^{-5}
Annual low-energy accelerator risks			
Design-basis target accident (1×10^{-4})	4.03×10^{-12}	7.39×10^{-7}	4.48×10^{-11}
Beyond-design-basis earthquake (1×10^{-5})	6.60×10^{-11}	1.97×10^{-7}	8.32×10^{-10}
35-year low-energy accelerator risk	2.45×10^{-9}	3.28×10^{-5}	3.07×10^{-8}
Annual support facility risks			
Medical and industrial isotopes localized solvent fire (0.044)	4.32×10^{-7}	6.91×10^{-4}	9.41×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	3.75×10^{-7}	6.80×10^{-4}	2.04×10^{-6}
Medical and industrial isotopes glovebox explosion (1.00×10^{-4})	1.25×10^{-7}	2.30×10^{-4}	6.80×10^{-7}
35-year support facility risk	3.26×10^{-5}	0.056	9.85×10^{-5}
Annual FMEF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	3.63×10^{-10}	2.66×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	2.32×10^{-13}	8.47×10^{-9}	7.81×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	6.18×10^{-11}	2.25×10^{-6}	2.08×10^{-11}
Processing facility beyond-design-basis earthquake (1×10^{-5})	8.23×10^{-8}	0.00321	1.00×10^{-5}[c]
35-year FMEF risk	2.88×10^{-6}	0.112	3.50×10^{-4}[(c)]
35-year Option risk	3.76×10^{-5}	0.176	4.75×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 3.76×10^{-5} and 4.75×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.176.

There are no hazardous chemical accidents associated with the new accelerator(s) or new support facility. The irradiation of neptunium-237, medical, industrial, and research and development isotopes in the new accelerator(s) would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The fabrication and processing of medical, industrial, and research and development isotopes at the new support facility would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The hazardous chemical accident impacts at FMEF are the same as those presented in Section 4.4.6.1.10.

4.5.3.2.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-37 from storage at SRS to the REDC target fabrication facility at ORR. DOE would transport the unirradiated neptunium-237 targets from REDC to the accelerator(s) site. Following irradiation in the accelerator(s), the targets would be returned to REDC for processing. After this processing, the plutonium-238 product would be shipped to LANL. Additionally, medical and industrial isotopes would be shipped from the accelerator(s) site to a local airport, and from there to locations throughout the country.

Approximately 37,000 shipments of radioactive materials would be made by DOE in support of the low-energy accelerator. The total distance traveled on public roads by trucks carrying radioactive materials would be 4.8 million kilometers (3.0 million miles); and in the air carrying medical and industrial isotopes, 23 million kilometers (14 million miles).

Approximately 343 shipments of radioactive materials would be made by DOE in support of the high-energy accelerator. The total distance traveled on public roads by trucks carrying radioactive materials would be 1.5 million kilometers (0.92 million miles).

The transportation impact analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION FOR THE LOW-ENERGY ACCELERATOR. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 15 person-rem; the dose to the public, 7 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0059 latent cancer fatality among transportation workers and 0.0037 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.02.

IMPACTS OF INCIDENT-FREE TRANSPORTATION FOR THE HIGH-ENERGY ACCELERATOR. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 9 person-rem; the dose to the public, 151 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0037 latent cancer fatality among transportation workers and 0.0076 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.004.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION FOR THE LOW-ENERGY ACCELERATOR. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: more than 1 in 10 million per year) would not breach the transportation package. The consequences of more severe accidents that could breach the transportation package and release radioactive material were evaluated and estimated to have probabilities of less than 1 in 10 million per year.

Estimates of the total ground transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting 0.11 traffic fatality.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION FOR THE HIGH-ENERGY ACCELERATOR. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FDPF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 0.14 person-rem, resulting in 7.2×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.03 traffic fatality.

4.5.3.2.12 Environmental Justice

Under this option, neptunium-237 targets would be irradiated in one or two new accelerators that would be constructed at a site yet to be specified. Fabrication and processing of neptunium-237 targets for plutonium-238 production would be performed at FMEF located at Hanford. A new support facility would be constructed at the same unspecified site for fabrication and processing targets not used for plutonium-238 production.

Activities at FMEF were evaluated under other alternatives and options in this NI PEIS (e.g., Section 4.4.3.1.12) and found to pose no significant radiological or other risks to minority and low-income populations. The environmental analysis of operations at the new accelerator(s) and support facility site shows that radiological and nonradiological risks to persons residing in the (hypothetical) potentially affected area would not be significant. Unless there are patterns of food consumption among minority or low-income residents surrounding the actual site (yet to be determined) that would result in a significant ingestion of radiologically contaminated food, it is plausible that operations at the site would pose no significant risks to minority and low-income persons. However, evaluations of environmental justice are necessarily site-specific and cannot be performed in detail for unspecified locations. In the event that this option were selected for implementation and a specific site selected for the new accelerator(s) and support facility, an additional evaluation of environmental justice at the accelerator(s) and support facility site during operation would be performed prior to implementation.

4.5.3.2.13 Waste Management

The impacts of managing wastes associated with the operation of new accelerator(s) to irradiate targets and a support facility to fabricate and process medical and industrial isotope targets and to meet research and development needs are assumed to be the same as for Option 1 (Section 4.5.1.2.13). Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.5.2.2.9 through 4.5.2.2.11.

The impacts of managing wastes associated with fabricating and processing neptunium-237 targets for plutonium-238 production in FMEF at Hanford are assumed to be the same as for Option 3 under Alternative 2 (Section 4.4.3.1.13). As shown in that section, the impacts on the waste management systems at Hanford would be small.

4.5.3.3 Decontamination and Decommissioning of the Accelerator(s) and Support Facility

The environmental impacts associated with the decontamination and decommissioning of the accelerator(s) and support facility at the generic DOE site are assessed in Section 4.5.1.3.

4.5.3.4 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.6 ALTERNATIVE 4—CONSTRUCT NEW RESEARCH REACTOR

Under Alternative 4, a new research reactor would be used for target irradiation for the evaluation period of 35 years. The new research reactor, to be constructed at an existing DOE site, would be used to irradiate all targets (i.e., for the production of plutonium-238, isotopes for medical and industrial uses, and materials testing for nuclear research and development). Ongoing operations at existing facilities as described in Chapter 3, Affected Environment, would continue.

The targets for plutonium-238 production would be fabricated in one of the three candidate facilities at ORNL, INEEL, or Hanford. The material needed for the target fabrication (neptunium-237) would be transported from SRS to the fabrication facilities. The targets would be irradiated at the new research reactor facility and transported back to the target fabrication facilities for postirradiation processing.

Targets for medical and industrial isotope production would be fabricated in a new support facility located at the same site as the new research reactor. The targets would be irradiated in the new research reactor and returned to the new support facility for postirradiation processing.

Alternative 4 site selection is not evaluated as part of this NI PEIS. Because Alternative 4 is evaluated at a generic DOE site, no credit was taken for any existing support infrastructure existing at the site and it was postulated that a new support facility would be required to support operation of the new research reactor and its missions. While this approach bounds the environmental impact assessment for the implementation of Alternative 4, it overstates the impacts because this NI PEIS integrates the impacts associated with constructing new support facilities and infrastructure that may be available at the existing DOE site. In the event that Alternative 4 is selected by the Record of Decision for subsequent consideration, follow-up NEPA assessments would evaluate potential locations for the new research reactor. It is highly unlikely that DOE would consider locating the new research reactor on a DOE site that does not have existing infrastructure capable of supporting all or most of the proposed medical and industrial isotope production and nuclear research and development mission requirements.

Under Alternative 4, nonirradiated targets, irradiated targets, and processed materials would be transported between the locations selected for storage, target fabrication, target irradiation, postirradiation processing, and the final destination of the plutonium-238. Alternative 4 also would include the decontamination and decommissioning of both the research reactor and the support facility when the missions are over, as well as deactivation of FFTF at Hanford.

The proposed new research reactor would provide ample neutrons for the production of plutonium-238 and for many of the isotopes listed in Table 1–1. The thermal flux would limit the new research reactor's ability to produce a number of isotopes requiring fast or high-energy neutrons. Its lower flux levels (10^{13} neutrons per square centimeter per second) and predominantly thermal flux would limit its ability to support many of the projected nuclear-based research and development needs.

The three options under this alternative and their associated target fabrication, postirradiation processing, and transportation activities are discussed below.

- **Option 1.** REDC at ORNL would be used to fabricate and process the neptunium-237 targets associated with plutonium-238 production. The neptunium-237 transported from SRS to ORNL would be stored at REDC. The plutonium-238 product would be transported from ORNL to LANL. A new support facility at an existing DOE site would be used to fabricate and process the targets required for the production of medical and industrial and research isotopes and to store the materials needed for target fabrication.

- **Option 2.** FDPF at INEEL would be used to fabricate and process the neptunium-237 targets associated with plutonium-238 production. The neptunium-237 transported from SRS to INEEL would be stored in FDPF or Building CPP–651. The plutonium-238 product would be transported from INEEL to LANL. A new support facility at an existing DOE site would be used to fabricate and process the targets required for the production of medical and industrial and research isotopes and to store the materials needed for target fabrication.

- **Option 3.** FMEF at Hanford would be used to fabricate and process neptunium-237 targets for plutonium-238 production. The neptunium-237 transported from SRS to Hanford would be stored in FMEF. The plutonium-238 product would be transported from Hanford to LANL. A new support facility at an existing DOE site would be used to fabricate and process the targets required for the production of medical and industrial and research isotopes and to store the materials needed for target fabrication.

The incremental environmental impacts associates with each option are presented separately for the research reactor and the support facility because both facilities may not be selected together. This segmentation assists in the selection of facilities from the two possible combinations, that is, research reactor plus support facility or research reactor only.

As described in Section 1.2.3, the nuclear research and development initiatives requiring an enhanced DOE nuclear infrastructure fall into three basic categories: materials research, nuclear fuels research, and advanced reactor development.

- Materials research involves irradiating materials in a high-flux field to determine the radiation effect during reactor normal operating conditions or to perform accelerated life-cycle testing. This form of testing would not introduce material into the research reactor that would result in additional releases during normal operation or accident conditions.

- Nuclear fuels research involves irradiating test fuel pellets, fuel pins, and fuel assemblies in high-temperature environments expected in future reactor designs. When the test specimens are inserted into the research reactor, there would be no significant increase of fissile material in the reactor core inventory that would result in additional releases during normal operation or accident conditions.

- Advanced reactor development involves test loop experiments under prototypical reactor conditions. When the test loop is operating in the research reactor core, there would be no significant increase of fissile material in the reactor core inventory that would result in additional releases during normal operation or accident conditions.

The environmental impacts associated with implementation of the proposed nuclear research and development missions cannot be distinguished from the impacts of operating the new research reactor without the nuclear research and development mission.

The baseline operational impacts at ORR, INEEL, and Hanford are presented in Table 4–1. These are the sites at which plutonium-238 production activities would take place under this alternative. The other activities associated with this alternative would take place at a DOE site not yet selected and, therefore, baseline impacts cannot be presented. The incremental impacts associated with each option for the identified sites can be added to the baselines to provide total site impacts.

4.6.1 Alternative 4 (Construct New Research Reactor)—Option 1

Option 1 involves constructing and operating the research reactor to irradiate all targets associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating REDC at ORR to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and constructing and operating the support facility to fabricate and process the other targets and materials and to process the associated products. This option includes storage in REDC of the neptunium-237 transported to ORR from SRS and storage in the new support facility of the other target materials transported to the generic site from other offsite facilities.

The transportation of the low-enriched uranium fuel for use in the research reactor, the transportation of the neptunium-237 to ORR and then to the generic site, the transportation of the other target materials to the generic site, and the transportation of all product materials following irradiation and postirradiation processing are also part of the option.

All options under this alternative include the decontamination and decommissioning of the research reactor and support facility at the generic DOE site following their operating lifetimes, and also the permanent deactivation of FFTF at Hanford.

4.6.1.1 Construction of the New Research Reactor and Support Facility

The environmental impacts associated with the construction of a new research reactor and support facility at the generic DOE site are assessed in this section.

4.6.1.1.1 Land Resources

LAND USE. The construction of a research reactor and support facility at a generic DOE site would disturb 1.6 hectares (4 acres) and 2.4 hectares (6 acres), respectively. Since the exact nature of the construction site is not known at this time (e.g., whether it has been previously disturbed or not), potential effects on land use cannot be determined. In general, if a location in a previously developed portion of a generic DOE site were selected, impacts on land use would be minimal. However, if an undisturbed location were chosen, land use would change from its present designation to industrial. If the reactor alternative were selected, tiered NEPA documentation would permit an exact determination of impacts on land use.

VISUAL RESOURCES. Impacts from construction of a research reactor and support facility to visual resources at a generic DOE site would depend on the specific location selected. Impacts could include a change in the present Visual Resource Management rating of the site and/or increase in visibility of the site from offsite locations due to the presence of new structures. If construction took place on undeveloped land, the Visual Resource Management rating could change from Class II or III (ratings typical of undeveloped portions of many DOE sites) to Class IV. If a previously developed location were chosen for the reactor, the Visual Resource Management rating would remain Class IV. In either case, new facilities may impact the view from off site locations by increasing the industrial nature of the viewshed. This impact would be more likely at a western site due to the generally level terrain and sparse vegetation. Specific impacts on visual resources would be determined in tiered NEPA documentation if the reactor alternative were selected.

4.6.1.1.2 Noise

Construction of a research reactor and support facility would result in some increase in noise levels from the use of earthmoving, materials handling, and impact equipment; employee vehicles; and truck traffic. Noise from construction activities, especially impulsive noise, would be expected to disturb wildlife in the immediate

area of the construction site. The change in noise levels in areas outside the DOE site would be dependent on the location selected and the exact nature of the construction location and activities required. However, generally if the location selected were within one of the larger DOE sites and more centrally located within the site, offsite noise impacts from construction activities can be expected to be small. Construction employee vehicles and truck traffic would result in an increase in traffic noise along roads used to access the site. However, this increase in traffic noise would be small unless the construction traffic volume is as large as the existing site traffic. Site-specific analysis would be conducted in tiered NEPA documentation if the reactor alternative were selected.

4.6.1.1.3 Air Quality

Construction of the new research reactor would result in an increase in employee vehicles and truck traffic. Criteria pollutants were modeled and compared to the most stringent standards (**Table 4–135**). The maximum ground-level concentrations that would result from reactor construction would be below the ambient air quality standards, although concentrations of some pollutants (i.e., PM_{10}) would be releatively high. Therefore, if the reactor were in an area that already had high background pollutant concentrations, resultant pollutant concentrations could approach or exceed the ambient standards. As a result, regulatory compliance would need to be assessed on case-by-case basis. No hazardous chemical emissions have been identified from construction activities.

Table 4–135 Incremental Concentrations Associated with Research Reactor Construction Under Alternative 4 (Construct New Research Reactor)—All Options

Pollutant	Averaging Time	Most Stringent Standard or Guideline (microgram per cubic meter)[a]	Modeled Increment (microgram per cubic meter)
Carbon monoxide	8 hours 1 hour	10,000 40,000	72 103
Nitrogen oxide	Annual	100	1
PM_{10}	Annual 24 hours	50 150	3 88

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standards.

Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995); data from Appendix E.

4.6.1.1.4 Water Resources

It is estimated that construction of the research reactor would require approximately 11.7 million liters (3.1 million gallons) of water per year. Construction of the support facility would require about 16.5 million liters (4.36 million gallons) of water per year (Appendix E; SAIC 2000). Water is expected to be required for such uses as mixing concrete, dust control, washing activities, and potable and sanitary needs. These are annual average values over the forecasted construction periods; these values do not include dewatering of excavations that could be required at some sites. The exact impact of these withdrawals on the resource would depend on the water source (surface water or groundwater) and its relative abundance. These factors would be used to determine the impact on the local and/or regional availability of the resource. Impacts would be expected to be small to negligible due to the relatively small volumes of water required for construction compared to expected site availability.

The construction of the research reactor is projected to generate approximately 11.4 million liters (3 million gallons) of sanitary wastewater per year. Construction of the support facility would generate an estimated 4 million liters (1.06 million gallons) of sanitary wastewater annually (Appendix E; SAIC 2000). Process wastewater could also be generated during construction associated with facility cold-startup and testing of auxiliary systems as construction progresses (e.g., cooling towers). Site selection would make use of existing infrastructure and nearby wastewater treatment facilities would be used to the extent possible and would be supplemented by portable or temporary facilities during construction as necessary. The potential impact on water resources would depend on the availability and capacity of appropriate treatment facilities. All wastewater would be disposed of in accordance with applicable regulatory requirements with discharges to surface waters in accordance with National Pollutant Discharge Elimination System (NPDES) effluent limitations.

Ground disturbance and runoff from denuded areas could potentially impact surface water quality near construction areas (Section 4.6.1.1.6). However, appropriate spill prevention practices and soil erosion and sediment control measures (e.g., silt fences, mulching disturbed areas) would be employed during construction to minimize water quality impacts.

Some locations on a generic DOE site could potentially be affected by flooding requiring appropriate siting decisions (refer to Section 3.6.4). Applicable regulatory requirements would be followed in siting facilities including Executive Order 11988, *Floodplain Management*.

Although specific impacts on water resources cannot be determined at this time, site-specific analysis would be conducted in tiered NEPA documentation if the research reactor alternative were selected.

4.6.1.1.5 Geology and Soils

Construction of the research reactor would disturb a total of approximately 1.6 hectares (4 acres) of land. Construction of the support facility would disturb an additional 2.4 hectares (6 acres) of land (Appendix E; SAIC 2000). Related impacts on geologic and soil resources cannot be determined at this time since they are site specific in nature. However, impacts would be expected to be less if previously disturbed land were used than if an undeveloped area were selected for construction. In general, construction activities would likely require appreciable quantities of sand and gravel and possibly other geologic materials and, depending on the site chosen, could temporarily deplete local deposits or stockpiles of these materials. Soil erosion potential is also closely related to the amount of land disturbed.

As discussed in Section 3.6.5, the proposed facilities could be located at a generic DOE site with seismic activity ranging from low to moderate. Known capable faults could be located within 19 kilometers (12 miles). However, no known large-scale geologic conditions are present at any generic DOE site that would preclude the construction and operation of properly designed facilities. Appropriate activities and subsurface investigations would be conducted to identify geologic hazards including seismic and volcanic features and other natural hazards (landslide areas, sinkholes, unstable soils) as part of the site selection process. As stated in DOE Order 420.1, DOE requires that nuclear or nonnuclear facilities be designed, constructed, and operated so that the public, the workers, and the environment are protected from the adverse impacts of natural phenomena hazards, including earthquakes. DOE Order 420.1, Section 4.4, as supplemented by DOE Guide 420.1-2, stipulates the natural phenomena hazards mitigation requirements for DOE facilities. Further, the natural phenomena hazards mitigation requirements of DOE Order 420.1 are consistent with the guidance for seismic design and construction contained in the National Earthquake Hazards Reduction Program (NEHRP) 1997 provisions (BSSC 1997). In addition, DOE Guide 420.1-2 was recently issued to recognize the consolidation of the three previous U.S. model building codes, including the Uniform Building Code (UBC), into the International Building Code (ICC 2000). The DOE requirements for seismic

engineering have followed the UBC, unless the importance of achieving a high level of protection warrants the use of more demanding methods and criteria (DOE Guide 420.1-2). Thus, new facilities would be designed and sited in accordance with DOE Order 420.1.

Site-specific analysis would be conducted in tiered NEPA documentation if the research reactor alternative were selected.

4.6.1.1.6 Ecological Resources

If the research reactor alternative were selected, tiered NEPA documentation would be undertaken to determine the exact nature of construction impacts on ecological resources. During that process, impacts on individual species and habitats that are sensitive to disturbance would be determined. This would include consideration of wetlands and threatened and endangered species. Wetland delineations and consultation with the U.S. Fish and Wildlife Service and state wildlife agency would take place, as necessary, to ensure that these resources would be protected.

Construction impacts on ecological resources are site specific. The nature of these impacts would be expected to vary depending on whether the site was located in the eastern or western portion of the United States. In fact, depending on the site location, impacts on some resources may not occur. Additionally, construction impacts on ecological resources would depend on whether the selected location was within an already disturbed portion of the site. In general impacts on terrestrial resources, wetlands, aquatic resources, and threatened and endangered species described below are applicable to an undeveloped site.

Terrestrial Resources. Construction of a research reactor and support facility would disturb 1.6 hectares (4 acres) and 2.4 hectares (6 acres), respectively, of terrestrial habitat. If these facilities were constructed at an undeveloped location, it is likely that woodland habitat would be lost at an eastern generic DOE site and shrubland would be disturbed at a western site. Land clearing activities would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would not be expected to survive. Construction activities and noise would cause larger mammals and birds in the construction and adjacent areas to move to similar habitat nearby. If the area to which they moved was below its carrying capacity, these animals would be expected to survive. However, if the area were already supporting the maximum number of individuals, the additional animals would compete for limited resources that could lead to habitat degradation and eventual loss of the excess population. Nests and young animals living within the disturbed area may not survive.

Wetlands. Clearing and grading operations could result in the direct loss of wetlands, although proper placement of the research reactor and support facility within the overall generic DOE site would eliminate or reduce the potential for such loss. Indirect impacts could also result from stormwater runoff carrying sediments to wetlands located adjacent to the site. Changes in hydrology, water quality, and soils could occur as a result of alterations in water levels, runoff, and the buildup of sediments. These changes could, in turn, alter the vegetative composition of the wetland. In general, both direct and indirect impacts would be more likely to occur at an eastern site due to the greater abundance of wetlands. If preliminary analysis determined that wetlands could be impacted by development, a wetland delineation would be required. Impacts on wetlands could also lead to the implementation of mitigation measures.

Aquatic Resources. During construction of a research reactor and support facility, impacts on aquatic resources could result from stormwater runoff. Runoff could alter flow rates, increase turbidity, and lead to sedimentation of streambeds. These impacts could, in turn, cause temporary and permanent changes in species composition and density, and alter breeding habitats. The implementation of erosion and sediment control procedures would lessen construction impacts.

Threatened and Endangered Species. Construction of a research reactor and support faculty would have the potential to impact threatened and endangered species. Sources of impacts would be similar to those discussed above for terrestrial resources, wetlands, and aquatic resources. The primary difference is that the resource of concern involves individual species that are sensitive to disturbance and whose existence may be threatened by development. Consultations with the U. S. Fish and Wildlife Service and appropriate state agency would be conducted at the site-specific level, as appropriate.

4.6.1.1.7 Cultural and Paleontological Resources

The construction of a research reactor and support facility at a generic DOE site would disturb 1.6 hectares (4 acres) and 2.4 hectares (6 acres), respectively. Since the exact nature of the construction site is not known at this time (e.g., whether it has previously been disturbed or not), potential effects on cultural resources cannot be determined. In general, if a location in a previously developed portion of a DOE generic site were selected, impacts on cultural resources may not occur. However, if an undisturbed location were chosen, cultural resources could be impacted. If the reactor alternative were selected, prehistoric and historic resources, including those that are or may be eligible for listing on the National Register of Historic Places, would be identified. These resources would be identified through site surveys and consultation with the State Historic Preservation Officer. Specific concerns about the presence, type, and location of Native American resources would be addressed through consultation with the potentially affected tribes in accordance with the *National Historic Preservation Act*, the *Native American Graves Protection and Repatriation Act*, and the *American Indian Religious Freedom Act*.

4.6.1.1.8 Socioeconomics

It is estimated that 160 workers would be needed each of the 4 years required to construct the research reactor at a generic DOE site. The impact of this influx of workers upon the site's region of influence and regional economic area would depend on whether the site were located near a large urbanized area or in a remote rural area. Since the population for the region of influence for a generic site could range from nearly 2.0 million people for a site in a large metropolitan area, to less than 200,000 for a site in a small rural community, the socioeconomic impacts of constructing a new research reactor and support facility would vary greatly. Therefore, if DOE were to select the new research reactor alternative, additional NEPA documentation would be required to select the specific DOE site to locate the new research reactor and support facility. In that document, DOE would perform a thorough evaluation of the socioeconomic impacts of the sites under consideration.

4.6.1.1.9 Public and Occupational Health and Safety—Normal Construction Activities

RADIOLOGICAL IMPACTS. During construction operations, it is not anticipated that there would be any resulting radiological releases to the environment; therefore, no additional dose to the public is expected. Furthermore, construction workers are not expected to receive exposures above natural background levels that exist within the construction areas. However, as a precautionary measure, workers would be badged as deemed appropriate.

HAZARDOUS CHEMICAL IMPACTS. No hazardous chemical releases would be expected from construction activities. Thus, there would be no hazardous chemical impacts associated with construction.

4.6.1.1.10 Public and Occupational Health and Safety—Construction Accidents

There are no radiological or hazardous chemical accidents postulated during the construction phases of the new research reactor or support facility. Workers could experience industrial accidents commonly associated with the construction of large facilities.

4.6.1.1.11 Environmental Justice

Section 4.6.1.1 addresses environmental effects due to construction activities that would be expected to occur at an unspecified reactor and support facility site. The analysis shows that radiological and nonradiological risks to persons residing in the (hypothetical) potentially affected areas are not significant. Unless there are patterns of food consumption among minority or low-income residents surrounding the actual site (yet to be determined) that would result in a significant ingestion of radiologically contaminated food, it is plausible that construction activities would pose no significant risks to minority and low-income persons. However, evaluations of environmental justice are necessarily site-specific and cannot be performed in detail for unspecified locations. In the event that this option were selected for implementation and a specific site selected for the new research reactor and support facility, an additional evaluation of environmental justice at the research reactor and support facility site during construction would be performed prior to implementation.

4.6.1.1.12 Waste Management

The expected generation rates of wastes at a generic DOE site that would be associated with the construction of a new research reactor to irradiate targets and a support facility to fabricate and process medical and industrial isotope targets and to meet research and development needs are provided in **Table 4–136**. These estimates represent the total amount of wastes generated during the construction period. These generation rates cannot be compared at this time with site treatment, storage, and disposal capacities because a DOE site has not yet been chosen for these facilities. Site-specific analyses would be conducted if this alternative were chosen, and appropriate NEPA documentation would be prepared.

Table 4–136 Estimated Waste Generation Associated with Constructing a New Research Reactor and Support Facility Under Alternative 4 (Construct New Research Reactor)—Option 1

Waste Type[a]	Estimated Waste Generation for New Research Reactor (total cubic meters)	Estimated Waste Generation for New Support Facility (total cubic meters)
Transuranic	0	0
Low-level radioactive		
Liquid	0	0
Solid	0	0
Mixed low-level radioactive	0	0
Hazardous		
Liquid	1	1
Solid	3	3
Nonhazardous		
Process wastewater	0	0
Sanitary wastewater	44,000	16,000
Solid (kilograms)	1,230,000	230,000

a. See definitions in Appendix G.9.
Note: To convert from cubic meters to cubic yards, multiply by 1.308.
Source: Appendix E; SAIC 2000.

Section 3.6.11.1 provides DOE site ranges for each waste type that include volume currently stored, projected generation, and for some wastes, disposal volume. Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.6.1.1.9 through 4.6.1.1.11.

4.6.1.2 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.6.1.2.1 Land Resources

LAND USE. The operation of a research reactor and support facility at a generic DOE site would not be expected to affect land use. This is because none of the anticipated operational impacts (e.g., air emissions) are expected to affect this resource.

REDC would be used for neptunium-237 storage, target fabrication, and processing. The use of REDC for this purpose would not change land use at the site since REDC is currently operating and its proposed use would be compatible with its present mission.

VISUAL RESOURCES. The primary source of impacts on visual resources from the operation of a research reactor and support facility would be air emissions. Releases from stacks associated with this alternative would be controlled and, therefore, would be unlikely to exceed Bureau of Land Management Visual Resource Management objectives. However, the operation of cooling towers could result in a visible plume. The extent and visibility of the plume would depend on site meteorological conditions and terrain features. While plume formation would be favored by meteorological conditions at an eastern generic DOE site, terrain features would tend to mask it from offsite locations; the opposite would tend to be true at a western site. If the reactor alternative were selected, the visual impact of the cooling tower plume would be determined in tiered NEPA documentation.

All activities associated with neptunium-237 storage, target fabrication, and processing would take place within REDC. Operations associated with the proposed mission would not result in any impact on visual resources or change in the current Visual Resource Management Class IV rating of the 7900 Area. This is because none of the anticipated operational impacts (e.g., air emissions) would be expected to affect this resource.

4.6.1.2.2 Noise

The operation of a reactor and support facility at a generic DOE site would result in some increase in noise levels from equipment (e.g., cooling systems, vents, motors, generators, compressors, pumps, and material-handling equipment), employee vehicles, and truck traffic. Noise from operation activities could disturb wildlife outside the facility fence line. The change in noise levels in areas outside the DOE site would be dependent on the location selected and the equipment. However, generally if the location selected is within one of the larger DOE sites and is more centrally located within the site, offsite noise impacts from operation can be expected to be small. Operation employee vehicles and truck traffic would result in an increase in traffic noise along roads used to access the site. However, this increase in traffic noise would be small unless the operation traffic volume were as large as the existing site traffic. Site-specific analysis would be conducted in tiered NEPA documentation if the reactor alternative were selected.

This option also involves using REDC for neptunium-237 target material storage, target fabrication, and processing. Interior modifications of these facilities in the 7900 Area of ORNL would be expected to result

in little change in noise impacts on wildlife around this area. The operation of REDC would not be expected to result in any change in noise impacts on wildlife around the 7900 Area and offsite noise impacts would be small because the nearest site boundary is 2.5 kilometers (1.6 miles) to the southeast. Operation would be expected to result in a minimal change in noise impacts on people near ORR as a result of changes in employee and truck traffic levels.

4.6.1.2.3 Air Quality

The operation of a new research reactor would result in some increase in air quality impacts due to operation of emergency diesel generators. Criteria pollutants were modeled and compared to the most stringent standards (**Table 4–137**). The maximum ground-level pollutant concentrations that would result from reactor operation would be well below the ambient air quality standards. However, if the reactor were in an area that already had high background pollutant concentrations, resultant pollutant concentrations could approach or exceed the ambient standards for some pollutants. As a result, regulatory compliance would need to be assessed on case-by-case basis. Hazardous chemical impacts are addressed in Section 4.6.1.2.9.

Air quality impacts associated with this option at ORR were determined to be the same as under Option 1 of Alternative 2 (Section 4.4.1.1.3).

The air quality impacts of transportation are presented in Section 4.6.1.2.11.

Table 4–137 Incremental Concentrations Associated with Research Reactor Operation Under Alternative 4 (Construct New Research Reactor)—Option 1

Criteria Pollutant	Averaging Time	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (micrograms per cubic meter)
Carbon monoxide	8 hours 1 hour	10,000 40,000	89.5 128
Nitrogen oxide	Annual	100	0.198
PM_{10}	Annual 24 hours	50 150	0.0035 3.46
Sulfur dioxide	Annual 24 hours 3 hours	80 365 1,300	0.062 61.2 138

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those based on annual averages, are not to be exceeded more than once per year. The annual arithmetic mean PM_{10} standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

Source: Modeled increments are based on the SCREEN 3 computer code (EPA 1995); data from Appendix E.

4.6.1.2.4 Water Resources

It is estimated that the operation of the research reactor at a generic DOE site would require 807 million liters (213.1 million gallons) of water per year to support such uses as process cooling, potable, and sanitary needs (Appendix E). The single largest system use would be for cooling tower operation and associated evaporative losses. The operation of the support facility would require an estimated 11.9 million liters (3.14 million gallons) of water per year (SAIC 2000). The exact impact of these withdrawals on the resource would depend on the water source (surface water or groundwater) and its relative abundance. These factors would be used to determine the impact on the local and/or regional availability of the resource. For surface water, a dedicated surface water intake may have to be constructed if the generic site's existing distribution system is inadequate to meet the increased demands of the facilities. For groundwater, additional wells may have to be developed

to supply the facilities directly or to provide increased production capacity for the generic site's existing supply system.

The operation of the research reactor is projected to generate approximately 7.9 million liters (2.1 million gallons) of process wastewater per year. It is expected that this process effluent would mainly consist of cooling tower blowdown. The support facility would generate an additional 3.6 million liters (0.95 million gallons) of process wastewater per year as a result of material processing. There would be no radiological liquid effluent discharge to the environment from either facility under normal operations. Approximately 11.6 million liters (3.07 million gallons) of sanitary wastewater would also be generated annually as a result of research reactor operations. Support facility operations would generate an estimated 8.3 million liters (2.2 million gallons) per year (Appendix E; SAIC 2000). Waste management activities and their effects are further detailed in Section 4.6.1.2.13. The potential impact on water resources would depend on the availability and capacity of appropriate treatment facilities. Process and sanitary wastewater would be discharged to either existing site wastewater treatment facilities or to new facilities constructed specifically to serve the proposed facilities. All wastewater would be disposed of in accordance with applicable regulatory requirements with discharges to surface waters in accordance with National Pollutant Discharge Elimination System (NPDES) effluent limitations.

Although specific impacts on water resources cannot be determined at this time, site-specific analysis would be conducted in tiered NEPA documentation if the research reactor alternative were selected.

REDC, an existing facility in the 7900 Area of ORNL, would be used for neptunium-237 storage, target fabrication, and processing in support of plutonium-238 production; these proposed activities would be similar to the current mission of REDC. As existing facilities would be used, there would be no construction-related impacts on water bodies, floodplains, or on surface or groundwater quality. In addition, no measurable increase in water use is anticipated to support target fabrication for plutonium-238 production. The only measurable increase would be an additional 23,000 liters (6,100 gallons) per year of process wastewater associated with target processing (Wham 1999c). Any change in the quantity or quality of process and sanitary wastewater discharges would be negligible compared to that of other activities, with no radiological liquid effluent discharge to the environment under normal operations (Wham 1999a; LMER 1997). Specifically, the anticipated additional 23,000 liters (6,100 gallons) of process wastewater generated per year would be negligible relative to the total volume of process wastewater generated and treated at ORNL daily, approximately 2.08 million liters (550,000 gallons) per day. Overall, no measurable impact on water resources at ORR is expected.

4.6.1.2.5 Geology and Soils

The operation of a research reactor and support facility would not be expected to result in impacts on geologic and soils resources at a generic DOE site. If cooling towers are used, the potential exists for salt deposition to alter soil chemistry. While high rainfall at an eastern site would tend to keep salt from accumulating in the soil, the potential exists that salt could accumulate at a western site where rainfall is sparse. If the reactor alternative were selected, impacts on geology and soils would be determined in tiered NEPA documentation. As discussed in Section 4.6.1.1.5, the proposed facilities would be designed and constructed in accordance with DOE Order 420.1 and sited to minimize the risk from geologic hazards. Thus, site geologic conditions would be unlikely to affect the facilities.

The use of REDC for neptunium-237 storage, target fabrication, and processing would not be expected to impact either geologic or soil resources, nor be jeopardized by large-scale geologic conditions. Hazards from large-scale geologic conditions at ORR, such as earthquakes, volcanoes, and sinkholes, were previously evaluated in the *Storage and Disposition PEIS* (DOE 1996a:4-260) as discussed in Section 4.2.2.2.5. The

analysis determined that these hazards present a low risk to long-term storage facilities. Further review of the data and analyses presented in that document and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions likewise present a low risk to REDC operations.

As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.6.1.2.6 Ecological Resources

If the new research reactor alternative were selected, tiered NEPA documentation would be undertaken to determine the exact nature of operational impacts on ecological resources. During this process, impacts on individual species and habitats that are sensitive to disturbance would be determined. This would include consideration of wetlands and threatened and endangered species.

While the exact nature of operational impacts on ecological resources cannot be determined until a specific site is selected, certain general types of impacts are possible. The nature and extent of these impacts would be expected to vary depending on whether the selected site was located in the eastern or western portion of the United States.

Terrestrial Resources. Activities associated with operations, such as noise and human presence, could affect wildlife living adjacent to the research reactor and support facility. These disturbances could cause some species to move from the area. Preventing workers from entering undisturbed areas would minimize impacts on wildlife living adjacent to the facilities. Emissions to the air and water, both nonradiological and radiological, could impact both plants and animals. Plants and animals could be exposed to pollutants via a number of pathways including direct exposure, contact with contaminated soil, ingestion, and inhalation. Further, bioaccumulation could affect species that consume exposed plants or animals. While regulatory limits would act to limit the effects of air emissions and effluent discharges, impacts would be analyzed once site and facility specific information became available.

Wetlands. Impacts from the operation of a research reactor and support facility at a western generic DOE site would not be expected to affect wetlands since discharges would be to an evaporation pond. At an eastern site, wastewater and cooling tower blowdown would be discharged to an onsite waterbody. While these discharges would be through permitted outfalls, the potential exists that wetlands could be affected. Potential impacts, such as changes in water levels and plant species composition, would depend on outfall location, water volume, discharge temperature, and water chemistry. Since these factors depend on site location and facility engineering design, operational impacts on site wetlands would have to be analyzed once these factors are known.

Aquatic Resources. Operational impacts on aquatic resources at a western site would not be expected since groundwater would be used and wastewater and cooling tower blowdown would be discharged to an evaporation pond. At an eastern site, potential impacts on aquatic resources could occur as a result of water withdrawal and discharge. Water withdrawal could lead to the loss of aquatic organisms through impingement and entrainment. The discharge of cooling water could result in alterations in aquatic communities. Alterations could include changes in aquatic vegetation and the loss of fish and benthic macroinvertebrates. Additionally, radionuclides and chemicals in the discharge water have the potential to impact aquatic organisms. The extent of potential impacts on the aquatic environment would depend upon site and facility specific information.

Threatened and Endangered Species. The operation of a research reactor and support facility would have the potential to impact threatened and endangered species. Sources of impacts would be similar to those

discussed above for terrestrial resources, wetlands, and aquatic resources. The primary difference is that the resources of concern involve individual species that are sensitive to disturbance and whose existence may be threatened by development.

REDC would be used for neptunium-237 storage, target fabrication, and processing. As noted in Section 4.6.1.2.2, there would be little change in noise impacts on wildlife. There would be no change in impacts on wetlands or aquatic resources since additional water would not be withdrawn from or discharged to site surface waters. Further, this option would not result in any new contaminants in existing discharges (Section 4.6.1.2.4). Threatened and endangered species would not be affected by operation because an existing facility within an already developed area would be used.

4.6.1.2.7 Cultural and Paleontological Resources

Impacts on cultural and palenontological resources from the operation of a research reactor and support facility at a generic DOE site would depend on the relative location of such resources to the site and/or transportation routes. While impacts would be expected to be nonexistent or small, they cannot be ruled out. For example, noise related to plant operation or traffic to and from the facility or alterations in the viewshed could adversely affect visitor enjoyment of an historic site. Since impacts on cultural resources are site dependent, specific operational impacts cannot be determined until a site were selected. The operation of a reactor and support facility would not be expected to impact paleontological resources.

The operation of REDC for neptunium-237 storage, target fabrication, and processing would not change the status of cultural and paleontological resources at ORR. The Graphite Reactor, which is located within ORNL, is listed on the National Register of Historic Places as a National Historic Landmark. Additionally, several other structures proposed for listing on the National Register of Historic Places are found within or near ORNL. However, neither the Graphite Reactor nor any of the other structures is located within the 7900 Area; thus, the use of REDC for target fabrication and processing would not change their status.

4.6.1.2.8 Socioeconomics

It is estimated that 120 workers would be needed each year to oprate the research reactor at a generic DOE site. The impact of this influx of workes upon the site's region of influence and regional economic area would depend on whether the site were located near a large urbanized area or in a remote rural area. Since the population for the region of influence for a generic site could range from nearly 2.0 million people for a site in a large metropolitan area, to less than 200,000 for a site in a small rural community, the socioeconomic impacts of operating a new research reactor and support facility would vary greatly. Therefore, if DOE were to select this option, additional NEPA documentation would be required to determine the specific socioeconomic impacts.

The socioeconomic impacts associated with neptunium-237 target fabrication and processing at ORR are addressed in Section 4.3.1.1.8.

4.6.1.2.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup and operations are given in **Table 4–138** for the generic DOE site and ORR: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. Radiological impacts from startup operations prior to fuel loading would be zero. After fuel loading, these impacts would be expected to be bounded by normal operation impacts. Therefore, startup impacts have not been treated separately from normal operational impacts. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual operations of the research reactor facilities and REDC, the projected incremental total population dose in the year 2020 would be 0.14 person-rem; the corresponding number of latent cancer fatalities in the populations surrounding the generic DOE site and ORR from 35 years of operations would be 0.0025. The incremental total dose to the maximally exposed member of the public from annual operations of the research reactor and support facility at the generic DOE site would be 0.0025 millirem; from 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 4.5×10^{-8}.

Table 4–138 Incremental Radiological Impacts on the Public Around the Generic DOE Site and ORR from Operational Facilities Under Alternative 4 (Construct New Research Reactor)—Option 1

Receptor	ORR REDC	Generic Site			Two-Site Total
		Research Reactor Operations	Reactor Support Facility Operations	Total	
Population within 80 kilometers (50 miles) in the year 2020					
Dose (person-rem)	8.8×10^{-5}	0.0022	0.14	0.14	0.14
35-year latent cancer fatalities	1.5×10^{-6}	3.9×10^{-5}	0.0025	0.0025	0.0025
Maximally exposed individual					
Annual dose (millirem)	1.9×10^{-6}	6.6×10^{-5}	0.0025	0.0025	NA[a]
35-year latent cancer fatality risk	3.3×10^{-11}	1.2×10^{-9}	4.4×10^{-8}	4.5×10^{-8}	NA[a]
Average exposed individual within 80 kilometers (50 miles)					
Annual dose[b] (millirem)	7.8×10^{-8}	1.4×10^{-6}	9.1×10^{-5}	9.2×10^{-5}	NA[a]
35-year latent cancer fatality risk	1.4×10^{-12}	2.5×10^{-11}	1.6×10^{-9}	1.6×10^{-9}	NA[a]

a. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of REDC or the generic site in the year 2020 (1,134,200 and 1,538,100, respectively).
Key: NA, not applicable.
Source: Appendix E; model results, using the GENII computer code (Napier et al. 1988).

Incremental doses to involved workers from normal operations are given in **Table 4–139**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to research reactor workers during startup and operations would be 100 millirem; for support facility workers, the incremental annual average dose during startup and operations would be 102 millirem; for REDC workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities is estimated to be 12, 12, and 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of

operations are included in Table 4–139. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–139 Incremental Radiological Impacts on Involved Workers at the Generic DOE Site and ORR from Operational Facilities Under Alternative 4 (Construct New Research Reactor)—Option 1

Receptor—Involved Workers[a]	ORR REDC	Generic Site		Two-Site Total
		Research Reactor Operations	Reactor Support Facility Operations	
Total dose (person-rem per year)	22[b]	12[b]	12[b]	46
35-year latent cancer fatalities	0.31	0.17	0.17	0.65
Average worker dose (millirem per year)	290	100	102	NA[c]
35-year latent cancer fatality risk	0.0041	0.0014	0.0014	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 75 badged workers at REDC, 120 research reactor workers, and 120 workers at the reactor support facility.
c. Values cannot be given for the average worker because the workers would be in three different facilities at two different sites.
Key: NA, not applicable.
Source: LMER 1997:22; Nielsen 1999; Wham 1999b.

HAZARDOUS CHEMICALS IMPACTS. The operation of a new reactor and associated support facility would result in some increase in emissions of hazardous chemicals due to diesel fuel burning from different sources of equipment used for operation. The operation of the reactor would require the emergency diesel generators to be tested approximately 1 hour each month and 24 hours once a year to ensure operability. Chemical releases were modeled based on 72 hours of operation. Resulting concentrations were determined to be very small and would have no incremental impact on the site current conditions (**Table 4–140**). Hazard indexes for the toxic chemicals were all far below one, and cancer risk values are well below acceptable risk values. Thus, there would be no hazardous chemical impacts from the operation of the new reactor.

Table 4–140 Incremental Hazardous Chemical Impacts from New Research Reactor Diesel Generator Operation Under Alternative 4 (Construct New Research Reactor)—Option 1

Chemicals	Modeled Annual Increment (micrograms per cubic meter)	RfC (micrograms per cubic meter)	Unit Cancer Risk (risk per micrograms per cubic meter)	Hazard Quotient	Cancer Risk
Benzene	4.83×10^{-5}	NA	0.0000078	NA	3.77×10^{-10}
Naphthalene	6.83×10^{-6}	3	NA	2.28×10^{-6}	NA
Toluene	1.75×10^{-5}	400	NA	4.38×10^{-8}	NA
Propylene	1.73×10^{-4}	NA	0.0000037	NA	6.42×10^{-10}

Key: NA, not applicable (the chemical is not a known carcinogen, or it is a carcinogen and only unit cancer would apply); RfC, Reference Concentration.
Note: Propylene oxide cancer unit was used for propylene.
Source: Data from Appendix E; EPA 1999; modeled increments are based on the SCREEN 3 computer code (EPA 1995).

Hazardous chemicals impacts for this option at ORR were determined to be the same as described in Alternative 2, Option 1 (Section 4.4.1.1.9).

4.6.1.2.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with research reactor target irradiation; support facility medical, industrial, and research and development isotope fabrication and processing; and REDC neptunium-237 target fabrication and processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–141** and **4–142**, respectively.

For 35 years of research reactor target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.49×10^{-9} and 8.41×10^{-9}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 2.29×10^{-5}.

For 35 years of support facility medical, industrial, and research and development target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 3.26×10^{-5} and 9.85×10^{-5}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.056.

For 35 years of REDC neptunium-237 target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 5.71×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.157.

Table 4–141 New Research Reactor, Support Facility, and REDC Accident Consequences Under Alternative 4 (Construct New Research Reactor)—Option 1

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
New research reactor accidents						
Design-basis maximum hypothetical accident	1.33×10^{-6}	6.65×10^{-10}	0.00283	1.41×10^{-6}	5.49×10^{-6}	2.20×10^{-9}
Beyond-design-basis earthquake	0.00373	1.87×10^{-6}	2.82	0.0141	0.0531	2.12×10^{-5}
Fuel-handling accident	1.90×10^{-9}	9.50×10^{-13}	7.26×10^{-6}	3.60×10^{-9}	5.83×10^{-9}	2.33×10^{-12}
Neptunium-237 target-handling accident	5.42×10^{-8}	2.71×10^{-11}	1.07×10^{-4}	5.36×10^{-8}	2.43×10^{-7}	9.72×10^{-11}
Medical isotope target-handling accident	1.04×10^{-5}	5.20×10^{-9}	0.102	5.12×10^{-5}	6.76×10^{-6}	2.70×10^{-9}
Support facility accidents						
Medical and industrial isotopes localized solvent fire	0.0194	9.72×10^{-6}	31.1	0.0156	0.00530	2.12×10^{-6}
Medical and industrial isotopes unlikely seismic event	0.0750	3.75×10^{-5}	136	0.0680	0.510	2.04×10^{-4}
Medical and industrial isotopes glovebox explosion	2.50	0.00125	4,600	2.30	17.0	0.00680
REDC accidents						
Ion exchange explosion during neptunium-237 target fabrication	6.13×10^{-9}	3.06×10^{-12}	8.58×10^{-5}	4.29×10^{-8}	5.60×10^{-10}	2.24×10^{-13}
Target dissolver tank failure during plutonium-238 separation	1.76×10^{-7}	8.79×10^{-11}	0.00196	9.82×10^{-7}	1.09×10^{-8}	6.74×10^{-12}
Ion exchange explosion during plutonium-238 separation	4.68×10^{-4}	2.34×10^{-7}	5.23	0.00261	4.49×10^{-5}	1.79×10^{-8}
Plutonium-238 processing facility beyond-design-basis earthquake	163	0.163	8.91×10^{5}	445	1,310	1.00[c]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 8.98×10^{-5} and 4.49×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.213.

Table 4–142 New Research Reactor, Support Facility, and REDC Accident Risks Under Alternative 4 (Construct New Research Reactor)—Option 1

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual new research reactor risks			
Design-basis maximum hypothetical accident (1×10^{-4})	6.65×10^{-14}	1.41×10^{-10}	2.20×10^{-13}
Beyond-design-basis earthquake (1×10^{-5})	1.87×10^{-11}	1.41×10^{-7}	2.12×10^{-10}
Fuel-handling accident (0.01)	9.50×10^{-15}	3.60×10^{-11}	2.33×10^{-14}
Neptunium-237 target-handling accident (0.01)	2.71×10^{-13}	5.36×10^{-10}	9.72×10^{-13}
Medical isotope target-handling accident (0.01)	5.20×10^{-11}	5.12×10^{-7}	2.70×10^{-11}
35-year new research reactor risk	2.49×10^{-9}	2.29×10^{-5}	8.41×10^{-9}
Annual support facility risks			
Medical and industrial isotopes localized solvent fire (0.044)	4.32×10^{-7}	6.91×10^{-4}	9.41×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	3.75×10^{-7}	6.80×10^{-4}	2.04×10^{-6}
Medical and industrial isotopes glovebox explosion (0.01)	1.25×10^{-7}	2.30×10^{-4}	6.80×10^{-7}
35-year support facility risk	3.26×10^{-5}	0.056	9.85×10^{-5}
Annual REDC risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	3.06×10^{-14}	4.29×10^{-10}	2.24×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	8.79×10^{-13}	9.82×10^{-9}	6.74×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	2.34×10^{-9}	2.61×10^{-5}	1.79×10^{-10}
Plutonium-238 processing facility beyond-design-basis earthquake (1×10^{-5})	1.63×10^{-6}	0.00445	1.00×10^{-5}[c]
35-year REDC risk	5.71×10^{-5}	0.157	3.50×10^{-4}[c]
35-year Option risk	8.98×10^{-5}	0.213	4.49×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

There are no hazardous chemical accidents associated with the new research reactor or new support facility. The irradiation of neptunium-237, medical, industrial, and research and development isotopes in the new research reactor would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The fabrication and processing of medical, industrial, and research and development isotopes at the new support facility would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The hazardous chemical accident impacts at REDC are the same as those presented in Section 4.4.4.1.10.

4.6.1.2.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the REDC target fabrication facility at ORR. DOE would transport the unirradiated neptunium-237 targets from REDC to the reactor site. Following irradiation in the reactor, the targets would be returned to REDC for processing. After this processing, the plutonium-238 product would be shipped to LANL. The reactor would receive low enriched uranium fuel from a U.S. fuel fabrication facility. Additionally, medical and industrial isotopes would be shipped from the reactor site to a local airport, and from there to locations throughout the country.

Approximately 37,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 7.5 million kilometers (4.7 million miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

The transportation impact analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 29 person-rem; the dose to the public, 313 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.012 latent cancer fatality among transportation workers and 0.16 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.026. About half of the crew risk, about 2 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FDPF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting in 0.19 traffic fatality. Nearly all of the radiological and about 59 percent of the traffic accident risk would result from shipping medical and industrial isotopes.

4.6.1.2.12 Environmental Justice

Under this option, neptunium-237 targets would be irradiated in a new reactor that would be constructed at a site yet to be specified. Fabrication and processing of neptunium-237 targets for plutonium-238 production would be performed at REDC located at ORR. A new support facility would be constructed at an unspecified site for fabrication and processing targets not used for plutonium-238 production.

Activities at REDC were evaluated under other alternatives and options in this NI PEIS (e.g., Section 4.4.1.1.12) and found to pose no significant radiological or other risks to minority and low-income populations. The environmental analysis of operations at the new research reactor and support facility site shows that radiological and nonradiological risks to persons residing in the (hypothetical) potentially affected

area would not be significant. Unless there are patterns of food consumption among minority or low-income resident surrounding the actual site (yet to be determined) that would result in a significant ingestion of radiologically contaminated food, it is plausible that operations at the site would pose no significant risks to minority and low-income persons. However, evaluations of environmental justice are necessarily site-specific and cannot be performed in detail for unspecified locations. In the event that this option were selected for implementation and a specific site selected for the new research reactor and support facility, an additional evaluation of environmental justice at the reactor and support facility site during operation would be performed prior to implementation.

4.6.1.2.13 Waste Management

The expected annual generation of wastes that would be associated with the operation of a new research reactor to irradiate targets and a support facility to fabricate and process medical and industrial isotope targets and to meet research and development needs are provided in **Table 4–143**. These generation rates cannot be compared at this time with site treatment, storage, and disposal capacities because a DOE site has not yet been chosen for these facilities. Section 3.6.11.1 provides DOE site ranges for each waste type that include volume currently stored, projected generation, and for some wastes, disposal volume. Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.6.1.2.9 through 4.6.1.2.11.

Table 4–143 Estimated Waste Generation Rates of Operating a New Research Reactor and Support Facility Under Alternative 4 (Construct New Research Reactor)—Option 1

Waste Type[a]	Estimated Waste Generation for New Research Reactor (cubic meters per year)	Estimated Waste Generation for New Support Facility (cubic meters per year)
Transuranic	0	0
Low-level radioactive		
Liquid	<6	0
Solid	50	20
Mixed low-level radioactive	<0.5	4
Hazardous	4	<1
Nonhazardous		
Process wastewater	7,950	16[b]
Sanitary wastewater	11,600	8,300
Solid	250	80

a. See definitions in Appendix G.9.
b. Assumes process wastewater generated at the same rate as Hanford 300 facilities.
Note: To convert from cubic meters per year to cubic yards per year, multiply by 1.308; < means "less than."
Source: Appendix E; SAIC 2000.

Depending in part on decisions in the Records of Decision for the *Waste Management PEIS* (DOE 1997a), wastes could be treated and disposed of on site or at other DOE sites or commercial facilities. It is also assumed that transuranic waste, low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous waste would be treated, stored, and disposed of in accordance with current and developing site practices. No high-level radioactive waste would be associated with irradiating targets in the new research reactor, with target fabrication or processing in the new support facility, or with neptunium-237 target fabrication and processing at REDC. No transuranic waste would be associated with irradiating targets in the research reactor or with target fabrication and processing in the new support facility.

Currently, DOE sites that manage low-level radioactive waste treat and/or dispose of the waste on site or off site, either at another DOE facility or a commercial facility. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision issued on February 18, 2000 (65 FR 10061), states that for the management of low-level radioactive waste, minimal treatment will be performed at all sites, and disposal will continue, to the extent practicable, on site at INEEL, LANL, ORR, and SRS. In addition, Hanford and the Nevada Test Site will be available to all DOE sites for low-level radioactive waste disposal. Less than 210 cubic meters (275 cubic yards) of liquid low-level radioactive waste and 1,750 cubic meters (2,300 cubic yards) of solid low-level radioactive waste would be generated over a 35-year period as a result of target irradiation at the new research reactor. Target fabrication and processing at the new support facility would generate about 700 cubic meters (920 cubic yards) of solid low-level radioactive waste. The minor amounts of low-level radioactive waste (less than 10 cubic meters [13.1 cubic yards]) (Brunson 1999a) generated from the decontamination of the shipping containers used to transport neptunium-237 from SRS to REDC (or FDPF or FMEF, depending on the option) for storage could easily be managed under the existing waste management practices and are not included in the table.

Most of DOE's mixed low-level radioactive waste is being stored on site awaiting the development of treatment methods. DOE is subject to the requirements mandated by the Federal Facility Compliance Act of 1992, and most DOE facilities that currently store or generate mixed low-level radioactive waste have either a state-approved or EPA region-approved site treatment plan or another type of agreement. Each site treatment plan or agreement requires the treatment of mixed waste, including mixed low-level radioactive waste, in accordance with its provisions. The low-level radioactive waste and mixed low-level radioactive waste Record of Decision, issued on February 18, 2000 (65 FR 10061), states that mixed low-level radioactive waste will be treated at Hanford, INEEL, ORR, and SRS and disposed of at Hanford and the Nevada Test Site. Over the 35-year operational period, less than 18 cubic meters (24 cubic yards) of mixed low-level radioactive waste would be generated as a result of target irradiation at the new research reactor. Target fabrication and processing at the new support facility would generate about 140 cubic meters (180 cubic yards) of mixed low-level radioactive waste.

The hazardous waste Record of Decision, issued on August 5, 1998 (63 FR 41810), states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of nonwastewater hazardous waste, with ORR and SRS continuing to treat some of their own nonwastewater hazardous waste on site in existing facilities where this is economically favorable. Wastewater, which is about 99 percent of DOE's hazardous waste, is treated on site. An estimated 140 cubic meters (180 cubic yards) of hazardous waste would be generated during the 35-year operational period at the research reactor and less than 35 cubic meters (46 cubic yards) at the new support facility.

DOE currently manages sanitary and industrial waste on a site-by-site basis. Some DOE sites dispose of this waste in onsite landfills that have permits issued by appropriate state agencies, while other sites use commercial landfills (DOE 1997a:1-29). Solid waste such as office paper, metal cans, and plastic and glass bottles that can be recycled would be sent off site for that purpose. Over the 35-year operational period, an estimated 280,000 cubic meters (370,000 cubic yards) of process wastewater, 406,000 cubic meters (531,000 cubic yards) of sanitary wastewater, and 8,800 cubic meters (12,000 cubic yards) of solid nonhazardous waste would be generated as a result of target irradiation at the new research reactor. Target fabrication and processing at the new support facility would generate about 560 cubic meters (730 cubic yards) of process wastewater, 291,000 cubic meters (381,000 cubic yards) of sanitary wastewater, and 2,800 cubic meters (3,700 cubic yards) of solid nonhazardous waste.

The impacts of managing wastes associated with fabricating and processing neptunium-237 targets for plutonium-238 production in REDC at ORR are assumed to be the same as for Option 1 under Alternative 1

(Section 4.3.1.1.13). As shown in that section, the impacts on the waste management systems at ORR would be minimal.

4.6.1.2.14 Spent Nuclear Fuel Management

The operation of the proposed new research reactor would generate about 0.31 metric ton heavy metal (682 pounds) of spent nuclear fuel per year. This spent nuclear fuel would be stored at the spent nuclear fuel pool at the reactor site. The spent nuclear fuel pool would be designed to provide enough capacity for 35 years of operation, that is, have a total capacity of about 11 metric tons (24,200 pounds). No dry fuel storage is anticipated at the site; therefore there are no environmental impacts associated with the construction of a dry fuel storage facility. The environmental impacts associated with the normal operation of the proposed new research reactor (which includes spent nuclear fuel storage) would result in an annual dose to the maximally exposed individual member of the public of 6.6×10^{-5} millirem from total site operations. This dose is well below the EPA's Clean Air Act standard of 10 millirem per year that is cited in DOE Order 5400.5. The environmental impacts associated with spent nuclear fuel management would be small.

4.6.1.3 Decontamination and Decommissioning of the Research Reactor and Support Facility

The environmental impacts associated with the decontamination and decommissioning of the research reactor and support facility at the generic DOE site are assessed in this section.

4.6.1.3.1 Land Resources

LAND USE. Decontamination and decommissioning of a research reactor and support facility would not involve the removal of any major structures, although some smaller facilities and pieces of equipment could be removed. Thus, the industrial nature of the land would not change.

VISUAL RESOURCES. Decontamination and decommissioning of a research reactor and support facility would not impact visual resources since no major structures would be removed. Thus, the Visual Resource Management Class IV rating of the site would remain unchanged.

4.6.1.3.2 Noise

Decontamination and decommissioning of a reactor and support facility would result in some increase in noise levels from the use of construction type equipment, materials handling and impact equipment, employee vehicles, and truck traffic. Actual noise levels would depend on the decontamination and decommissioning activities selected. Noise from these activities, especially impulsive noise, would be expected to disturb wildlife in the immediate area of the facilities. The change in noise levels in areas outside the DOE site would depend on the location selected and the exact nature of the activities required. However, generally if the reactor and support facility location were within one of the larger DOE sites and were more centrally located within the site, offsite noise impacts from decontamination and decommissioning activities would be expected to be small. Employee vehicles and truck traffic would result in an increase in traffic noise along roads used to access the site. However, this increase in traffic noise would be small unless the decontamination and decommissioning traffic volume were as large as the traffic from facility operation and other site activities. Site-specific analysis would be conducted in tiered NEPA documentation if the reactor alternative were selected.

4.6.1.3.3 Air Quality

Deactivation and decommissioning of the new reactor and support facility would result in some change in the air quality impacts. However, they would not be expected to be higher than the impacts associated with construction and operation.

4.6.1.3.4 Water Resources

Decontamination and decommissioning of the research reactor and support facility would involve permanent shutdown, stabilization, and monitoring of the deactivated facilities. As a result, processing and auxiliary systems would be shutdown and process and sanitary wastewater discharges would cease from the vacated facilities. This would eliminate the annual discharge of approximately 7.9 million liters (2.1 million gallons) of nonradioactive process wastewater from the research reactor and 3.6 million liters (0.95 million gallons) from the support facility on an annual basis. The discharge of 11.6 million liters (3.07 million gallons) per year of sanitary wastewater from the research reactor and 8.3 million liters (2.2 million gallons) from the support facility would be eliminated to onsite treatment facilities. The effects of decontamination and decommissioning on waste management are further detailed in Section 4.6.1.3.13. Site water withdrawals to supply the facilities would also be reduced by approximately 807 million liters (213.1 million gallons) per year for the research reactor and 11.9 million liter (3.14 million gallons) for the support facility (Appendix E; SAIC 2000).

4.6.1.3.5 Geology and Soils

No major structures would be demolished to effect decontamination and decommissioning of the research reactor and support facility. Some ground disturbance could occur associated with removal of some smaller facilities and pieces of equipment. However, ground disturbance would be confined to previously disturbed areas immediately adjacent to the reactor complex and support facility, with the impact on geologic and soil resources expected to be negligible overall.

4.6.1.3.6 Ecological Resources

Since no major structures would be demolished during decontamination and decommissioning of a research reactor and support facility, the area would continue to be of limited value to wildlife. Noise from decontamination and decommissioning activities would be expected to disturb wildlife in the immediate area; however, this disturbance would be of limited duration. Water use would decrease at the generic site with the decommissioning of a research reactor and support facility. This would result in a decrease in impingement and entrainment of aquatic organisms, as well as a decrease in impacts from effluent discharge at a site where surface water bodies are used. At a site where water is withdrawn from groundwater and discharged to an evaporation pond, the cessation of discharge from a reactor and support facility could result in a reduction in the size of the pond or its possible elimination. This could, in turn, result in the loss (or elimination) of associated aquatic and terrestrial wildlife, as well as wetland habitat. The response of any threatened or endangered species to decontamination and decommissioning of a reactor and support facility could vary from positive (e.g., due to a decrease in human presence and emissions) to negative (e.g., due to the elimination of aquatic or wetland habitat), depending on the species involved.

4.6.1.3.7 Cultural and Paleontological Resources

Decontamination and decommissioning of a research reactor and support facility would not change the status of cultural and paleontological resources. Any required ground disturbance would be confined to previously disturbed areas immediately adjacent to the reactor and support facility.

4.6.1.3.8 Socioeconomics

Decommissioning of the research reactor and support facility would result in a negative impact on the socioeconomic characteristics of the DOE site at which they were located. This impact would depend on whether the candidate site was located near a large urbanized area or in a remote rural area. Since the population for the region of influence for a generic DOE site could range from nearly 2.0 million people for a site in a large metropolitan area, to less than 200,000 for a site in a small rural community, the socioeconomic impacts of decommissioning would vary greatly. If DOE were to select the new research reactor alternative, additional NEPA documentation would be required to evaluate the specific socioeconomic impacts of the decommissioning.

4.6.1.3.9 Public and Occupational Health and Safety—Normal Decontamination and Decommissioning Activities

Assessments of incremental radiological and chemical impacts associated with the decontamination and decommissioning of the research reactor and support facility are presented in this section. Supplemental information is provided in Appendix H.

During decontamination and decommissioning operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers are described below.

RADIOLOGICAL IMPACTS. In the *Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG-0586, (NRC 1988), NRC determined that the health impact to the public from the decommissioning of research reactors was "negligible." This statement was based on the analsyis of a 60-megawatt thermal light water pool reactor fueled with TRIGA fuel. The generic reactor facility used in the analysis of generic research reactor environmental impacts is a 50-megawatt thermal light water pool reactor fueled with TRIGA fuel. In the same NUREG, NRC also concluded that the public health impact from radiological releases associated with the decommissioning and decontamination of process facilities similar to the generic research reactor support facility was also "negligible." Based on these NRC conclusions, the environmental impact on the public health and safety from the routine release of radionuclides during the decontamination and decommissioning of the generic research reactor and its support facility addressed in this NI PEIS are deemed to be negligible.

A probability coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991).

Incremental doses to involved workers from decontamination and decommissioning operations are given in **Table 4–144**; these workers are defined as those directly associated with all decontamination and decommissioning activities. The incremental annual average dose to involved workers during decontamination and decommissioning operations at the research reactor would be 275 millirem; for support facility workers, the incremental annual average dose during decontamination and decommissioning operations would be 25 millirem. The incremental annual dose received by the total site workforce for each of these facilities is estimated to be 11 and 1 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from annual decontamination and decommissioning operations are included in Table 4–144. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

HAZARDOUS CHEMICAL IMPACTS. Limited impacts would result from hazardous chemicals associated with deactivation and decommissioning activities.

Table 4–144 Incremental Radiological Impacts on Involved Workers at the Generic DOE Site from the Research Reactor and Support Facility Decontamination and Decommissioning Activities Under All Options of Alternative 4 (Construct New Research Reactor)

Receptor—Involved Workers[a]	Generic Site Decontamination and Decommissioning Activities		
	Research Reactor	Research Reactor Support Facility	Total
Total dose (person-rem per year)	11[b]	1[b]	12
4-year latent cancer fatalities	0.018	0.0016	0.019
Average worker dose (millirem per year)	275	25	150
4-year latent cancer fatality risk	4.4×10^{-4}	4.0×10^{-5}	4.8×10^{-5}

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 40 badged workers.
Source: NRC 1988.

4.6.1.3.10 Public and Occupational Health and Safety—Decontamination and Decommissioning Accidents

Impacts from postulated accidents associated with the decontamination and decommissioning of the research reactor and support facility are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–145** and **4–146**, respectively.

Table 4–145 Research Reactor and Support Facility Decontamination and Decommissioning Accident Consequences Under All Options of Alternative 4 (Construct New Research Reactor)

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
Spent nuclear fuel cask drop	7.01×10^{-12}	3.51×10^{-15}	2.97×10^{-8}	1.48×10^{-11}	1.30×10^{-11}	5.20×10^{-15}
Reactor core tank vaporization	1.58×10^{-7}	7.85×10^{-11}	3.70×10^{-3}	1.85×10^{-6}	5.33×10^{-7}	2.13×10^{-10}

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
Source: Model results using MACCS2 (Chanin and Young 1997).

Table 4–146 Research Reactor and Support Facility Decontamination and Decommissioning Accident Risks Under All Options of Alternative 4 (Construct New Research Reactor)

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Spent nuclear fuel cask drop (5.0×10^{-6})	1.75×10^{-20}	7.40×10^{-17}	2.60×10^{-20}
Reactor core tank vaporization (1.0×10^{-4})	7.85×10^{-15}	1.85×10^{-10}	2.13×10^{-14}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
Source: Model results using MACCS2 (Chanin and Young 1997).

For a spent nuclear fuel cask drop, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.75×10^{-20} and 2.60×10^{-20}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 7.40×10^{-17}.

For a reactor core tank vaporization accident, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 7.85×10^{-15} and 2.13×10^{-14}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 1.85×10^{-10}.

There are no hazardous chemical accidents postulated during the decontamination and decommissioning phases of the new research reactor or the new support facility. Involved workers could experience industrial accidents commonly associated with these types of activities.

4.6.1.3.11 Environmental Justice

Environmental effects due to decontamination and decommissioning activities that would be expected to occur at the unspecified reactor and support facility site are addressed in Section 4.6.1.3. The environmental analysis of decontamination and decommissioning activities at the new reactor and support facility site shows that radiological and nonradiological risks to persons residing in the (hypothetical) potentially affected area are not significant. Unless there are patterns of food consumption among minority or low-income residents surrounding the actual site (yet to be determined) that would result in a significant ingestion of radiologically contaminated food, it is plausible that decontamination and decommissioning activities at the site would pose no significant risks to minority and low-income persons. However, evaluations of environmental justice are necessarily site-specific and cannot be performed in detail for unspecified locations. In the event that this option were selected for implementation and a specific site selected for the new research reactor and support facility, an additional evaluation of environmental justice at the reactor and support facility site during decontamination and decommissioning would be performed prior to implementation.

4.6.1.3.12 Waste Management

The decontamination and decommissioning of the new research reactor and support facility would generate numerous types of wastes. The materials that may be removed or stabilized as a result of decontamination and decommissioning would be managed and reused, recycled, or disposed of in accordance with applicable Federal and state regulations. No analysis of waste management impacts, however, can be formulated at this time. Once proposals concerning decontamination and decommissioning activities are developed, DOE will undertake any additional NEPA analysis that may be necessary or appropriate.

4.6.1.3.13 Spent Nuclear Fuel Management

The Nuclear Waste Policy Act of 1982, as amended, assigned to the Secretary of Energy the responsibility for the development of a geologic repository for the ultimate disposal of high-level radioactive waste and spent nuclear fuel. When such a repository is available, spent nuclear fuel would be transferred from nuclear reactor sites to the repository for disposal. Until a repository becomes available, spent nuclear fuel associated with the operation of the research reactor would be stored in the reactor pool. Upon cessation of research reactor operations, the reactor would be decontaminated and decommissioned. At that time, spent nuclear fuel stored in the pool would be packaged in acceptable containers and shipped to the geologic repository for disposal.

4.6.1.4 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.6.2 Alternative 4 (Construct New Research Reactor)—Option 2

Option 2 involves constructing and operating the research reactor to irradiate all targets associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating FDPF at INEEL to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and constructing and operating the support facility to fabricate and process the other targets and materials and to process the associated products. This option includes storage in Building CPP–651 or FDPF of the neptunium-237 transported to INEEL from SRS and storage in the new support facility of the other target materials transported to the generic site from other offsite facilities.

The transportation of the low enriched uranium fuel for use in the research reactor, the transportation of the neptunium-237 to INEEL and then to the generic site, the transportation of the other target materials to the generic site, and the transportation of all product materials following irradiation and postirradiation processing are also part of this option.

All options under this alternative include the decontamination and decommissioning of the research reactor and support facility at the generic site following their operating lifetimes, and also the permanent deactivation of FFTF at Hanford.

4.6.2.1 Construction of the New Research Reactor and Support Facility

The environmental impacts associated with the construction of a new research reactor and support facility at the generic DOE site are assessed in Section 4.6.1.1.

4.6.2.2 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.6.2.2.1 Land Resources

LAND USE. Impacts on land use associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.1.

Building CPP–651 and/or FDPF, which are located at INTEC, would be used for neptunium-237 storage, and FDPF would be used for target fabrication and processing. Use of these facilities would not change land use at the site since both are currently operating and their proposed use would be compatible with their present mission.

VISUAL RESOURCES. Impacts on visual resources associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.1.

All activities associated with neptunium-237 storage would take place within Building CPP–651 and/or FDPF, and target fabrication and processing in FDPF. Operations associated with the proposed mission would not result in any impact on visual resources or change in the current Visual Resource Management Class IV rating

of INTEC. This is because none of the anticipated operational impacts (e.g., air emissions) would be expected to affect this resource.

4.6.2.2.2 Noise

Noise impacts associated with operation of a research reactor and support facility are addressed in Section 4.6.1.2.2.

This option also involves using the Building CPP–651 and/or FDPF, both in the INTEC area of INEEL, for neptunium-237 target material storage, and FDPF for target fabrication and processing. Interior modifications of these facilities would be expected to result in little change in noise impacts on wildlife around this area. The operation of this facility would not be expected to result in any change in noise impacts on wildlife around the INTEC area and offsite noise impacts would be small because the nearest site boundary is 12 kilometers (7.5 miles) to the south. Operation would be expected to result in minimal change in noise impacts on people near the INEEL as a result of changes in employee and truck traffic levels.

4.6.2.2.3 Air Quality

Air quality impacts associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.3.

Impacts associated with this option at INEEL were determined to be the same as under Option 2 of Alternative 2 (Section 4.4.2.1.3).

The air quality impacts of transportation are presented in Section 4.6.2.2.11.

4.6.2.2.4 Water Resources

Impacts on water resources associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.4.

Building CPP–651 and/or the FDPF, which are both in the INTEC area of INEEL, would be used for neptunium-237 storage, with target fabrication and processing in support of plutonium-238 production conducted in FDPF. As existing facilities would be used, there would be no construction-related impacts on water bodies, floodplains, or on surface or groundwater quality. In addition, no measurable increase in water use is anticipated to support material storage, target fabrication for plutonium-238 production (Moor 1999). The only measurable increase would be an additional 23,000 liters (6,100 gallons) per year of process wastewater associated with target processing in FDPF (Kirkham 1999; Wham 1999c). There would be no radiological liquid effluent discharge to the environment under normal operations, and no measurable impact on water resources at INEEL is expected.

4.6.2.2.5 Geology and Soils

Impacts on geology and soils associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.5. As discussed in Section 4.6.1.1.5, the proposed facilities would be designed and constructed in accordance with DOE Order 420.1 and sited to minimize the risk from geologic hazards. Thus, site geologic conditions would be unlikely to affect the facilities.

The use of Building CPP–651 and/or FDPF for neptunium-237 storage, and FDPF for target fabrication and processing would not be expected to impact geologic resources, nor be jeopardized by large-scale geologic

conditions. Hazards from large-scale geologic conditions at INEEL, such as earthquakes and volcanoes, were previously evaluated in the *Storage and Disposition PEIS* (DOE 1996a:4-148) as discussed in Section 4.2.3.2.5. The analysis determined that these hazards present a low risk to long-term storage facilities. That analysis was reviewed in the SPD EIS (DOE 1999a:4-267-268). Further review of the data and analyses presented in these referenced documents and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions likewise present a low risk to the proposed use of the INTEC facilities. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.6.2.2.6 Ecological Resources

Impacts on ecological resources associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.6.

Building CPP–651 and/or FDPF would be used for neptunium-237 storage, and FDPF for target fabrication and processing. As noted in Section 4.6.2.2.2, there would be no change in noise impacts on wildlife. Because water usage and wastewater discharge would be small fractions of current values, there would be no impact on aquatic resources (Section 4.6.2.2.4). Threatened and endangered species would not be affected by operation because an existing facility(s) within an already developed area would be used.

4.6.2.2.7 Cultural and Paleontological Resources

Impacts on cultural and paleontological resources associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.7.

Although six historic structures are associated with INTEC, their status would not be affected by operation of Building CPP–651 and/or FDPF for neptunium-237 storage, and FDPF for target fabrication and processing. Also, the status of Native American and paleontological resources occurring in the vicinity of INTEC would not be affected by the operation of these facilities.

4.6.2.2.8 Socioeconomics

The socioeconomic impacts associated with the operation of the new research reactor and support facility at a generic DOE site are addressed in Section 4.6.1.2.8.

The socioeconomic impacts associated with neptunium-237 target fabrication and processing at INEEL are addressed in Section 4.3.2.1.8.

4.6.2.2.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup and operations are given in **Table 4–147** for the generic DOE site and INEEL: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public.

Radiological impacts from startup operations prior to fuel loading would be zero. After fuel loading, these impacts would be expected to be bounded by the normal operation impacts. Therefore, startup impacts have not been treated separately from normal operational impacts. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

Table 4–147 Incremental Radiological Impacts on the Public Around the Generic DOE Site and INEEL from Operational Facilities Under Alternative 4 (Construct New Research Reactor)—Option 2

Receptor	INEEL FDPF	Generic Site			Two-Site Total
		Research Reactor Operations	Reactor Support Facility Operations	Total	
Population within 80 kilometers (50 miles) in the year 2020					
Dose (person-rem)	3.9×10^{-6}	0.0022	0.14	0.14	0.14
35-year latent cancer fatalities	6.7×10^{-8}	3.9×10^{-5}	0.0025	0.0025	0.0025
Maximally exposed individual					
Annual dose (millirem)	2.6×10^{-7}	6.6×10^{-5}	0.0025	0.0025	NA[a]
35-year latent cancer fatality risk	4.6×10^{-12}	1.2×10^{-9}	4.4×10^{-8}	4.5×10^{-8}	NA[a]
Average exposed individual within 80 kilometers (50 miles)					
Annual dose[b] (millirem)	2.1×10^{-8}	1.4×10^{-6}	9.1×10^{-5}	9.2×10^{-5}	NA[a]
35-year latent cancer fatality risk	3.7×10^{-13}	2.5×10^{-11}	1.6×10^{-9}	1.6×10^{-9}	NA[a]

a. The annual natural background radiation level at INEEL is 362 millirem for the average individual; the population within 80 kilometers (50 miles) of FDPF in the year 2020 would receive 68,200 person-rem. The annual natural background radiation level at the generic site is estimated to range between 295 and 362 millirem for the average individual; the population within 80 kilometers (50 miles) in the year 2020 would receive between 68,200 and 334,600 person-rem.
b. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
c. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FDPF or the generic site in the year 2020 (188,400 and 1,538,100, respectively).
Key: NA, not applicable.
Source: Appendix E; model results, using the GENII computer code (Napier et al. 1988).

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

As a result of annual operations of the research reactor facilities and FDPF, the projected incremental total population dose in the year 2020 would be 0.14 person-rem; the corresponding number of latent cancer fatalities in the populations surrounding the generic DOE site and INEEL from 35 years of operations would be 0.0025. The incremental total dose to the maximally exposed member of the public from annual operations of the research reactor and support facility at the generic DOE site would be 0.0025 millirem; from 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 4.5×10^{-8}.

Incremental doses to involved workers from normal operations are given in **Table 4–148**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to research reactor workers during operations would be 100 millirem; for support facility workers, the incremental annual average dose during operations would be 102 millirem; for FDPF workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities is estimated to be 12, 12, and 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–148.

Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–148 Incremental Radiological Impacts on Involved Workers at the Generic DOE Site and INEEL from Operational Facilities Under Alternative 4 (Construct New Research Reactor)—Option 2

Receptor—Involved Workers[a]	INEEL FDPF	Generic Site		Two-Site Total
		Research Reactor Operations	Reactor Support Facility Operations	
Total dose (person-rem per year)	22[b]	12[b]	12[b]	46
35-year latent cancer fatalities	0.31	0.17	0.17	0.65
Average worker dose (millirem per year)	290	100	102	NA[c]
35-year latent cancer fatality risk	0.0041	0.0014	0.0014	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 75 badged workers at FDPF, 120 research reactor workers, and 120 workers at the reactor support facility.
c. Values cannot be given for the average worker because the workers would be in three different facilities at two different sites.
Key: NA, not applicable.
Source: LMER 1997:22; Wham 1999b; also see Table 4–139.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts associated with the operation of the research reactor and support facility are addressed in Section 4.6.1.2.9.

Impacts from hazardous chemicals at INEEL were determined to be the same as in Alternative 2, Option 2 (Section 4.4.2.1.9).

4.6.2.2.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with research reactor target irradiation; support facility medical, industrial, and research and development isotope fabrication and processing; and FDPF neptunium-237 target fabrication and processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–149** and **4–150**, respectively.

For 35 years of research reactor target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.49×10^{-9} and 8.41×10^{-9}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 2.29×10^{-5}.

For 35 years of support facility medical, industrial, and research and development target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 3.26×10^{-5} and 9.85×10^{-5}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.056.

For 35 years of FDPF neptunium-237 target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 1.49×10^{-5} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0287.

Table 4–149 New Research Reactor, Support Facility, and FDPF Accident Consequences Under Alternative 4 (Construct New Research Reactor)—Option 2

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
New research reactor accidents						
Design-basis maximum hypothetical accident	1.33×10^{-6}	6.65×10^{-10}	0.00283	1.41×10^{-6}	5.49×10^{-6}	2.20×10^{-9}
Beyond-design-basis earthquake	0.00373	1.87×10^{-6}	2.82	0.0141	0.0531	2.12×10^{-5}
Fuel-handling accident	1.90×10^{-9}	9.50×10^{-13}	7.26×10^{-6}	3.60×10^{-9}	5.83×10^{-9}	2.33×10^{-12}
Neptunium-237 target-handling accident	5.42×10^{-8}	2.71×10^{-11}	1.07×10^{-4}	5.36×10^{-8}	2.43×10^{-7}	9.72×10^{-11}
Medical isotope target-handling accident	1.04×10^{-5}	5.20×10^{-9}	0.102	5.12×10^{-5}	6.76×10^{-6}	2.70×10^{-9}
Support facility accidents						
Medical and industrial isotopes localized solvent fire	0.0194	9.72×10^{-6}	31.1	0.0156	0.00530	2.12×10^{-6}
Medical and industrial isotopes unlikely seismic event	0.0750	3.75×10^{-5}	136	0.0680	0.510	2.04×10^{-4}
Medical and industrial isotopes glovebox explosion	2.50	0.00125	4,600	2.30	17.0	0.00680
FDPF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.01×10^{-9}	1.01×10^{-12}	2.49×10^{-5}	1.24×10^{-8}	7.26×10^{-9}	2.91×0^{-12}
Target dissolver tank failure during plutonium-238 separation	6.11×10^{-8}	3.05×10^{-11}	5.65×10^{-4}	2.82×10^{-7}	2.17×10^{-7}	8.69×10^{-11}
Ion exchange explosion during plutonium-238 separation	1.63×10^{-5}	8.13×10^{-9}	0.150	7.51×10^{-5}	5.79×10^{-5}	2.31×10^{-8}
Plutonium-238 processing facility beyond-design-basis earthquake	42.5	0.0425	1.64×10^{5}	82.0	1,200	1.0[c]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 4.75×10^{-5} and 4.49×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.0848.

Table 4–150 New Research Reactor, Support Facility, and FDPF Accident Risks Under Alternative 4 (Construct New Research Reactor)—Option 2

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual new research reactor risks			
Design-basis maximum hypothetical accident (1×10^{-4})	6.65×10^{-14}	1.41×10^{-10}	2.20×10^{-13}
Beyond-design-basis earthquake (1×10^{-5})	1.87×10^{-11}	1.41×10^{-7}	2.12×10^{-10}
Fuel-handling accident (0.01)	9.50×10^{-15}	3.60×10^{-11}	2.33×10^{-14}
Neptunium-237 target-handling accident (0.01)	2.71×10^{-13}	5.36×10^{-10}	9.72×10^{-13}
Medical isotope target-handling accident (0.01)	5.20×10^{-11}	5.12×10^{-7}	2.70×10^{-11}
35-year new research reactor risk	2.49×10^{-9}	2.29×10^{-5}	8.41×10^{-9}
Annual support facility risks			
Medical and industrial isotopes localized solvent fire (0.044)	4.32×10^{-7}	6.91×10^{-4}	9.41×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	3.75×10^{-7}	6.80×10^{-4}	2.04×10^{-6}
Medical and industrial isotopes glovebox explosion (1.00×10^{-4})	1.25×10^{-7}	2.30×10^{-4}	6.80×10^{-7}
35-year support facility risk	3.26×10^{-5}	0.056	9.85×10^{-5}
Annual FDPF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	1.24×10^{-10}	2.91×10^{-14}
Target dissolver tank failure during plutonium-238 separation (0.01)	3.05×10^{-13}	2.82×10^{-9}	8.69×10^{-13}
Ion exchange explosion during plutonium-238 separation (0.01)	8.13×10^{-11}	7.51×10^{-7}	2.31×10^{-10}
Plutonium-238 processing facility beyond-design-basis earthquake (1×10^{-5})	4.25×10^{-7}	8.20×10^{-4}	1.00×10^{-5}[c]
35-year FDPF risk	1.49×10^{-5}	0.0287	3.50×10^{-4}[c]
35-year Option risk	4.75×10^{-5}	0.0848	4.49×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

There are no hazardous chemical accidents associated with the new research reactor or new support facility. The irradiation of neptunium-237, medical, industrial, and research and development isotopes in the new research reactor would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The fabrication and processing of medical, industrial, and research and development isotopes at the new support facility would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The hazardous chemical accident impacts at FDPF are the same as those presented in Section 4.4.5.1.10.

4.6.2.2.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the FDPF target fabrication facility at INEEL. DOE would transport the unirradiated neptunium-237 targets from FDPF to the reactor site. Following irradiation in the reactor, the targets would be returned to FDPF for processing. After this processing, the plutonium-238 product would be shipped to LANL. The reactor would receive low enriched uranium fuel from a U.S. fuel fabrication facility. Additionally, medical and industrial isotopes would be shipped from the reactor site to a local airport, and from there to locations throughout the country.

Approximately 37,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 7.8 million kilometers (4.9 million miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

The transportation impact analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 31 person-rem; the dose to the public, 339 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.013 latent cancer fatality among transportation workers and 0.17 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.027. About half of the crew risk, about 2 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FDPF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting in 0.19 traffic fatality. Nearly all of the radiological and about 59 percent of the traffic accident risk would result from shipping medical and industrial isotopes.

4.6.2.2.12 Environmental Justice

Under this option, neptunium-237 targets would be irradiated in a new reactor that would be constructed at a site yet to be specified. Fabrication and processing of neptunium-237 targets for plutonium-238 production would be performed at FDPF at INEEL. A new support facility would be constructed at an unspecified site for fabrication and processing targets not used for plutonium-238 production.

Activities at FDPF were evaluated under other alternatives and options in this NI PEIS (e.g., Section 4.4.2.1.12) and found to pose no significant radiological or other risks to minority and low-income populations. The environmental analysis of operations at the new research reactor and support facility site shows that radiological and nonradiological risks to persons residing in the (hypothetical) potentially affected

areas would not be significant. Unless there are patterns of food consumption among minority or low-income resident surrounding the actual site (yet to be determined) that would result in a significant ingestion of radiologically contaminated food, it is plausible that operations at the site would pose no significant risks to minority and low-income persons. However, evaluations of environmental justice are necessarily site-specific and cannot be performed in detail for unspecified locations. In the event that this option were selected for implementation and a specific site selected for the new research reactor and support facility, an additional evaluation of environmental justice at the reactor and support facility site during operation would be performed prior to implementation.

4.6.2.2.13 Waste Management

The impacts of managing wastes associated with the operation of a new research reactor to irradiate targets and a support facility to fabricate and process medical and industrial isotope targets and to meet research and development needs are assumed to be the same as for Option 1 (Section 4.6.1.2.13). Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.6.2.2.9 through 4.6.2.2.11.

The impacts of managing wastes associated with fabricating and processing neptunium-237 targets for plutonium-238 production in FDPF at INEEL are assumed to be the same as for Option 2 under Alternative 1 (Section 4.3.2.1.13). As shown in that section, the impacts on the waste management systems at INEEL would be minimal.

4.6.2.2.14 Spent Nuclear Fuel Management

The impacts associated with spent nuclear fuel management under this option would be the same as for Option 1, and are given in Section 4.6.1.2.14.

4.6.2.3 Decontamination and Decommissioning of the Research Reactor and Support Facility

The environmental impacts associated with the decontamination and decommissioning of the research reactor and support facility at the generic DOE site are assessed in Section 4.6.1.3.

4.6.2.4 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.6.3 Alternative 4 (Construct New Research Reactor)—Option 3

Option 3 involves construction and operating the research reactor to irradiate all targets associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating FMEF at Hanford to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and constructing and operating the support facility to fabricate and process the other targets and materials and to process the associated products. This option includes storage in FMEF of the neptunium-237 transported to Hanford from SRS and storage in the new support facility of the other target materials transported to the generic site from other offsite facilities.

The transportation of the low enriched uranium fuel for use in the research reactor, the transportation of the neptunium-237 to Hanford and then to the generic site, the transportation of the other target materials to the generic site, and the transportation of the product materials following irradiation and postirradiation processing are also part of this option.

All options under this alternative include the contamination and decommissioning of the research reactor and support facility at the generic DOE site following their operating lifetimes, and also the permanent deactivation of FFTF at Hanford.

4.6.3.1 Construction of the New Research Reactor and Support Facility

Environmental impacts associated with the construction of a new research reactor and support facility at the generic DOE site are assessed in Section 4.6.1.1.

4.6.3.2 Operations and Transportation

The environmental impacts associated with storage, processing, and irradiation operations, and with all transportation activities, are assessed in this section.

4.6.3.2.1 Land Resources

LAND USE. Impacts on land use associated with the operation of a reactor and support facility are addressed in Section 4.6.1.2.1.

FMEF would be used for neptunium-237 storage, target fabrication, and processing. Land use within the 400 Area would not change since the use of FMEF would be compatible with the mission for which it was designed.

VISUAL RESOURCES. Impacts on visual resources associated with the operation of a reactor and support facility are addressed in Section 4.6.1.2.1.

All activities associated with neptunium-237 storage, target fabrication, and processing would take place within FMEF. Operations associated with the proposed mission would not result in any impact on visual resources or change in the current Visual Resource Management Class IV rating of the 400 Area. This is because none of the anticipated operational impacts (e.g., air emissions) would be expected to affect this resource.

4.6.3.2.2 Noise

Noise impacts associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.2.

This option also involves using FMEF for target material storage, target fabrication, and processing. Activities associated with construction of a new stack would be typical of small construction projects and would result in some temporary increase in noise. Noise sources associated with this construction would not be expected to be loud impulsive sources and would not be expected to result in disturbance of wildlife around the 400 Area. The operation of FMEF would not be expected to result in any change in noise impacts on wildlife around the 400 Area and offsite noise impacts would also be minor because the nearest site boundary is 7 kilometers (4.3 miles) to the east. Operation would be expected to result in minimal change in noise impacts on people near Hanford as a result of changes in employee and truck traffic levels.

4.6.3.2.3 Air Quality

Air quality impacts associated with the operation of the new research reactor and support facility are addressed in Section 4.6.1.2.3.

Air quality impacts at Hanford associated with this option were determined to be the same as in Alternative 2, Option 3 (Section 4.4.3.1.3).

The air quality impacts of transportation are presented in Section 4.6.3.2.11.

4.6.3.2.4 Water Resources

Impacts on water resources associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.4.

FMEF in the 400 Area of Hanford would be used for neptunium-237 storage, target fabrication, and processing in support of plutonium-238 production. The operation of FMEF for this purpose would be likely to increase groundwater withdrawals in the 400 Area by approximately 19 million liters (5 million gallons). This includes approximately 15 million liters (4 million gallons) per year to support FMEF cooling needs and an additional 3.8 million liters (1 million gallons) per year for potable and sanitary water demands due to increased staffing. However, no impact on regional groundwater levels would be expected from increased withdrawals. FMEF groundwater usage would constitute an increase of about 10 percent over the 197 million liters (52 million gallons) withdrawn annually in the 400 Area during standby operations. Sanitary wastewater discharges from FMEF would also increase by roughly 3.8 million liters (1 million gallons) per year to the Energy Northwest treatment system, which has sufficient capacity. Also, the operation of FMEF for target fabrication and processing would generate approximately 15 million liters (4 million gallons) per year of process wastewater. This wastewater would be discharged to the 400 Area process sewer system and ultimately to the 400 Area Pond (i.e., 4608 B/C percolation ponds) (DOE 2000a:B-3; Nielsen 1999:38, 39, 41). As discharges to the pond are regulated under State Waste Discharge Permit No. ST-4501 and there are no radiological liquid effluent pathways to the environment from FMEF, the impact on groundwater quality would be negligible.

Waste management aspects of this option and their effects are further discussed in Section 4.6.3.2.13.

4.6.3.2.5 Geology and Soils

Impacts on geology and soils associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.5. As discussed in Section 4.6.1.1.5, the proposed facilities would be designed and constructed in accordance with DOE Order 420.1 and sited to minimize the risk from geologic hazards. Thus, site geologic conditions would be unlikely to affect the facilities.

The use of FMEF for neptunium-237 storage, target fabrication, and processing would not be expected to impact geologic resources, nor be jeopardized by large-scale geologic conditions. Hazards from large-scale geologic conditions at Hanford, such as earthquakes and volcanoes, were previously evaluated in the *Storage and Disposition PEIS* (DOE 1996a: 4-45) as discussed in Section 4.2.4.2.5. The analysis determined that these hazards present a low risk to long-term storage facilities. That analysis was reviewed in the SPD EIS (DOE 1999a:4-260). Further review of the data and analyses presented in these referenced documents and the site-specific data presented in this NI PEIS indicates that the large-scale geologic conditions likewise present a low risk to FMEF operations. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.6.3.2.6 Ecological Resources

Impacts on ecological resources associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.6.

This option also involves using FMEF for neptunium-237 storage, target fabrication, and processing. As noted in Section 4.6.3.2.2, there would be no loud noises that would disturb wildlife. Because water usage and wastewater discharge would be small fractions of current values, there would be no change in impacts on aquatic habitat or wetlands associated with the Columbia River (Section 4.6.3.2.4). Threatened and endangered species would not be affected by operation because an existing facility within an already developed area would be used.

4.6.3.2.7 Cultural and Paleontological Resources

Impacts on cultural and paleontological resources associated with the operation of a research reactor and support facility are addressed in Section 4.6.1.2.7.

Neptunium-237 storage, target fabrication, and processing would take place at FMEF, which is in the 400 Area. No prehistoric, historic, or paleontological sites have been identified either within the 400 Area or within 2 kilometers (1.2 miles) of the 400 Area. Six buildings located within the 400 Area, including two FFTF structures (the Reactor Containment Building and FFTF Control Building), have been determined to be eligible for the National Register as contributing properties within the Historic District recommended for mitigation. The operation of FMEF would not affect the status of these structures. No Native American resources are known to occur within the 400 Area.

4.6.3.2.8 Socioeconomics

The socioeconomic impacts associated with the operation of a new research reactor and support facility at a generic DOE site are addressed in Section 4.6.1.2.8.

The socioeconomic impacts associated with neptunium-237 target fabrication and processing at Hanford are the same as those addressed in Section 4.4.3.1.8.

4.6.3.2.9 Public and Occupational Health and Safety—Normal Operations

Assessments of incremental radiological and chemical impacts associated with this option are presented in this section. Supplemental information is provided in Appendix H.

During normal operations, there would be incremental radiological and hazardous chemical releases to the environment and also incremental direct in-plant exposures. The resulting doses and potential health effects to the public and workers for this option are described below.

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup and operations are given in **Table 4–151** for the generic DOE site and Hanford: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. Radiological impacts from startup operations prior to fuel loading would be zero. After fuel loading, these impacts would be expected to be bound by the normal operational impacts. Therefore, startup impacts have not been treated separately from normal operational impacts. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

A probability coefficient of 5×10^{-4} latent cancer fatality per rem is applied for the public, and a coefficient of 4×10^{-4} latent cancer fatality per rem is applied for workers (ICRP 1991). The value for workers is lower due to the absence of children and the elderly, who are more radiosensitive.

Table 4–151 Incremental Radiological Impacts on the Public Around the Generic DOE Site and Hanford from Operational Facilities Under Alternative 4 (Construct New Research Reactor)—Option 3

Receptor	Hanford FMEF	Generic Site			Two-Site Total
		Research Reactor Operations	Reactor Support Facility Operations	Total	
Population within 80 kilometers (50 miles) in the year 2020					
Dose (person-rem)	4.4×10^{-5}	0.0022	0.14	0.14	0.14
35-year latent cancer fatalities	7.7×10^{-7}	3.9×10^{-5}	0.0025	0.0025	0.0025
Maximally exposed individual					
Annual dose (millirem)	4.7×10^{-7}	6.6×10^{-5}	0.0025	0.0025	NA[a]
35-year latent cancer fatality risk	8.2×10^{-12}	1.2×10^{-9}	4.4×10^{-8}	4.4×10^{-8}	NA[a]
Average exposed individual within 80 kilometers (50 miles)					
Annual dose[b] (millirem)	8.9×10^{-8}	1.4×10^{-6}	9.1×10^{-5}	9.2×10^{-5}	NA[a]
35-year latent cancer fatality risk	1.6×10^{-12}	2.5×10^{-11}	1.6×10^{-9}	1.6×10^{-9}	NA[a]

a. A "Total" cannot be given in this case because the same individual cannot be located at two different sites simultaneously.
b. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FMEF or the generic site in the year 2020 (494,400 and 1,538,100, respectively).
Key: NA, not applicable.
Source: Appendix E; model results, using the GENII computer code (Napier et al. 1988).

As a result of annual operations of the research reactor facilities and FMEF, the projected incremental total population dose in the year 2020 would be 0.14 person-rem; the corresponding number of latent cancer fatalities in the populations surrounding the generic DOE site and Hanford from 35 years of operations would be 0.0025. The incremental total dose to the maximally exposed member of the public from annual operations of the research reactor and support facility at the generic DOE site would be 0.0025 millirem; from 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 4.8×10^{-8}.

Incremental doses to involved workers from normal operations are given in **Table 4–152**; these workers are defined as those directly associated with all process activities. The incremental annual average dose to research reactor workers during operations would be 100 millirem; for support facility workers, the incremental annual average dose during startup and operations would be 102 millirem; for FMEF workers, the incremental annual average dose would be approximately 290 millirem. The incremental annual dose received by the total site workforce for each of these facilities is estimated to be 12, 12, and 22 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–152. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–152 Incremental Radiological Impacts on Involved Workers at the Generic DOE Site and Hanford from Operational Facilities Under Alternative 4 (Construct New Research Reactor)—Option 3

Receptor—Involved Workers [a]	Hanford FMEF	Generic Site		One- or Two-Site Total
		Research Reactor Operations	Reactor Support Facility Operations	
Total dose (person-rem per year)	22[b]	12[b]	12[b]	46
35-year latent cancer fatalities	0.31	0.17	0.17	0.65
Average worker dose (millirem per year)	290	100	102	NA[c]
35-year latent cancer fatality risk	0.0041	0.0014	0.0014	NA[c]

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 1994). To reduce doses to levels that are as low as is reasonably achievable (ALARA), an effective ALARA program would be enforced.
b. Based on an estimated 75 badged workers at FMEF, 120 research reactor workers, and 120 workers at the reactor support facility.
c. Values cannot be given for the average worker because the workers would be in three different facilities at two different sites.
Key: NA, not applicable.
Source: LMER 1997:22; Wham 1999b.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts associated with the operation of the research reactor and support facility are addressed in Section 4.6.1.2.9.

Impacts from hazardous chemicals at Hanford were determined to be the same as in Alternative 2, Option 3 (Section 4.4.3.1.9).

4.6.3.2.10 Public and Occupational Health and Safety—Facility Accidents

Impacts from postulated accidents associated with research reactor target irradiation; support facility medical, industrial, and research and development isotope fabrication and processing; and FMEF neptunium-237 target fabrication and processing are presented in this section. Detailed descriptions of the accident analyses are provided in Appendix I.

Consequences and associated risks are presented in **Tables 4–153** and **4–154**, respectively.

For 35 years of research reactor target irradiation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 2.49×10^{-9} and 8.41×10^{-9}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 2.29×10^{-5}.

For 35 years of support facility medical, industrial, and research and development target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 3.26×10^{-5} and 9.85×10^{-5}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.056.

For 35 years of FMEF neptunium-237 target fabrication and processing, the increased risk of a latent cancer fatality to the maximally exposed individual and of an early fatality to a noninvolved worker would be 2.88×10^{-6} and 3.50×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.112.

Table 4–153 New Research Reactor, Support Facility, and FMEF Accident Consequences Under Alternative 4 (Construct New Research Reactor)—Option 3

Accident	Maximally Exposed Offsite Individual		Population to 80 Kilometers (50 Miles)		Noninvolved Worker	
	Dose (rem)	Latent Cancer Fatality[a]	Dose (person-rem)	Latent Cancer Fatalities[b]	Dose (rem)	Latent Cancer Fatality[a]
New research reactor accidents						
Design-basis maximum hypothetical accident	1.33×10^{-6}	6.65×10^{-10}	0.00283	1.41×10^{-6}	5.49×10^{-6}	2.20×10^{-9}
Beyond-design-basis earthquake	0.00373	1.87×10^{-6}	2.82	0.0141	0.0531	2.12×10^{-5}
Fuel-handling accident	1.90×10^{-9}	9.50×10^{-13}	7.26×10^{-6}	3.60×10^{-9}	5.83×10^{-9}	2.33×10^{-12}
Neptunium-237 target-handling accident	5.42×10^{-8}	2.71×10^{-11}	1.07×10^{-4}	5.36×10^{-8}	2.43×10^{-7}	9.72×10^{-11}
Medical isotope target- handling accident	1.04×10^{-5}	5.20×10^{-9}	0.102	5.12×10^{-5}	6.76×10^{-6}	2.70×10^{-9}
Support facility accidents						
Medical and industrial isotopes localized solvent fire	0.0194	9.72×10^{-6}	31.1	0.0156	0.00530	2.12×10^{-6}
Medical and industrial isotopes unlikely seismic event	0.0750	3.75×10^{-5}	136	0.0680	0.510	2.04×10^{-4}
Medical and industrial isotopes glovebox explosion	2.50	0.00125	4,600	2.30	17.0	0.00680
FMEF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.02×10^{-9}	1.01×10^{-12}	7.26×10^{-5}	3.63×10^{-8}	6.65×10^{-10}	2.66×10^{-13}
Target dissolver tank failure during plutonium-238 separation	4.64×10^{-8}	2.32×10^{-11}	0.00169	8.47×10^{-7}	1.95×10^{-8}	7.81×10^{-12}
Ion exchange explosion during plutonium-238 separation	1.24×10^{-5}	6.18×10^{-9}	0.451	2.25×10^{-4}	5.20×10^{-6}	2.08×10^{-9}
Plutonium-238 processing facility beyond-design-basis earthquake	16.5	0.0165	6.41×10^{5}	321	921	1.0[c]

a. Likelihood of a latent cancer fatality.
b. Number of latent cancer fatalities.
c. Early fatality due to radiation dose. A radiation dose of 450 to 500 rem causes fatalities in 50 percent of those exposed. Early fatalities are expected for exposures greater than 600 rem.

Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes

For 35 years under this option, the increased risk of a latent cancer fatality to the maximally exposed individual and of a fatality to a noninvolved worker would be 3.55×10^{-5} and 4.49×10^{-4}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.168.

Table 4–154 New Research Reactor, Support Facility, and FMEF Accident Risks Under Alternative 4 (Construct New Research Reactor)—Option 3

Accident (Frequency)	Maximally Exposed Offsite Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual new research reactor risks			
Design-basis maximum hypothetical accident (1×10^{-4})	6.65×10^{-14}	1.41×10^{-10}	2.20×10^{-13}
Beyond-design-basis earthquake (1×10^{-5})	1.87×10^{-11}	1.41×10^{-7}	2.12×10^{-10}
Fuel-handling accident (0.01)	9.50×10^{-15}	3.60×10^{-11}	2.33×10^{-14}
Neptunium-237 target-handling accident (0.01)	2.71×10^{-13}	5.36×10^{-10}	9.72×10^{-13}
Medical isotope target-handling accident (0.01)	5.20×10^{-11}	5.12×10^{-7}	2.70×10^{-11}
35-year new research reactor risk	2.49×10^{-9}	2.29×10^{-5}	8.41×10^{-9}
Annual support facility risks			
Medical and industrial isotopes localized solvent fire (0.044)	4.32×10^{-7}	6.91×10^{-4}	9.41×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	3.75×10^{-7}	6.80×10^{-4}	2.04×10^{-6}
Medical and industrial isotopes glovebox explosion (0.01)	1.25×10^{-7}	2.30×10^{-4}	6.80×10^{-7}
35-year support facility risk	3.26×10^{-5}	0.056	9.85×10^{-5}
Annual FMEF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	3.63×10^{-10}	2.66×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	2.32×10^{-13}	8.47×10^{-9}	7.81×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	6.18×10^{-11}	2.25×10^{-6}	2.08×10^{-11}
Plutonium-238 processing facility beyond-design-basis earthquake (1×10^{-5})	8.23×10^{-8}	0.00321	1.00×10^{-5}[c]
35-year FMEF risk	2.88×10^{-6}	0.112	3.50×10^{-4}[c]
35-year Option risk	3.55×10^{-5}	0.168	4.94×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

There are no hazardous chemical accidents associated with the new research reactor or new support facility. The irradiation of neptunium-237, medical, industrial, and research and development isotopes in the new research reactor would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The fabrication and processing of medical, industrial, and research and development isotopes at the new support facility would not require the use of hazardous chemicals in amounts that exceed the Threshold Planning Quantities on the Extremely Hazardous Substances List (EPA 1998).

The hazardous chemical accident impacts at FMEF are the same as those presented in Section 4.4.6.1.10.

4.6.3.2.11 Public and Occupational Health and Safety—Transportation

DOE would transport neptunium-237 from storage at SRS to the FMEF target fabrication facility at Hanford. DOE would transport the unirradiated neptunium-237 targets from FMEF to the reactor site. Following irradiation in the reactor, the targets would be returned to FMEF for processing. After this processing, the plutonium-238 product would be shipped to LANL. The reactor would receive low enriched uranium fuel from a U.S. fuel fabrication facility. Additionally, medical and industrial isotopes would be shipped from the reactor site to a local airport, and from there to locations throughout the country.

Approximately 37,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 8.2 million kilometers (5.1 million miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

The transportation impact analysis is described in detail in Appendix J.

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 34 person-rem; the dose to the public, 382 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.013 latent cancer fatality among transportation workers and 0.19 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.028. About half of the crew risk, about 2 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of irradiated neptunium-237 targets to FDPF with a severity Category V accident in an urban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.61 person-rem to the public with an associated 3.1×10^{-4} latent cancer fatality, and 2.6 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.3×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated) or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting in 0.20 traffic fatality. Nearly all of the radiological and about 57 percent of the traffic accident risk would result from shipping medical and industrial isotopes.

4.6.3.2.12 Environmental Justice

Under this option, neptunium-237 targets would be irradiated in a new reactor that would be constructed at a site yet to be specified. Fabrication and processing of neptunium-237 targets for plutonium-238 production would be performed at FMEF at Hanford. A new support facility would be constructed at an unspecified site for fabrication and processing targets not used for plutonium-238 production.

Activities at FMEF were evaluated under other alternatives and options in this NI PEIS (e.g., Section 4.4.3.1.12) and were found to pose no significant radiological or other risks to minority and low-income populations. The environmental analysis of operations at the new research reactor and support facility site shows that radiological and nonradiological risks to persons residing in the (hypothetical) potentially

affected areas would not be significant. Unless there are patterns of food consumption among minority or low-income residents surrounding the actual site (yet to be determined) that would result in a significant ingestion of radiologically contaminated food, it is plausible that operations at the site would pose no significant risks to minority and low-income persons. However, evaluations of environmental justice are necessarily site-specific and cannot be performed in detail for unspecified locations. In the event that this option were selected for implementation and a specific site selected for the new research reactor and support facility, then an additional evaluation of environmental justice at the reactor and support facility site during operation would be performed prior to implementation.

4.6.3.2.13 Waste Management

The impacts of managing wastes associated with the operation of a new research reactor to irradiate targets and a support facility to fabricate and process medical and industrial isotope targets and to meet research and development needs are assumed to be the same as for Option 1 (Section 4.6.1.2.13). Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.6.3.2.9 through 4.6.3.2.11.

The impacts of managing wastes associated with fabricating and processing neptunium-237 targets for plutonium-238 production in FMEF at Hanford are assumed to be the same as for Option 3 under Alternative 1 (Section 4.3.3.1.13). As shown in that section, the impacts on the waste management systems at Hanford would be minimal.

4.6.3.2.14 Spent Nuclear Fuel Management

The impacts associated with spent nuclear fuel management under this option would be the same as for Option 1, and are given in Section 4.6.1.2.14.

4.6.3.3 Decontamination and Decommissioning of the Research Reactor and Support Facility

The environmental impacts associated with the decontamination and decommissioning of the research reactor and support facility at the generic DOE site are assessed in Section 4.6.1.3.

4.6.3.4 Permanent Deactivation of FFTF

The environmental impacts associated with permanently deactivating FFTF are addressed in Section 4.4.1.2.

4.7 ALTERNATIVE 5—PERMANENTLY DEACTIVATE FFTF (WITH NO NEW MISSIONS)

Under Alternative 5, DOE would permanently deactivate FFTF at Hanford with no new missions. Medical and industrial isotope production and nuclear research and development missions at the existing facilities, as described in Chapter 3, Affected Environment, would continue. DOE's nuclear facilities infrastructure would not be enhanced. Plutonium-238 required to support future U.S. space missions could be purchased from Russia. The environmental impacts associated with FFTF deactivation are addressed in Section 4.4.1.2.

4.8 CUMULATIVE IMPACTS

The projected incremental environmental impacts of (1) constructing (as necessary) and operating the proposed facilities to store, fabricate, irradiate, and process the various targets addressed in this NI PEIS for 35 years; (2) deactivating FFTF; and (3) decommissioning the accelerator(s), research reactor, and support facility were added to the environmental impacts of other past, present, and reasonably foreseeable future actions at or near the candidate sites to obtain cumulative site impacts. The other past and present site activities are included in the baseline impacts presented in Chapter 3. Cumulative transportation impacts were determined by analyzing the impacts along the various routes used to transport the materials associated with nuclear infrastructure activities over the 35-year period. The methodology for assessing cumulative impacts is presented in Section G.10.

In this section, cumulative site impacts are presented only for those "resources" at a site that may reasonably be expected to be affected by the storage, fabrication, irradiation, and processing of the various targets. These include site employment, electrical consumption, water usage, air quality, waste management, and public and occupational health and safety. This section also includes the cumulative impacts associated with intersite transportation.

Impacts of the following are considered in the cumulative site impacts assessment:

- Current (baseline) activities at or in the vicinity of the candidate sites.
- Other onsite and offsite activities that are reasonably foreseeable and documented.
- Construction (as necessary) and operation of the proposed facilities to fabricate, irradiate, and process targets.

Activities whose impacts are contained in cumulative site impacts include, but are not limited to, operation of the Spallation Neutron Source Facility at ORR, implementation of the Advanced Mixed Waste Treatment Project at INEEL, and remediation of the high-level waste tanks at Hanford.

Details of activities that may be implemented in the foreseeable future at any of the nuclear infrastructure candidate sites and evaluated in the cumulative impacts assessment are given in the following documents:

- *Surplus Plutonium Disposition Final Environmental Impact Statement* (DOE 1999a) (Record of Decision Issued)

- *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE 1996a) (Record of Decision issued)

- *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE 1996b) (Record of Decision issued)

- *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (DOE 1995b) (Record of Decision issued)

- *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE 1997a) (Final EIS issued; Records of Decision issued for the various waste types)

- *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995c) (Record of Decision issued)

- *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel* (DOE 1996c) (Record of Decision issued)

- *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE 1996d) (Record of Decision issued)

- *Advanced Mixed Waste Treatment Project Final Environmental Impact Statement* (DOE 1999c) (Record of Decision issued)

- *Final Environmental Impact Statement for the Tank Waste Remediation System, Hanford Site, Richland, Washington* (DOE 1996e) (Record of Decision issued)

- *Hanford Reach of the Columbia River Comprehensive River Conservation Study and Environmental Impact Statement* (NPS 1994) (Record of Decision issued)

- *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999d)

- *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel* (DOE 2000b)

- *Final Environmental Impact Statement, Construction and Operation of the Spallation Neutron Sources* (DOE 1999e) (Record of Decision issued)

- *Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (DOE 1999f) (Record of Decision issued)

- *Idaho High-Level Waste and Facilities Disposition Draft Environmental Impact Statement* (DOE 1999g)

- *Final Environmental Impact Statement for Treating Transuranic (TRU)/Alpha Low-Level Waste at the Oak Ridge National Laboratory* (DOE 2000c) (Record of Decision issued)

- *Environmental Assessment Melton Valley Storage Tanks Capacity Increase Project—Oak Ridge National Laboratory* (DOE/EA-1044 and FONSI, April 1995d)

- *Management of Spent Nuclear Fuel on the Oak Ridge Reservation* (DOE/EA-1117 and FONSI, February 1996f)

- *Environmental Assessment for Transportation of Low-Level Radioactive Waste from the Oak Ridge Reservation to Off-Site Treatment or Disposal Facilities* (DOE/EA-1315, draft EA April 2000d)

- *Environmental Assessment for Transportation of Mixed Low-Level Radioactive Waste from the Oak Ridge Reservation to Off-Site Treatment or Disposal Facilities* (DOE/EA-1317, draft EA in progress 2000e)

- *Environmental Assessment for the Selection and Operation of the Proposed Field Research Centers for the NABIR (Natural and Accelerated Bioremediation Field Research Center) Program* (DOE 2000f) (FONSI issued April 2000).

The related programs included in the cumulative impact assessment for the potentially affected candidate sites are identified in **Table 4–155**.

Table 4–155 Other Past, Present, and Reasonably Foreseeable Actions Considered in the Cumulative Impact Assessment

Activities	ORR	INEEL	Hanford
Disposition of Surplus Plutonium		X	X
Storage and Disposition of Weapons-Usable Fissile Materials	X	X	X
Disposition of Surplus Highly Enriched Uranium	X		
Waste Management PEIS	X	X	X
Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management	X	X	X
Foreign Research Reactor Spent Nuclear Fuel Management		X	X
Stockpile Stewardship and Management	X		
Tank Waste Remediation			X
Radioactive Releases from WNP Nuclear Power Plant			X
Hanford Reach of the Columbia River Comprehensive River Conservation Study			X
Hanford Comprehensive Land Use Plan			X
Advanced Mixed Waste Treatment Project		X	
Treatment and Management of Sodium-Bonded Spent Nuclear Fuel		X	
Construction and Operation of the Spallation Neutron Source	X		
Long-Term Management and Use of Depleted Uranium Hexafluoride	X		
Treatment and Shipment of Transuranic Waste	X		
Management of Liquid Low-Level Radioactive Waste	X		
Management of Spent Nuclear Fuel	X		
Transportation of Low-Level Radioactive Waste to Offsite Treatment or Disposal	X		
Transportation of Mixed Low-Level Radioactive Waste to Offsite Treatment or Disposal	X		
Natural and Accelerated Bioremediation Field Research Center Assessment	X		
High-Level Waste and Facilities Disposition		X	

Source: Literature review.

In the tables that are included in the following sections, existing site activities are combined with reasonably foreseeable activities at each site and presented under the heading "Site Activities." Activities associated with nuclear infrastructure operations are not included under "Site Activities." The impacts associated with the construction (as necessary), operation, and decommissioning or deactivation (as necessary) of the proposed target fabrication, irradiation, and processing facilities are shown as "New Nuclear Infrastructure Operations."

A bounding option was analyzed for each site. The bounding option is the option that would involve the greatest amounts of operational activities and associated environmental impacts at the candidate site. For example, the bounding option for ORR is Option 7 of Alternative 2, under which both HFIR and REDC operations would be involved in plutonium-238 production.

In addition to reasonably foreseeable site activities, other activities within the regions of the candidate sites were considered in the cumulative impact analysis for the selected resources. However, because of the

distances between the candidate sites and these other existing and planned facilities, there is little opportunity for interactions among them.

4.8.1 Cumulative Impacts at ORR

For ORR, the bounding option for this NI PEIS is Option 7 of Alternative 2. This option calls for the operation of HFIR to irradiate neptunium-237 targets and the operation of REDC to fabricate and process these targets. The impacts associated with HFIR and REDC operations for other missions are included in "site activities."

4.8.1.1 Resource Requirements

Cumulative impacts on resource requirements at ORR are presented in **Table 4–156**. ORR would remain within its site capacity for all major resources. If Option 7 of Alternative 2 were implemented, the proposed nuclear infrastructure facilities would require essentially no change in the site's use of electricity or water. There would be no additional land disturbance or development. Cumulatively, ORR would use approximately 36 percent of its available land, 9 percent of its electrical capacity, and 36 percent of its water capacity. Site employment would increase by approximately 41 workers.

Table 4–156 Maximum Cumulative Resource Use and Impacts at ORR

Resource	Site Activities[a]	New Nuclear Infrastructure Operations	Cumulative Total	Total Site Capacity
Site employment	3,467	41[b]	3,508	NA
Electrical consumption (megawatt-hours per year)	1,276,380	Negligible[c]	~1,276,380	13,880,000
Developed land (hectares)	4,966	0	4,966	13,794
Water usage (million liters per year)	15,802	Negligible[c]	~15,802	44,348

a. Environmental impacts associated with past, present, and reasonably foreseeable future activities, but not including impacts associated with nuclear infrastructure activities.
b. Some, or all of these worker requirements, may be filled by the reassignment of the existing site workforce.
c. Electrical consumption and water usage associated with this option would be negligible compared to that associated with other activities at ORR.

Note: To convert from hectares to acres, multiply by 2.47; to convert from liters per year to gallons per year, multiply by 0.264; to convert from megawatt-hours to British thermal units, multiply by 3.42×10^6; ~ means "approximately," and indicates that the cumulative impacts are virtually the same as those associated with other "site activities" because new nuclear infrastructure operations would contribute only minimally.
Key: NA, not applicable.
Source: DOE 1996a:4-246, 4-255; 1999a:3-185; 1999e:4-45, 5-21, 5-177; LMER 1997; Wham 1999a; Sections 4.4.7.1.4 and 4.4.7.1.8.

4.8.1.2 Air Quality

Cumulative impacts on air quality at ORR are presented in **Table 4–157**. ORR is currently in compliance with all Federal and State ambient air quality standards, and would continue to remain in compliance even if the

Table 4–157 Maximum Cumulative Air Pollutant Concentrations at ORR for Comparison with Ambient Air Quality Standards

Criteria Pollutant	Averaging Time	Most Stringent Standard[a] (micrograms per cubic meter)	Site Activities[b] (micrograms per cubic meter)	New Nuclear Infrastructure Operations (micrograms per cubic meter)	Cumulative Concentration (micrograms per cubic meter)
Carbon Monoxide	8 hours	10,000	85.5	0	85.5
	1 hour	40,000	172	0	172
Nitrogen dioxide	Annual	100	20.9	1.99×10^{-4}	20.9
PM_{10}	Annual	50	12.9	0	12.9
	24 hours	150	55.4	0	55.4
Sulfur dioxide	Annual	80	50.2	0.04	50.2
	24 hours	365	271	0.31	271
	3 hours	1,300	984	0.70	985

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period.
b. Environmental impacts associated with past, present, and reasonably foreseeable future activities, but not including impacts associated with nuclear infrastructure activities.

Source: DOE 1996a, 1999e:5-27; modeled results from nuclear infrastructure operations are based on the SCREEN 3 computer code (EPA 1995); Sections 4.4.1.1.3 and 4.4.7.1.3.

cumulative effects of all activities are included. As shown in the table, the contributions of nuclear infrastructure operations to overall site concentrations would be very small.

4.8.1.3 Public and Occupational Health and Safety—Normal Operations

Cumulative impacts in terms of radiation exposure to the public and workers at ORR are presented in **Table 4–158**. There would be no expected increase in the number of latent cancer fatalities in the population from ORR site operations if nuclear infrastructure operations were to occur at HFIR and REDC. The dose limits for individual members of the public are given in DOE Order 5400.5. As discussed in that order, the dose limit from airborne emissions is 10 millirem per year, as required by the Clean Air Act; the dose limit from drinking water is 4 millirem per year, as required by the Safe Drinking Water Act; and the dose limit from all pathways combined is 100 millirem per year. Therefore, as is evident in Table 4–158, the dose to the maximally exposed individual would be expected to remain well within the regulatory limits. Onsite workers would be expected to see an increase of approximately 0.31 latent cancer fatality due to radiation from nuclear infrastructure operations over the 35-year operational period.

Table 4–158 Maximum Cumulative Radiation Exposures and Impacts at ORR

Impact	Maximally Exposed Individual		Population Dose Within 80 Kilometers (50 Miles) (Year 2020)		Total Site Workforce	
	Annual Dose (millirem per year)	Risk of a Latent Cancer Fatality[a]	Dose (person-rem)	Number of Latent Cancer Fatalities[a]	Dose (person-rem per year)	Number of Latent Cancer Fatalities[a]
Site activities[b]	3.8	6.7×10^{-5}	35.9	0.63	130	1.8
New nuclear infrastructure operations at HFIR and REDC	1.9×10^{-6}	3.3×10^{-11}	8.8×10^{-5}	1.5×10^{-6}	22	0.31
Cumulative	3.8	6.7×10^{-5}	35.9	0.63	152	2.1

a. These values are calculated based on a 35-year exposure period.
b. Environmental impacts associated with past, present, and reasonably foreseeable future activities, but not including impacts associated with nuclear infrastructure activities. Impacts presented in the source documents have been adjusted, as appropriate, to reflect the Records of Decision for waste management, as discussed in Chapter 3.

Source: (1) Hamilton et al. 1998:chap. 6 and DOE 1996a:chap. 4, table 4.7.2.5.9-1 for impacts to the public from "site activities"; (2) DOE 1996b:table 4.6.2.5-1, 1999e:5-51, and Table 3–7 of this NI PEIS for impacts to the site workforce from "site activities"; and (3) Section 4.4.7.1.9 of this NI PEIS for all impacts associated with nuclear infrastructure operations.

4.8.1.4 Waste Management

Cumulative amounts of wastes generated at ORR are presented in **Table 4–159**. It is unlikely that there would be major impacts on waste management at ORR because sufficient capacity would exist to manage the site wastes. None of the options assessed in this NI PEIS would generate more than a small amount of additional waste at ORR.

Table 4–159 Cumulative Amounts of Wastes Generated at ORR[a] (cubic meters)

Waste Type	Site Activities[b]	New Nuclear Infrastructure Operations	Cumulative Total
Transuranic	2,559	385	2,944
Low-level radioactive	341,128	2,100[c]	343,228
Mixed low-level radioactive	28,038	<175	~28,213
Hazardous (kilograms)	1,260,000	227,500	1,487,500
Nonhazardous			
Liquid	23,852,937	805	23,853,742
Solid	2,604,143	5,180	2,609,323

a. The amounts of wastes given in the table are totals for the 35-year period of nuclear infrastructure operations.
b. The amounts associated with "site activities" are derived from information in the DOE 2000c and Wham 1999c references cited below, under "Source," and represent wastes associated with past, present, and reasonably foreseeable future activities, but do not include wastes associated with nuclear infrastructure activities.
c. Does not include the low-level radioactive waste (i.e., less than 1 cubic meter per year) expected to be generated from the operation of HFIR at ORR, nor the canisters used to transport neptunium-237 to the site which would constitute less than 10 cubic meters of low-level radioactive waste.

Note: To convert from cubic meters to cubic yards, multiply by 1.308; < means "less than"; ~ means "approximately."
Source: DOE 2000c:S-31; Wham 1999c; Sections 4.3.1.1.13 and 4.4.7.1.13.

4.8.2 Cumulative Impacts at INEEL

For INEEL, the bounding option for this NI PEIS is Option 2 of Alternative 2. This option calls for the operation of ATR to irradiate neptunium-237 targets and the operation of FDPF to fabricate and process these targets. The impacts associated with ATR and FDPF operations for other missions are included in "site activities."

4.8.2.1 Resource Requirements

Cumulative impacts on resource requirements at INEEL are presented in **Table 4–160**. INEEL would remain within its site capacity for all major resources. If Option 2 of Alternative 2 were implemented, the proposed nuclear infrastructure facilities would require essentially no change in the site's use of electricity or water. There would be no additional land disturbance or development. Cumulatively, INEEL would use approximately 2 percent of its available land, 77 percent of its electricity capacity, and 14 percent of its water capacity. Site employment would increase by approximately 24 workers.

Table 4–160 Maximum Cumulative Resource Use and Impacts at INEEL

Resource	Site Activities[a]	New Nuclear Infrastructure Operations	Cumulative Total	Total Site Capacity
Site employment	7,993	24[b]	8,017	NA
Electrical consumption (megawatt-hours per year)	304,700	Negligible[c]	~304,700	394,200
Developed land (hectares)	4,600	0	4,600	230,000
Water usage (million liters per year)	6,075	Negligible[c]	~6,075	43,000

a. Environmental impacts associated with past, present, and reasonably foreseeable future activities, but not including impacts associated with nuclear infrastructure activities.
b. Some, or all, of those worker requirements may be filled by the reassignment of the existing workforce.
c. Electrical consumption and water usage associated with this option would be negligible compared to that associated with other activities at INEEL.

Note: To convert from hectares to acres, multiply by 2.47; to convert from liters per year to gallons per year, multiply by 0.264; to convert from megawatt-hours to British thermal units, multiply by 3.42×10^6; ~ means "approximately," and indicates that the cumulative impacts are virtually the same as those associated with other "site activities" because new nuclear infrastructure operations would contribute only minimally.
Key: NA, not applicable.
Source: DOE 1999a:3-85, 4-379; Sections 4.4.2.1.4 and 4.4.2.1.8.

4.8.2.2 Air Quality

Cumulative impacts on air quality at INEEL are presented in **Table 4–161**. INEEL is currently in compliance with all Federal and state ambient air quality standards, and would continue to remain in compliance, even with consideration of the cumulative effects of all activities. The contributions of nuclear infrastructure operations to overall site concentrations are expected to be very small.

Table 4–161 Maximum Cumulative Air Pollutant Concentrations at INEEL for Comparison with Ambient Air Quality Standards

Criteria Pollutant	Averaging Time	Most Stringent Standard[a] (micrograms per cubic meter)	Site Activities[b] (micrograms per cubic meter)	New Nuclear Infrastructure Operations (micrograms per cubic meter)	Cumulative Concentration (micrograms per cubic meter)
Carbon monoxide	8 hours	10,000	303	0	303
	1 hour	40,000	1,330	0	1,330
Nitrogen dioxide	Annual	100	11.3	3.66×10^{-4}	11.3
PM_{10}	Annual	50	3.01	0	3.01
	24 hours	150	43.6	0	43.6
Sulfur dioxide	Annual	80	6.01	0.024	6.03
	24 hours	365	142	0.19	142
	3 hours	1,300	616	0.43	616

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period.
b. Environmental impacts associated with past, present, and reasonably foreseeable future activities, but not including impacts associated with nuclear infrastructure activities.

Source: DOE 1996a:4-928, 4-929; 1999c:5.7-15; 2000b:sec. 4.11; modeled results for nuclear infrastructure operations are based on the SCREEN 3 computer code (EPA 1995); Section 4.4.2.1.3.

4.8.2.3 Public and Occupational Health and Safety—Normal Operations

Cumulative impacts in terms of radiation exposure to the public and workers at INEEL are presented in **Table 4–162**. There would be no expected increase in the number of latent cancer fatalities in the population from INEEL site operations if nuclear infrastructure operations were to occur at ATR and FDPF. The dose limits for individual members of the public are given in DOE Order 5400.5. As discussed in that order, the dose limit from airborne emissions is 10 millirem per year, as required by the Clean Air Act; the dose limit from drinking water is 4 millirem per year, as required by the Safe Drinking Water Act; and the dose limit from all pathways combined is 100 millirem per year. Therefore, as is evident in Table 4–162, the dose to the maximally exposed individual would be expected to remain well within the regulatory limits. Onsite workers would be expected to see an increase of approximately 0.31 latent cancer fatality due to radiation from nuclear infrastructure operations over the 35-year operational period.

Table 4–162 Maximum Cumulative Radiation Exposures and Impacts at INEEL

	Maximally Exposed Individual		Population Dose Within 80 Kilometers (50 Miles) (Year 2020)		Total Site Workforce	
Impact	Annual Dose (millirem per year)	Risk of a Latent Cancer Fatality[a]	Dose (person-rem)	Number of Latent Cancer Fatalities[a]	Dose (person-rem per year)	Number of Latent Cancer Fatalities[a]
Site activities[b]	0.047	8.2×10^{-7}	0.35	0.0061	200	2.8
New nuclear infrastructure operations at ATR & FDPF	2.6×10^{-7}	4.6×10^{-12}	3.9×10^{-6}	6.8×10^{-8}	22	0.31
Cumulative	0.047	8.2×10^{-7}	0.35	0.0061	222	3.1

a. These values are calculated based on a 35-year exposure period.
b. Environmental impacts associated with past, present, and reasonably foreseeable future activities, but not including impacts associated with nuclear infrastructure activities.

Source: DOE 2000d, Section 4.11; Section 4.4.2.1.9.

4.8.2.4 Waste Management

Cumulative amounts of wastes generated at INEEL are presented in **Table 4–163**. It is unlikely that there would be major impacts on waste management at INEEL because sufficient capacity would exist to manage the site wastes. None of the alternatives assessed in this NI PEIS would generate more than a small amount of additional waste at INEEL.

Table 4–163 Cumulative Amounts of Wastes Generated at INEEL[a] (cubic meters)

Waste Type	Site Activities[b]	New Nuclear Infrastructure Operations	Cumulative Total
Transuranic	65,125[c]	245	65,370
Low-level radioactive	151,845	2,275[d]	154,120
Mixed low-level radioactive	16,640	<175	~16,815
Hazardous	3,637	227,500 kilograms (644 cubic meters)[e]	4,281
Nonhazardous	275,127	5,985	281,112

a. The amounts of wastes given in the table are totals for the 35-year period of nuclear infrastructure operations.
b. The amounts associated with "site activities" are derived from information in the DOE references cited below, under "Source," and represent wastes associated with past, present, and reasonably foreseeable future activities, but do not include wastes associated with nuclear infrastructure activities..
c. Includes 65,000 cubic meters in storage at the Radioactive Waste Management Complex.
d. Does not include the low-level radioactive waste (i.e., less than 1 cubic meter per year) expected to be generated from the operation of ATR at INEEL, nor the canisters used to transport neptunium-237 to the site which constitute less than 10 cubic meters of low-level radioactive waste.
e. Assumes for hazardous waste that 353 kilograms equals one cubic meter (22.0 pounds equals one cubic foot).

Note: To convert from cubic meters to cubic yards, multiply by 1.308; < means "less than."; ~ means "approximately".
Source: DOE 2000b:Section 4.11; Sections 4.3.2.1.13 and 4.4.1.1.13.

4.8.3 Cumulative Impacts at Hanford

For Hanford, the bounding option for this NI PEIS depends on the parameter assessed. For example, under Public and Occupational Health and Safety, the highest radiological doses and associated latent cancer fatalities to the public would be associated with Option 1 of Alternative 1, whereas the highest doses and latent cancer fatalities to workers would be associated with Option 3 of this same alternative. Processing of targets in RPL versus processing in FMEF accounts for there being different bounding options (refer to Tables 4–38, 4–39, 4–16, and 4–17). For each of the parameters addressed in this section, a footnote is included in each of the cumulative impact tables, as necessary, to indicate the bounding alternative/option.

4.8.3.1 Resource Requirements

Cumulative impacts on resource requirements at Hanford are presented in **Table 4–164**. Hanford would remain within its site capacity for all major resources. If any of the options under Alternative 1 were implemented, the proposed nuclear infrastructure facilities would require a small increase in the site's use of electricity and water. For the bounding options identified in Table 4–164, this reflects an increase of about 2 and 1 percent, respectively, over current baseline utilization for these resources. There would be no additional land disturbance or development. Cumulatively, Hanford would use approximately 6 percent of its available land, 23 percent of its electrical capacity, and 37 percent of its water capacity. Site employment would increase by approximately 130 workers.

Table 4–164 Maximum Cumulative Resource Use and Impacts at Hanford

Resource	Site Activities[a]	New Nuclear Infrastructure Operations	Cumulative Total	Total Site Capacity
Site employment	16,005	130[b]	16,135	NA
Electrical consumption (megawatt-hours per year)	507,000	55,000[c]	562,000	2,484,336
Developed land (hectares)	8,700	0	8,700	145,000
Water usage (million liters per year)	3,006	80[c]	3,086	8,263

a. Environmental impacts associated with past, present, and reasonably foreseeable future activities, but not including impacts associated with nuclear infrastructure activities.
b. Bounded by Option 3 of Alternative 1. Some, or all, of these worker requirements may be filled by the reassignment of the existing site workforce.
c. Electrical consumption and water usage are bounded by Option 3 or 6 of Alternative 1, with the values reflecting the increase over standby operations from restart of FFTF and associated support activities in FMEF.

Note: To convert from hectares to acres, multiply by 2.47; to convert from liters per year to gallons per year, multiply by 0.264; to convert from megawatt-hours to British thermal units, multiply by 3.42×10^6.
Key: NA, not applicable.
Source: DOE 1999a:3-45, 4-376; Sections 4.3.3.1.4 and 4.3.3.1.8.

4.8.3.2 Air Quality

Cumulative impacts on air quality at Hanford are presented in **Table 4–165**. Hanford is currently in compliance with all Federal and state ambient air quality standards, and would continue to remain in compliance even with consideration of the cumulative effects of all activities. The nuclear infrastructure contributions to overall site concentrations are expected to be very small.

Table 4–165 Maximum Cumulative Air Pollutant Concentrations at Hanford for Comparison with Ambient Air Quality Standards[a]

Criteria Pollutant	Averaging Time	Most Stringent Standard or Guideline[b] (micrograms per cubic meter)	Site Activities[c] (micrograms per cubic meter)	New Nuclear Infrastructure Operations (micrograms per cubic meter)	Cumulative Concentration (micrograms per cubic meter)
Carbon monoxide	8 hours	10,000	34.1	52.1	86.2
	1 hour	40,000	48.3	74.4	123
Nitrogen dioxide	Annual	100	0.25	0.0118	0.262
PM_{10}	Annual	50	0.0179	0.00084	0.0187
	24 hours	150	0.77	9.84	10.6
Sulfur dioxide	Annual	50	1.63	0.0166	1.65
	24 hours	260	8.91	9.17	18.1
	3 hours	1,300	29.6	20.6	50.2
	1 hour	660	32.9	22.9	55.8

a. Bounded by Option 3 of Alternative 1. Periodic testing of emergency diesel generators would result in higher values for certain pollutants and time periods (Section 4.3.3.1.3).
b. The more stringent of the Federal and State standards is presented if both exist for the averaging period.
c. Environmental impacts associated with past, present, and reasonably foreseeable future activities, but not including impacts associated with nuclear infrastructure activities.

Source: DOE 1999a; modeled results for nuclear infrastructure operations are based on the SCREEN 3 computer code (EPA 1995); Section 4.3.3.1.3.

4.8.3.3 Public and Occupational Health and Safety—Normal Operations

Cumulative impacts in terms of radiation exposure to the public and workers at Hanford are presented in **Table 4–166**. There would be no expected increase in the number of latent cancer fatalities in the population

from Hanford site operations if nuclear infrastructure operations were to occur at FMEF. The dose limits for individual members of the public are given in DOE Order 5400.5. As discussed in that order, the dose limit from airborne emissions is 10 millirem per year, as required by the Clean Air Act; the dose limit from drinking water is 4 millirem per year, as required by the Safe Drinking Water Act; and the dose limit from all pathways combined is 100 millirem per year. Therefore, as is evident in Table 4–166, the dose to the maximally exposed individual would be expected to remain well within the regulatory limits. Onsite workers would be expected to see an increase of approximately 0.40 latent cancer fatality due to radiation from nuclear infrastructure operations over the 35-year operational period.

Radiation doses listed under site activities in Table 4–166 include exposures due to activities associated with waste management (as estimated in the Hanford Comprehensive Land-Use Plan (DOE 1999d), the tank waste remediation system (DOE 1996e), management of spent nuclear fuel from the K Basins (DOE 1995e), disposal of decommissioned naval reactor plants (Navy 1996), and the Plutonium Finishing Plant Stabilization (DOE 1996g).

Table 4–166 Maximum Cumulative Radiation Exposures and Impacts at Hanford

	Maximally Exposed Individual		Population Dose Within 80 Kilometers (50 Miles) (Year 2020)		Total Site Workforce	
Impact	Annual Dose (millirem per year)	Risk of a Latent Cancer Fatality[a]	Dose (person-rem)	Number of Latent Cancer Fatalities[a]	Dose (person-rem per year)	Number of Latent Cancer Fatalities[a]
Site activities[b]	1.9	3.3×10^{-5}	33	0.58	841	11.8
New nuclear infrastructure operations at FFTF and FMEF or RPL[c]	0.0054	9.5×10^{-8}	0.25	0.0045	28	0.40
Cumulative	1.9	3.3×10^{-5}	33.3	0.58	869	12.2

a. These values are calculated based on a 35-year exposure period.
b. Environmental impacts associated with past, present, and reasonably foreseeable future activities, but not including impacts associated with nuclear infrastructure activities.
c. Impacts on the public are bounded by Option 1 of Alternative 1; impacts on workers are bounded by Option 3 of Alternative 1.
Source: (1) DOE 1999a:4-377, 4-378 and PNNL 1998:chap. 5 for impacts to the public from "site activities"; (2) DOE 1995e:table 5-42, 1996e:table 5.11.1, 1996g:table 3-12a, 1999d:sec. 5.6.4; Navy 1996:sec. 4.3.3.5; and REMS Query for impacts to the site workforce from "site activities"; and (3) Sections 4.3.1.1.9 and 4.3.3.1.9 of this NI PEIS for all impacts associated with nuclear infrastructure operations.

4.8.3.4 Waste Management

Cumulative amounts of wastes generated at Hanford are presented in **Table 4–167**. It is unlikely that there would be major impacts on waste management at Hanford because sufficient capacity would exist to manage the site wastes. None of the alternatives assessed in this NI PEIS would generate more than a relatively small amount of additional waste at Hanford. Currently, it is DOE's intent that waste generated from the restart and operation of FFTF be managed independent of the existing Hanford site waste management infrastructure by using commercially available facilities for all waste treatment and disposal activities. DOE has developed a draft *Waste Minimization and Management Plan for FFTF* to incorporate pollution prevention and waste minimization practices in its consideration of the future of FFTF (DOE 2000a). If a decision were made to restart FFTF, this plan would be used to ensure that optimum opportunities are provided for characterizing potential waste streams, identifying source reduction and recycling strategies, evaluating disposition options, developing sustainable designs, and implementing effective management strategies. This plan identifies DOE's preferred options for management, treatment, and/or disposition of all waste streams related to the restart and operation of FFTF. These preferred options primarily use commercial waste handling and disposal

facilities. Although it is DOE's intent to use commercial waste handling and disposal facilities, the Hanford waste management infrastructure is analyzed in this NI PEIS as a reasonable alternative for the management of wastes resulting from FFTF restart and operation in case commercial disposal is not practicable at the time of restart and operation.

Table 4–167 Cumulative Amounts of Wastes Generated at Hanford[a] (cubic meters)

Waste Type	Site Activities[b]	New Nuclear Infrastructure Operations[c]	Cumulative Total
Transuranic	9,880	385[c]	10,265
Low-level radioactive	95,666	5,005[c, d]	100,671
Mixed low-level radioactive	46,207	315[c]	46,522
Hazardous	19,600	3,100[e]	22,700
Nonhazardous			
Liquid	7,000,000	1,494,500[c]	8,494,500
Solid	1,505,000	10,500[c]	1,515,500

a. The amounts of wastes given in the table are totals for the 35-year period of nuclear infrastructure operations.
b. The amounts associated with "site activities" are derived from information in the DOE references cited below, under "Source," and represent wastes associated with past, present, and reasonably foreseeable future activities, but do not include wastes associated with nuclear infrastructure activities.
c. The bounding alternative for this waste type is Alternative 1, Option 3 or 6.
d. Does not include the low-level radioactive waste expected to be generated from the canisters used to transport neptunium-237 to the site, which would constitute less than 10 cubic meters.
e. The bounding alternative for hazardous waste is Alternative 2, Option 3, 6, or 9; Alternative 3, Option 3; or Alternative 4, Option 3; which all include the deactivation of FFTF and neptunium-237 target fabrication and processing at FMEF. The inventory of bulk metallic sodium (Section 4.4.1.2.13) is not included because alternative sponsors and/or users will be found for its disposition.

Note: To convert from cubic meters to cubic yards, multiply by 1.308.
Source: DOE 1998; 1999a:sec. 4.3.3.1.13 and 4.4.1.2.13 and tables 4–45, 4–81, and 3–26; 1999h.

4.8.3.5 Spent Nuclear Fuel Management

As discussed in Section 4.3.1.1.14, the operation of FFTF for the proposed mission at 100 megawatts for 35 years under Alternative 1 would produce a total of about 16 metric tons of heavy metal (35,200 pounds) of spent nuclear fuel. The existing spent nuclear fuel at Hanford is about 2,133 metric tons of heavy metal (46,926,000 pounds), including defense and nondefense spent nuclear fuel (DOE 1995c). The environmental impacts associated with the existing spent nuclear fuel management at Hanford are addressed in the following documents:

- DOE 1996a—*Storage and Disposition of Weapons-Usable Fissile Materials Fuel Programmatic Environmental Impact Statement*

- DOE 1995c—*Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho Nuclear Engineering Laboratory Environmental Restoration and Waste Management Final Environmental Impact Statement*

- DOE 1997c—*Environmental Assessment - Management of Hanford Site, Non-Defense Production Reactor Spent Nuclear Fuel*

The above documents conclude that the environmental impacts associated with the existing inventory of spent nuclear fuel at Hanford are minimal. The restart of FFTF under Alternative 1 would generate 16 metric tons of heavy metal of spent nuclear fuel, which is less than 1 weight percent of the total spent nuclear fuel

inventory presently at Hanford. As such, the environmental impacts associated with spent nuclear fuel management would remain minimal.

4.8.4 Cumulative Impacts at the Generic CLWR Site

No incremental environmental impacts at the generic site would be associated with the normal operation of a CLWR to irradiate targets (refer to Sections 4.4.4 through 4.4.6). Therefore, the cumulative impacts at the generic CLWR site would not be affected by any action assessed in this NI PEIS, and are not addressed further.

4.8.5 Cumulative Impacts at the New Accelerator(s) Generic DOE Site

Cumulative impacts cannot be presented for a generic site. If Alternative 3 were selected for implementation, a subsequent site-specific analysis would be conducted for the DOE site chosen for the combination of new accelerator(s) and support facility (refer to Section 4.5), and appropriate NEPA documentation would be prepared to address the cumulative impacts for that site.

4.8.6 Cumulative Impacts at the New Research Reactor Generic DOE Site

Cumulative impacts cannot be presented for a generic site. If Alternative 4 were selected for implementation, a subsequent site-specific analysis would be conducted for the DOE site chosen for the new research reactor and support facility or research reactor only (refer to Section 4.6), and appropriate NEPA documentation would be prepared to address the cumulative impacts for that site.

4.8.7 Cumulative Impacts of Transportation

The cumulative impacts from transportation associated with nuclear infrastructure activities are identified in Appendix J. Because likely transportation routes cross many states, cumulative impacts are compared on a national basis. Under all alternatives assessed in this NI PEIS, occupational radiation exposure to transportation workers and exposure to the public are estimated to each represent less than 0.05 percent of the cumulative exposures from nationwide transportation (DOE 1999i) over the 35-year period of nuclear infrastructure activities. No additional traffic fatality is expected; the incremental increase in traffic fatalities would be less than 0.0001 percent per year.

4.9 MITIGATION MEASURES

As shown throughout Chapter 4, the impacts of all the alternatives would be small. No specific mitigation measures would be necessary because all potential environmental impacts would be below acceptable levels or applicable standards.

Nevertheless, DOE would maintain all public and worker exposures, both direct exposures and indirect exposures via airborne emissions, as low as is reasonably achievable. This is a long-standing DOE policy to control or manage radiation exposures and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. This DOE policy is not a dose limit but rather a process that has as its objective the attainment of dose levels as far below the applicable limits as practical.

Similarly, DOE has a long-standing policy to minimize waste generation. Thus, DOE would conduct all operations in a manner that generates the smallest amount of waste practical. This policy applies to all types of waste, including solid and liquid radioactive wastes, hazardous wastes, and mixed wastes.

Alternatives 3 and 4 involve the construction of major new facilities. In these alternatives, DOE would employ modern construction practices that minimize the environmental impacts.

4.10 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

Regardless of the option selected by DOE, there may be some associated unavoidable adverse environmental impacts, although the impacts would be small. Some health risks to workers and the public would be unavoidable at the time the option were implemented. Workers at operating sites and involved in truck shipments would be subject to the same types and frequencies of injuries and accidental deaths that workers experience across the industrial sector of the nation. Workers would also be exposed to the specific health risks of exposures to radiation and hazardous chemicals. The public would generally be at a lower risk than any of the workers involved in processing activities. During processing operations, air quality would be unavoidably affected as the result of criteria and hazardous and toxic air pollutant emissions at the site, and from worker vehicles and truck shipment vehicles. Nonradiological air quality impacts at any particular site are not expected to affect attainment status of the site's air quality control region for each criteria air pollutant.

Construction activities associated with several options (including construction of a new 76-meter (250-foot) stack at Hanford, one or two new DOE accelerators and support facility, and a new DOE nuclear research reactor and support facility) would result in short term elevated levels of particulate matter in localized areas. In addition, portions of nonsensitive terrestrial habitats would be lost when these new facilities were constructed. None of these habitat losses is expected to constitute a significant impact on the resident plant and animal species because these species have broad ranges and the amount of lost habitat would comprise only a small fraction of these communities.

If an alternative were selected which involved a DOE site not yet selected for implementation (generic DOE site), the issue of unavoidable adverse environmental impacts would be assessed as part of the site selection process. Appropriate NEPA documentation would be prepared.

4.11 RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

Short-term environmental impacts are those that would occur during construction and operation of target fabrication, storage, irradiation, or processing facilities. Impacts that extend beyond the period of facility operations are considered to be long-term impacts.

The implementation of any of the options assessed in this NI PEIS would result either in the short-term use of existing facilities and environmental resources, or in the construction of new facilities and their operation and ultimate decontamination and decommissioning. Facility modifications would be required for the implementation of neptunium-237 target fabrication and postirradiation plutonium-238 processing technologies at ORR, INEEL, and Hanford. In addition, facility modifications would be required at Hanford to support target fabrication and postirradiation processing for civilian nuclear research and industrial and medical isotope production in FFTF and perhaps at other DOE sites for targets irradiated in either one or two new DOE accelerators or a new DOE research reactor. Some new target fabrication and postirradiation processing facilities might be required to support targets irradiated in either one or two new DOE accelerators or a new DOE research reactor.

The implementation of options that require construction of new facilities would require short-term use of the environment and a variety of resources such as land, construction materials, and labor. Development of these facilities would commit lands to those uses from the beginning of the construction period through the duration of the operation period and until such facility would be fully decommissioned. Depending upon the specific locations at sites selected for these facilities, some terrestrial habitat may be lost when the area is cleared for construction. Disturbance of this acreage would eliminate the natural productivity of the land. At the end of the operational period, these facilities could be converted to other uses or decontaminated and decommissioned and the land returned to its original use or a condition compatible with future uses.

Transportation between SRS and the candidate neptunium-237 target fabrication sites; between the candidate sites for neptunium-237 target fabrication and processing and the irradiation sites; between the candidate postirradiation plutonium-238 processing sites and LANL; between an east coast port and Hanford for shipment of mixed oxide fuel; and between a U.S. fuel fabrication facility and Hanford for shipment of highly enriched uranium fuel would occur on existing roadways. Most target fabrication and postirradiation processing for industrial and medical isotopes and for civilian nuclear research would occur on the same site as the irradiation of those targets; however, there would be air and truck transport of the irradiation products to certain distribution centers. There would also be some transport of targets containing hazardous materials to the irradiation sites. These activities would result in emissions to the atmosphere that would not measurably affect regional or global air quality. Short-term uses of the environment would have no appreciable beneficial or adverse effects on long-term productivity of the environment on, or in the vicinity of, any of the sites assessed in this NI PEIS.

4.12 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

This section describes the major irreversible and irretrievable commitments of resources that can be identified at this programmatic level of analysis. A commitment of resources is irreversible when primary or secondary impacts limit the future options for a resource. An irretrievable commitment refers to the use or consumption of resources neither renewable nor recoverable for future use.

Processing activities related to the production of plutonium-238 described in this NI PEIS would be conducted at existing facilities. In addition, the fabrication and processing of targets used to produce industrial and medical isotopes and to conduct civilian nuclear research using FFTF at Hanford would also be conducted in existing facilities. Modifications to existing facilities would consist of improvements required to meet current environmental standards or the installation of new processing equipment. In addition, the use of FMEF at Hanford would require construction of a 76-meter (250-foot) stack.

The implementation of several alternatives described in this NI PEIS would require the construction of new facilities to fabricate, irradiate, or process targets to produce plutonium-238 for space missions, industrial and medical isotopes, or to conduct civilian nuclear research. These alternatives would include those using one or two new accelerators or a new research reactor to irradiate the targets. To limit the cost and environmental impacts of these alternatives, DOE would consider modifying existing appropriate facilities at the irradiation sites rather than constructing new facilities.

The land that is currently occupied by either existing or new processing or irradiation facilities could ultimately be returned to open space uses if buildings, roads, and other structures were removed, areas cleaned up, and the land revegetated. Alternatively, the facilities could be modified for use in other DOE programs. The commitment of such land is irreversible in the short term, but not necessarily irreversible in the long term.

The irreversible and irretrievable commitment of material resources during the life-cycles of the activities described in this NI PEIS includes construction materials that cannot be recovered or recycled, materials that are rendered radioactive and cannot be decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Where construction would be necessary, materials required include wood, concrete, sand, gravel, plastics, steel, aluminum, and other metals. These construction resources, except for those that can be recovered and recycled with present technology, would be irretrievably lost. However, none of those identified construction resources is in short supply, and all are readily available in the vicinity of locations being considered for new facilities. Materials required for the processing equipment, utilities, and fuel required for transportation options comprise the irretrievable resources required to implement the various options that use either new or existing facilities. None of the alternatives requires resources that would noticeably affect local or national supplies, or that would noticeably affect the quality of the local or global environment.

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