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 civilian nuclear energy 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 civilian nuclear energy 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 civilian nuclear energy 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, and a commercial light water reactor [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.

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 4–55**. 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.

Table 4–55 Incremental ORR Concentrations[a] Associated with Alternative 2 (Use Only Existing Operational Facilities)—Option 1

Pollutant	Averaging Period	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 SCREEN3 computer code (EPA 1995).

The air quality impacts of transportation among SRS, INEEL, ORR, and LANL are presented in Section 4.4.1.1.11.

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, an existing facility in the 7900 Area of ORNL at ORR, would be used for neptunium-237 storage, target fabrication, and processing in support of plutonium-238 production with impacts on ORR water resources indicators the same as those described in Section 4.3.1.1.4. In summary, a small increase in water use and sanitary wastewater generation is anticipated, mainly attributable to increased staffing levels. Also, there would be a very small increase in process wastewater generation, but there would be no radiological liquid effluent discharge to the environment under normal operations.

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 *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 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 letters to comply with Section 7 of the Endangered Species Act were sent to the U.S. Fish and Wildlife Service and the Idaho Department of Fish and Game (see Table 5–3). Each agency was asked to provide information on potential impacts of the proposed action on threatened and endangered species. The Idaho Department of Fish and Game indicated that its database contained no known occurrences of special status plants or animals near the project area. While DOE has made additional contact with the U.S. Fish and Wildlife Service, a response is pending from this agency. Although no federally listed species are expected to be impacted by the proposed action, no action would be taken relative to the use of facilities at INEEL prior to the receipt of input from the Service.

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 was conducted with the U.S. Fish and Wildlife Service (see Table 5–3) and resulted in the Service concluding that it does not anticipate adverse effects to federally listed endangered species that occur near the project area. DOE has also consulted with the Tennessee Department of Environment and Conservation; a response concerning state-listed species is pending from this agency. Although no state-listed species are expected to be impacted by the proposed action, no action would be taken relative to the use of facilities at ORR prior to the receipt of input from 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 was initiated with the State Historic Preservation Office (see Table 5–3). The State Historic Preservation Office indicated that ATR is likely to be eligible for the National Register of Historic Places as a contributory property in a potential historic district of exceptional significance. However, at this time, the State Historic Preservation Office has determined that more information is needed prior to assisting DOE in evaluating this property. The State Historic Preservation Office also indicated that since there would be no new construction, there is little potential for effects on archaeological properties. DOE would provide additional information as required to the Idaho State Historic Preservation Office prior to the use of any facility at INEEL for the proposed project. Consultation was conducted with interested Native American tribes; however, responses are pending.

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 was initiated with the State Historic Preservation Office (see Table 5–3). While DOE has made additional contact with the State Historic Preservation Office, a response is pending from this office. Although impacts to cultural resources are not expected as a result of the proposed action, no action would be taken relative to the use of facilities at ORR prior to the receipt of input from 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 4–56** 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.

Table 4–56 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).

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 4–57**; 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 170 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0 and approximately 12 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–57. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–57 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	12[b]	12
35-year latent cancer fatalities	0	0.17	0.17
Average worker dose (millirem per year)	0	170	NA[c]
35-year latent cancer fatality risk	0	0.0023	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 1999j). Further, DOE recommends that facilities adopt a more limiting, 500 millirem per year, Administrative Control Level (DOE 1999j). 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: Mecham 1999; Wham 1999b, 2000.

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 4–58**.

Table 4–58 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 SCREEN3 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 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, summing 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 4–59** and **4–60**, 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 4–60 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 0.089 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.

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.

Table 4–59 ATR and REDC Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 1

	Maximally Exposed 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}	2.24x0^{-13}
Target dissolver tank failure during plutonium-238 separation	1.76×10^{-7}	8.79×10^{-11}	0.00196	9.82×10^{-7}	1.69×10^{-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[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 4–60 ATR and REDC Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 1

Accident (Frequency)	Maximally Exposed 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}
Large-break LOCA incremental risks[c]	6.90×10^{-9}	4.00×10^{-5}	9.80×10^{-8}
Neptunium-237 target handling with 5 kg/yr plutonium-238 production[d] (0.001)	1.03×10^{-10}	6.41×10^{-8}	1.30×10^{-9}
35-year ATR risk[e]	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}[f]
35-year REDC risk	5.71×10^{-5}	0.157	3.50×10^{-4}
35-year Option risk[g]	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. The incremental 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.
d. There would be no neptunium-237 targets for the zero-production case. Thus, the 5-kg/yr production rate target-handling risks are the incremental risks.
e. The 35-year risk is determined by summing the incremental annual risks and then multiplying by 35.
f. Risk of an early fatality.
g. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

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.

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 689 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, 240 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 0.0064.

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 4–56). As shown in Table 4–58, 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. The number of expected latent cancer fatalities among populations at risk due to radiological accidents listed in Table 4–60 would be approximately 0.16. 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 waste 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 waste 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 the Fast Flux Test Facility, 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

Several sources of air pollutants are operated to support FFTF during standby: an emergency gas turbine generator, a diesel-driven fire pump, and oil-fired preheaters. If any of Alternatives 2 through 5 were selected for implementation, then these sources would be shut down. Concentrations of air pollutants at the Hanford Site boundary resulting from these sources were estimated from a dispersion-modeling screening analysis conducted with maximum expected emission rates and worst-case meteorological conditions. Although these sources are operated intermittently, and they are not necessarily operated simultaneously, concentrations of air pollutants from all three sources were summed to give the conservative estimate of air quality impacts of maintaining FFTF in standby shown in **Table 4–61.** Concentrations of air pollutants listed in Table 4–61 are negative to indicate that they represent a decrease in adverse impacts relative to air quality with FFTF in standby, although the decrease would be less than the conservative estimate for standby.

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 would be 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 (3.8 million liters [1 million gallons] per year) of 400 Area sanitary wastewater discharges to the Energy Northwest treatment system would also be eliminated. In addition, groundwater withdrawals by 400 Area facilities during standby of approximately 197 million liters (52 million gallons) per year would be greatly reduced or eliminated entirely (see Section 4.2.1.2.4). 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

Table 4–61 Incremental Hanford Concentrations Associated with All Options of Alternatives 2 through 5

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (micrograms per cubic meter)
Carbon monoxide	8 hours 1 hour	10,000[b] 40,000[b]	-3.5 -5.1
Nitrogen dioxide	Annual	100[b]	-0.032
PM_{10}	Annual 24 hours	50[c] 150[c]	-0.002 -0.898
Sulfur dioxide	Annual 24 hours 3 hours 1 hour	50[d] 260[d] 1,300[b] 660[d]	-0.164 -29.8 -67.0 -74.4

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 equal to or 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 SCREEN3 computer code (EPA 1995); additional data from Nielsen 2000.

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. Any necessary ground disturbance would be 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 242 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 242 jobs would result in the loss of 613 indirect jobs in the region around Hanford. The potential employment loss of 855 direct and indirect jobs represents less than 0.4 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 1,494 persons. Given the current population-to-student ratio in the region of influence, this would likely result in a decrease of about 309 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: 19 less teachers would be needed if the current student-to-teacher ratio of 16.0:1 was maintained; 2 less police officers would be needed to maintain the current officer-to-population ratio of 1.5:1000; 5 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, 28 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 4–62**: 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}.

Table 4–62 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.

Estimated incremental doses to involved workers associated with annual deactivation activities are given in **Table 4–63**; 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 4–63. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–63 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 1999j). Further, DOE recommends that facilities adopt a more limiting, 500 millirem per year, Administrative Control Level (DOE 1999j). 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 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 4–64** and **4–65**, respectively.

Table 4–64 Consequences of FFTF Deactivation Accident

	Maximally Exposed 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]**
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 4–65 Risks of FFTF Deactivation Accident

Accident (Frequency)[a]	Maximally Exposed 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).

For an FFTF deactivation accident, the increased risk of a latent cancer fatality to the maximally exposed individual 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}.

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 4–62). 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 4–65, 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 the Fast Flux Test Facility, Hanford Site, Richland, Washington* (DOE 1995a), 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 1995a: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 1995a: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 site's Interim Storage Area (ISA). 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 4–66**. 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 4–66 Incremental INEEL Concentrations[a] Associated with Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Pollutant	Averaging Period	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 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	0.25

a. For comparison with ambient air quality standards.
Source: 40 CFR Part 50; ID DHW 1998; modeled increments are based on the SCREEN3 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 4–67**.

Table 4–67 PSD Class II Increments Compared to INEEL Concentrations Associated with Alternative 2 (Use Only Existing Operational Facilities)—Option 2

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

Key: PSD, Prevention of Significant Deterioration.
Source: Modeled increments are based on the SCREEN3 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 indicators at INEEL would be the same as those described in Section 4.3.2.1.4. In summary, a small increase in water use and sanitary wastewater generation would be anticipated, mainly attributable to increased staffing levels. Also, there would be a very small increase in process wastewater generation, but 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 letters to comply with Section 7 of the Endangered Species Act were sent to the U.S. Fish and Wildlife Service and the Idaho Department of Fish and Game (see Table 5–3). Each agency was asked to provide information on potential impacts of the proposed action on threatened and endangered species. The Idaho Department of Fish and Game indicated that its database contained no known occurrences of special status plants or animals near the project area. While DOE has made additional contact with the U.S. Fish and Wildlife Service, a response is pending from this agency. Although no federally listed species are expected to be impacted by the proposed action, no action would be taken relative to the use of facilities at INEEL prior to the receipt of input from the Service.

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 was initiated with the State Historic Preservation Office (see Table 5–3). The State Historic Preservation Office indicated that Building CPP–651 and FDPF are likely to be eligible for the National Register of Historic Places as contributory properties in a potential historic district of exceptional significance. However, at this time, the State Historic Preservation Office has determined that more information is needed prior to assisting DOE in evaluating these properties. The State Historic Preservation Office also indicated that since there would be no new construction, there is little potential for effects on archaeological properties. DOE would provide additional information as required to the Idaho State Historic Preservation Office prior to the use of any facility at INEEL for the proposed project. Consultation was conducted with interested Native American tribes; however, responses are pending.

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 4–68** 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.

Table 4–68 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	6.7×10^{-8}	6.7×10^{-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	2.0×10^{-8}	2.0×10^{-8}
35-year latent cancer fatality risk	0	3.6×10^{-13}	3.6×10^{-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).

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 6.7×10^{-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 4–69**; 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 170 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0 and approximately 12 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–69. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–69 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	12[b]	12
35-year latent cancer fatalities	0	0.17	0.17
Average worker dose (millirem per year)	0	170	NA[c]
35-year latent cancer fatality risk	0	0.0023	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 1999j). Further, DOE recommends that facilities adopt a more limiting, 500 millirem per year, Administrative Control Level (DOE 1999j). 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: Mecham 1999; Wham 1999b, 2000.

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 4–70**.

Table 4–70 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 SCREEN3 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 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, summing 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 4–71** and **4–72**, 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.

Table 4–71 ATR and FDPF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Accident	Maximally Exposed 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[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}
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.

Table 4–72 ATR and FDPF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 2

Accident (Frequency)	Maximally Exposed 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}
Large-break LOCA incremental risks[c]	6.90×10^{-9}	4.00×10^{-5}	9.80×10^{-8}
Neptunium-237 target handling with 5 kg/yr plutonium-238 production (0.001)[d]	1.03×10^{-10}	6.41×10^{-8}	1.30×10^{-9}
35-year ATR risk[e]	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}[f]
35-year FDPF risk	1.49×10^{-5}	0.0287	3.50×10^{-4}
35-year Option risk[g]	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. The incremental 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.
d. There would be no neptunium-237 targets for the zero-production case. Thus, the 5-kg/yr production rate target-handling risks are the incremental risks.
e. The 35-year risk is determined by summing the incremental annual risks and then multiplying by 35.
f. Risk of an early fatality.
g. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

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 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 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.

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 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 4–73**. 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 highway (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 4–73 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 highway (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 a noninvolved worker, 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 highway access.

The impacts associated with the accidental release of nitric acid and nitric oxide at FDPF are presented in **Table 4–74**.

Table 4–74 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
Noninvolved worker (640 meters)	Parts per million Level of concern Potential health effects	3.3 <ERPG-2 Mild, transient	8.4 <ERPG-2 Mild, transient	4.2 <LOC Mild, transient	67.5 >LOC Serious
Nearest highway maximally exposed 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
Site boundary maximally exposed 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.

4.4.2.1.11 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 59 intersite shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 0.15 million kilometers (0. 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 1.3 person-rem; the dose to the public, 8 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0005 latent cancer fatality among transportation workers and 0.004 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 0.0007.

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 0.0006 traffic fatality.

4.4.2.1.12 Environmental Justice

NORMAL OPERATIONS. For 35 years of normal operations under this option, the number of expected latent cancer fatalities among populations residing within 80 kilometers (50 miles) of ATR and FDPF would be essentially zero (derived from information in Table 4–68). As shown in Table 4–70, 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, 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 expected latent cancer fatalities among the populations at risk due to radiological accidents listed in Table 4–72 would be approximately 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, waste would be associated with FDPF operations to fabricate and process neptunium-237 targets.

The impacts of managing waste 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 4–75**. 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 4–75 Incremental Hanford Concentrations[a] Associated with Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Pollutant	Averaging Period	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 24 hours 3 hours 1 hour	50 260 1,300 660	0.0087 0.069 0.16 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: 40 CFR Part 50; WDEC 1998; modeled increments are based on the SCREEN3 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 4–76**.

Table 4–76 PSD Class II Increments Compared to Hanford Concentrations Associated with Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Pollutant	Averaging Period	Allowable PSD Increment (micrograms per cubic meter)	Modeled Increment (micrograms per cubic meter)
Nitrogen dioxide	Annual	25	4.43×10^{-5}
Sulfur dioxide	Annual 24 hours 3 hours	20 91 512	0.0087 0.069 0.16

Key: PSD, Prevention of Significant Deterioration.
Source: Modeled increments are based on the SCREEN3 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 the same as those described in Section 4.3.3.1.4. Specifically, the operation of FMEF for this purpose is projected to require approximately 19 million liters (5 million gallons) of groundwater annually. 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.

It should be noted that the increase in water use and sanitary and process wastewater discharge for FMEF operations would essentially be negated by the larger reductions in water use and wastewater generation in the 400 Area associated with the permanent deactivation of FFTF (see Section 4.4.1.2.4).

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 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 4.4.3.1.4). 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 letters concerning threatened and endangered species were sent to the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the Washington State Department of Natural Resources, and the State of Washington Department of Fish and Wildlife (see Table 5–3). Each agency was asked to provide information on potential impacts of the proposed action on threatened and endangered species. Both the Washington State Department of Natural Resources and the State of Washington Department of Fish and Wildlife provided lists of state species of concern that occur in the vicinity of the project area. As noted above, no impacts to any threatened or endangered species are expected, including those of concern to these agencies. While DOE has made additional contacts with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, responses are pending from these agencies. Although no federally listed species are expected to be impacted by the proposed action, no action would be taken relative to the use of facilities at Hanford prior to the receipt of input from these Federal agencies.

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 was conducted with the State Historic Preservation Office (see Table 5–3) and resulted in concurrence by the State Historic Preservation Office that the proposed action would have no effect on historic properties at Hanford. Consultation was also conducted with interested Native American tribes that resulted in comments at public hearings by members representing the Nez Perce and Confederated Tribes of the Umatilla Indian Reservation. Responses to their specific comments are addressed in Volume 3.

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), 199 new jobs could increase the region's population by approximately 383 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 79 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 4–77** 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.

Table 4–77 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	8.3×10^{-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).

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 8.3×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–78**; 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 170 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0 and approximately 12 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–78. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–78 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	12[b]	12
35-year latent cancer fatalities	0	0.17	0.17
Average worker dose (millirem per year)	0	170	NA[c]
35-year latent cancer fatality risk	0	0.0023	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 1999j). Further, DOE recommends that facilities adopt a more limiting, 500 millirem per year, Administrative Control Level (DOE 1999j). 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: Mecham 1999; Wham 1999b, 2000.

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.

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 4–79**.

Table 4–79 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 SCREEN3 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 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, summing 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 4–80** and **4–81**, 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.

Table 4–80 ATR and FMEF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Accident	Maximally Exposed 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[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}
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	0.00823	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 4–81 ATR and FMEF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 3

Accident (Frequency)	Maximally Exposed 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}
Large-break LOCA incremental risks[c]	6.90×10^{-9}	4.00×10^{-5}	9.80×10^{-8}
Neptunium-237 target handling with 5 kg/yr plutonium-238 production (0.001)[d]	1.03×10^{-10}	6.41×10^{-8}	1.30×10^{-9}
35-year ATR risk[e]	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}(f)
35-year FMEF risk	2.88×10^{-6}	0.112	3.50×10^{-4}
35-year Option risk[g]	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. The incremental 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.
d. There would be no neptunium-237 targets for the zero-production case. Thus, the 5-kg/yr production rate target-handling risks are the incremental risks.
e. The 35-year risk is determined by summing the incremental annual risks and then multiplying by 35.
f. Risk of an early fatality.
g. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

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.

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 4–82**. 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 highway (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 4–82 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 1,900 meters (0.31 and 1.18 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 highway (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 a noninvolved worker, 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 highway access.

The impacts associated with the accidental release of nitric acid and nitric oxide at FMEF are presented in **Table 4–83**.

Table 4–83 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
Noninvolved worker (640 meters)	Parts per million Level of concern Potential health effects	3.3 <ERPG-2 Mild, transient	8.6 <ERPG-2 Mild, transient	4.2 <LOC Mild, transient	66 >LOC Serious
Nearest highway maximally exposed 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
Site boundary maximally exposed 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.

4.4.3.1.11 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 689 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 0.83 million kilometers (0.52 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. 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, 81 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0020 latent cancer fatality among transportation workers and 0.040 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 0.0014.

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 0.017 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 4–77). As shown in Table 4–79, 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, 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 expected latent cancer fatalities among the populations at risk due to radiological accidents listed in Table 4–81 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 waste 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 4–84**. The impacts on the Hanford waste management systems, in terms of managing the additional waste, 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.

Table 4–84 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 (cubic meters per year)	Estimated Additional Waste Generation as a Percent of[b]		
		Onsite Treatment Capacity	Onsite Storage Capacity	Onsite Disposal Capacity
Transuranic/High-level radioactive[c]	11	(c)	(c)	NA
Low-level radioactive				
Liquid	6	(d)	(d)	(d)
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	(d)	(d)	(d)
Sanitary wastewater	3,800	1.6[e]	NA	NA
Solid	150	NA	NA	NA

a. See definitions in Section G.9.
b. 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.
c. Refer to the text for a discussion on waste classification and treatment. This waste would be stored at FMEF pending availability of a suitable repository. It is assumed that this waste would be remotely handled.
d. Refer to the text.
e. 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: Chapin 2000; DOE 2000a; Hoyt et al. 1999; Nielsen 1999.

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 4–84, and its management need not be addressed separately.

In accordance with the Records of Decision for the *Waste Management PEIS* (DOE 1997a), waste 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 high-level radioactive waste issued on August 12, 1999 (64 FR 46661), immobilized high-level radioactive waste would be stored on site until transfer to a geologic repository. 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.

The analysis for the Draft NI PEIS assumed that the waste generated from the processing of irradiated neptunium-237 targets is transuranic waste. However, as a result of comments received during the public comment period, DOE is considering whether the waste from processing of irradiated neptunium-237 targets should be classified as high-level radioactive waste and not transuranic waste. Irrespective of how the waste is classified (i.e., transuranic or high-level radioactive waste), the composition and characteristics are the same, and the waste management activities (i.e., treatment and onsite storage) as described in this NI PEIS would be the same. In addition, either waste type would require disposal in a suitable repository. If it is transuranic waste, it would be nondefense waste and could not be disposed of at WIPP under current law. Because nondefense transuranic waste has no current disposal path, DOE Headquarters' approval would be necessary before a decision were made to generate such waste, as required by DOE Order 435.1. If the waste is classified as high-level radioactive waste, it is assumed for the purposes of this analysis that Yucca Mountain, Nevada, if approved, would be the final disposal site for DOE's high-level radioactive waste. The other differences between these two waste classifications are that a high-level radioactive waste repository requires a much more rigorous waste-form qualification process than a transuranic waste repository and there is a slightly different set of requirements for high-level radioactive waste than for transuranic waste delineated in DOE Manual 435.1.

Target fabrication and processing in FMEF would generate a total of 385 cubic meters (504 cubic yards) of transuranic or high-level radioactive waste over the 35-year operational period. As described in Section 3.4.5 of the *Preconceptual Design Planning for Chemical Processing to Support Pu-238 Production* (Wham 1998), the waste would be vitrified into a glass matrix at a glass melter installed within FMEF. The resulting glass matrix would be stored at FMEF pending availability of a repository for permanent disposal. The impacts of managing the additional quantities of this 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 the existing onsite low-level radioactive Burial Grounds. 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 waste 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 waste 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 waste at Hanford that would be associated with this option (refer to Table 4–84) can be compared with the current waste generation rates at the site, given in Table 3–34 (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 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 4–85** 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.

Table 4–85 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).

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.

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 4–86**; 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 170 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0 and approximately 12 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–86. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–86 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	12[b]	12
35-year latent cancer fatalities	0	0.17	0.17
Average worker dose (millirem per year)	0	170	NA[c]
35-year latent cancer fatality risk	0	0.0023	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 1999j). Further, DOE recommends that facilities adopt a more limiting, 500 millirem per year, Administrative Control Level (DOE 1999j). 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: Wham 1999b, 2000.

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).

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 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 Section I.1.2.

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 plant specific, summing 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 4–87** and **4–88**, 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 4–89**. The early fatalities shown in Table 4–89 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 (without neptunium-237 targets). Baseline accident risks are obtained from the data in Tables 4–88 and 4–89 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 0.073 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 0.00305. The increased risk of an early fatality in the surrounding population would be 2.07×10^{-6}.

For 35 years of REDC 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 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.

Table 4–87 Generic CLWR and REDC Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 4

Accident	Maximally Exposed 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}	186	0.0931	NA[c]	NA
Large-break LOCA with 5 kg/yr plutonium-238 production	0.0313	1.57×10^{-5}	187	0.0935	NA	NA
Early containment failure with 0 kg/yr plutonium-238 production	3,350	1.00[d]	1.80×10^{6}	1,250	NA	NA
Early containment failure with 5 kg/yr plutonium-238 production	3,670	1.00[d]	1.90×10^{6}	1,340	NA	NA
Late containment failure with 0 kg/yr plutonium-238 production	1.11	5.55×10^{-4}	1.06×10^{5}	53.6	NA	NA
Late containment failure with 5 kg/yr plutonium-238 production	1.12	5.60×10^{-4}	1.06×10^{5}	53.6	NA	NA
Containment bypass with 0 kg/yr plutonium-238 production	1,540	1.00[d]	1.45×10^{6}	922	NA	NA
Containment bypass with 5 kg/yr plutonium-238 production	1,680	1.00[d]	1.52×10^{6}	978	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}	1.69×10^{-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[d]

a. Likelihood of a latent cancer fatality.

b. Number of latent cancer fatalities. The MACCS2 computer code calculates the dose to each exposed individual in the population, applies the appropriate cancer risk factor, and then sums the individual probabilities to determine the 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 4–88 Generic CLWR and REDC Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 4

Accident (Frequency)	Maximally Exposed 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}	4.33×10^{-6}	NA[c]
Large-break LOCA with 5 kg/yr plutonium-238 production (4.65×10^{-5})	7.30×10^{-10}	4.35×10^{-6}	NA
Large-break LOCA incremental risks[d]	5.00×10^{-12}	2.00×10^{-8}	NA
Early containment failure with 0 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}(e)	9.89×10^{-5}	NA
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}(e)	1.06×10^{-4}	NA
Early containment failure incremental risks	0.0	7.10×10^{-6}	NA
Late containment failure with 0 kg/yr plutonium-238 production (1.07×10^{-5})	5.94×10^{-9}	5.74×10^{-4}	NA
Late containment failure with 5 kg/yr plutonium-238 production (1.07×10^{-5})	5.99×10^{-9}	5.74×10^{-4}	NA
Late containment failure incremental risks	5.00×10^{-11}	0.00	NA
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}(e)	0.00141	NA
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}(e)	0.00149	NA
Containment bypass incremental risks	0.0	8.00×10^{-5}	NA
35-year CLWR risk[f]	1.93×10^{-9}	0.00305	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[g]	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 incremental 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.
f. The 35-year risk is determined by summing the incremental annual risks and then multiplying by 35.
g. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

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 4–89 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})	8.65	6.85×10^{-7}
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	8.76	6.94×10^{-7}
Early containment failure incremental risk[c]	NA	9.00×10^{-9}
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	3.48	5.32×10^{-6}
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	3.51	5.37×10^{-6}
Containment bypass incremental risk	NA	5.00×10^{-8}
35-year CLWR risk[d]	NA	2.07×10^{-6}

a. Number of early fatalities assuming that the accident has occurred.
b. Risk of an early fatality.
c. The incremental 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.
d. The 35-year risk is determined by summing the incremental annual risks and then multiplying by 35.

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).

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 689 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 2.6 million kilometers (1.6 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 14 person-rem; the dose to the public, 299 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.006 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 0.0056.

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 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 0.074 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 (see Section 2.7.1.1). 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 waste 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 waste 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 the same 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 4–90** 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.

Table 4–90 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	6.7×10^{-8}	6.7×10^{-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	2.0×10^{-8}	NA[a]
35-year latent cancer fatality risk	0	3.6×10^{-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).

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 6.7×10^{-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 4–91**; 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 170 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0 and approximately 12 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–91. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–91 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	12[b]	12
35-year latent cancer fatalities	0	0.17	0.17
Average worker dose (millirem per year)	0	170	NA[c]
35-year latent cancer fatality risk	0	0.0023	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 1999j). Further, DOE recommends that facilities adopt a more limiting, 500 millirem per year, Administrative Control Level (DOE 1999j). 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: Wham 1999b, 2000.

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 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 plant specific, summing 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 4–92** and **4–93**, 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 4–94**. The early fatalities shown in Table 4–94 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 0.00305. The increased risk of an early fatality in the surrounding population would be 2.07×10^{-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 0.0318.

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 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 4–92 Generic CLWR and FDPF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 5

Accident	Maximally Exposed 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}	186	0.0931	NA[c]	NA
Large-break LOCA with 5 kg/yr plutonium-238 production	0.0313	1.57×10^{-5}	187	0.0935	NA	NA
Early containment failure with 0 kg/yr plutonium-238 production	3,350	1.00[d]	1.80×10^{6}	1,250	NA	NA
Early containment failure with 5 kg/yr plutonium-238 production	3,670	1.00[d]	1.90×10^{6}	1,340	NA	NA
Late containment failure with 0 kg/yr plutonium-238 production	1.11	5.55×10^{-4}	1.06×10^{5}	53.6	NA	NA
Late containment failure with 5 kg/yr plutonium-238 production	1.12	5.60×10^{-4}	1.06×10^{5}	53.6	NA	NA
Containment bypass with 0 kg/yr plutonium-238 production	1,540	1.00[d]	1.45×10^{6}	922	NA	NA
Containment bypass with 5 kg/yr plutonium-238 production	1,680	1.00[d]	1.52×10^{6}	978	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. The MACCS2 computer code calculates the dose to each exposed individual in the population, applies the appropriate cancer risk factor, and then sums the individual probabilities to determine the 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 4–93 Generic CLWR and FDPF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 5

Accident (Frequency)	Maximally Exposed 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}	4.33×10^{-6}	NA[c]
Large-break LOCA with 5 kg/yr plutonium-238 production (4.65×10^{-5})	7.30×10^{-10}	4.35×10^{-6}	NA
Large-break LOCA incremental risks[d]	5.00×10^{-12}	2.00×10^{-8}	NA
Early containment failure with 0 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}[e]	9.89×10^{-5}	NA
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}[e]	1.06×10^{-4}	NA
Early containment failure incremental risks	0.0	7.10×10^{-6}	NA
Late containment failure with 0 kg/yr plutonium-238 production (1.07×10^{-5})	5.94×10^{-9}	5.74×10^{-4}	NA
Late containment failure with 5 kg/yr plutonium-238 production (1.07×10^{-5})	5.99×10^{-9}	5.74×10^{-4}	NA
Late containment failure incremental risks	5.00×10^{-11}	0.0	NA
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}[e]	0.00141	NA
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}[e]	0.00149	NA
Containment bypass incremental risks	0.0	8.00×10^{-5}	NA
35-year CLWR risk[f]	1.93×10^{-9}	0.00305	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[g]	1.49×10^{-5}	0.0318	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 incremental 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.
f. The 35-year risk is determined by summing the incremental annual risks and then multiplying by 35.
g. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

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 4–94 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})	8.65	6.85×10^{-7}
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	8.76	6.94×10^{-7}
Early containment failure incremental risk[c]	NA	9.00×10^{-9}
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	3.48	5.32×10^{-6}
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	3.51	5.37×10^{-6}
Containment bypass incremental risk	NA	5.00×10^{-8}
35-year CLWR risk[d]	NA	2.07×10^{-6}

a. Number of early fatalities assuming that the accident has occurred.
b. Risk of an early fatality.
c. The incremental 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.
d. The 35-year risk is determined by summing the incremental annual risks and multiplying by 35.

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 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 4–95**. 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 highway (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 4–95 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 highway (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 a noninvolved worker, 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 highway access.

The impacts associated with the accidental release of nitric acid and nitric oxide at FDPF are presented in **Table 4–96**.

Table 4–96 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
Noninvolved worker (640 meters)	Parts per million Level of concern Potential health effects	3.3 <ERPG-2 Mild, transient	8.4 <ERPG-2 Mild, transient	4.2 <LOC Mild, transient	67.5 >LOC Serious
Nearest highway maximally exposed 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
Site boundary maximally exposed 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 689 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 3.1 million kilometers (1.9 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 17 person-rem; the dose to the public, 357 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.007 latent cancer fatality among transportation workers and 0.18 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 0.0066.

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 0.088 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 (see Section 2.7.1.1). 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 waste 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 waste 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 the discharge of process and sanitary effluents by FMEF would increase.

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 4–97** 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.

Table 4–97 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	8.3×10^{-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).

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 8.3×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–98**; 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 170 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0 and approximately 12 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–98. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–98 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	12[b]	12
35-year latent cancer fatalities	0	0.17	0.17
Average worker dose (millirem per year)	0	170	NA[c]
35-year latent cancer fatality risk	0	0.0023	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 1999j). Further, DOE recommends that facilities adopt a more limiting, 500 millirem per year, Administrative Control Level (DOE 1999j). 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: Wham 1999b, 2000.

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 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 plant specific, summing 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 4–99** and **4–100**, 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 4–101**. The early fatalities shown in Table 4–101 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 0.00305. The increased risk of an early fatality in the surrounding population would be 2.07×10^{-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 0.112.

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 0.115.

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.

Table 4–99 Generic CLWR and FMEF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 6

Accident	Maximally Exposed 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}	186	0.0931	NA[c]	NA
Large-break LOCA with 5 kg/yr plutonium-238 production	0.0313	1.57×10^{-5}	187	0.0935	NA	NA
Early containment failure with 0 kg/yr plutonium-238 production	3,350	1.00[d]	1.80×10^{6}	1,250	NA	NA
Early containment failure with 5 kg/yr plutonium-238 production	3,670	1.00[d]	1.90×10^{6}	1,340	NA	NA
Late containment failure with 0 kg/yr plutonium-238 production	1.11	5.55×10^{-4}	1.06×10^{5}	53.6	NA	NA
Late containment failure with 5 kg/yr plutonium-238 production	1.12	5.60×10^{-4}	1.06×10^{5}	53.6	NA	NA
Containment bypass with 0 kg/yr plutonium-238 production	1,540	1.00[d]	1.45×10^{6}	922	NA	NA
Containment bypass with 5 kg/yr plutonium-238 production	1,680	1.00[d]	1.52×10^{6}	978	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	0.00823	6.41×10^{5}	321	921	1.0[d]

a. Likelihood of a latent cancer fatality.

b. Number of latent cancer fatalities. The MACCS2 computer code calculates the dose to each exposed individual in the population, applies the appropriate cancer risk factor, and then sums the individual probabilities to determine the 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 4–100 Generic CLWR and FMEF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 6

Accident (Frequency)	Maximally Exposed 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}	4.33×10^{-6}	NA[c]
Large-break LOCA with 5 kg/yr plutonium-238 production (4.65×10^{-5})	7.30×10^{-10}	4.35×10^{-6}	NA
Large-break LOCA incremental risks[d]	5.00×10^{-12}	2.00×10^{-8}	NA
Early containment failure with 0 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}[(e)]	9.89×10^{-5}	NA
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	7.92×10^{-8}[(e)]	1.06×10^{-4}	NA
Early containment failure incremental risks	0.0	7.10×10^{-6}	NA
Late containment failure with 0 kg/yr plutonium-238 production (1.07×10^{-5})	5.94×10^{-9}	5.74×10^{-4}	NA
Late containment failure with 5 kg/yr plutonium-238 production (1.07×10^{-5})	5.99×10^{-9}	5.74×10^{-4}	NA
Late containment failure incremental risks	5.00×10^{-11}	0.0	NA
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}[(d)]	0.00141	NA
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	1.53×10^{-6}[(e)]	0.00149	NA
Containment bypass incremental risks	0.0	8.00×10^{-5}	NA
35-year CLWR risk[f]	1.93×10^{-9}	0.00305	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[g]	2.88×10^{-6}	0.115	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 incremental 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.
f. The 35-year risk is determined by summing the incremental annual risks and then multiplying by 35.
g. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

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 4–101 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})	8.65	6.85×10^{-7}
Early containment failure with 5 kg/yr plutonium-238 production (7.92×10^{-8})	8.76	6.94×10^{-7}
Early containment failure incremental risk[c]	NA	9.00×10^{-9}
Containment bypass with 0 kg/yr plutonium-238 production (1.53×10^{-6})	3.48	5.32×10^{-6}
Containment bypass with 5 kg/yr plutonium-238 production (1.53×10^{-6})	3.51	5.37×10^{-6}
Containment bypass incremental risks	NA	5.00×10^{-8}
35-year CLWR risk[d]	NA	2.07×10^{-6}

a. Number of early fatalities assuming that the accident has occurred.
b. Risk of an early fatality.
c. The incremental 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.
d. The 35-year risk is determined by summing the incremental annual risks and then multiplying by 35.
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).

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 4–102**. 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 highway (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 4–102 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 1,900 meters (0.31 and 1.18 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 highway (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 a noninvolved worker, 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 highway access. 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 4–103**.

Table 4–103 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
Noninvolved worker (640 meters)	Parts per million Level of concern Potential health effects	3.3 <ERPG-2 Mild, transient	8.6 <ERPG-2 Mild, transient	4.2 <LOC Mild, transient	66 >LOC Serious
Nearest highway maximally exposed 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
Site boundary maximally exposed 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 689 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 3.6 million kilometers (2.2 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 20 person-rem; the dose to the public, 411 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.008 latent cancer fatality among transportation workers and 0.21 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 0.0075.

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 (see Section 2.7.1.1). 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 waste 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 waste 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 was conducted with the U.S. Fish and Wildlife Service (see Table 5–3) and resulted in the Service concluding that it does not anticipate adverse effects to federally listed endangered species that occur near the project area. DOE has also consulted with the Tennessee Department of Environment and Conservation; a response concerning state-listed species is pending from this agency. Although no state-listed species are expected to be impacted by the proposed action, no action would be taken relative to the use of facilities at ORR prior to the receipt of input from the state.

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 was initiated with the State Historic Preservation Office (see Table 5–3). While DOE has made additional contact with the State Historic Preservation Office, a response is pending from this office. Although impacts to cultural resources are not expected as a result of the proposed action, no action would be taken relative to the use of facilities at ORR prior to the receipt of input from 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 4–104** 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.

Table 4–104 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).

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 4–105**; 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 170 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0, 0, and approximately 12 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–105. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–105 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	12[b]	12
35-year latent cancer fatalities	0	0	0.17	0.17
Average worker dose (millirem per year)	0	0	170	NA[c]
35-year latent cancer fatality risk	0	0	0.0023	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 1999j). Further, DOE recommends that facilities adopt a more limiting, 500 millirem per year, Administrative Control Level (DOE 1999j). 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: Mecham 1999; Wham 1999b, 2000.

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 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, summing 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 4–106** and **4–107**, 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 4–107 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 0.089 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 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 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.

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.

Table 4–106 ATR, HFIR, and REDC Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 7

	Maximally Exposed 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 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}	1.69×10^{-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[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 4–107 ATR, HFIR, and REDC Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 7

Accident (Frequency)	Maximally Exposed 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}
Large-break LOCA incremental risks[c]	4.20×10^{-9}	2.00×10^{-5}	5.50×10^{-8}
Neptunium-237 target handling with 3 kg/yr plutonium-238 production[d] (0.001)	6.15×10^{-11}	3.93×10^{-8}	7.80×10^{-10}
35-year ATR risk[e]	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}
Large-break LOCA incremental risks[c]	0.0	1.00×10^{-6}	0.0
Neptunium-237 target handling with 2 kg/yr plutonium-238 production[d] (0.001)	2.48×10^{-10}	1.68×10^{-7}	9.80×10^{-10}
35-year HFIR risk[e]	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}[f]
35-year REDC risk	5.71×10^{-5}	0.157	3.50×10^{-4}
35-year Option risk[g]	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. The incremental 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.
d. There would be no neptunium-237 targets for the zero-production case. Thus, the (3 kg/yr at ATR, 2 kg/yr at HFIR) production rate target-handling risks are the incremental risks.
e. The 35-year risk is determined by summing the incremental annual risks and then multiplying by 35.
f. Risk of an early fatality.
g. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

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.

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 563 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, 192 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.004 latent cancer fatality among transportation workers and 0.096 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 0.0052.

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, 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 expected latent cancer fatalities among populations at risk due to accidents listed in Table 4–107 would be approximately 0.16. 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 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). 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 waste 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 waste 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 waste 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 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 4–108** 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 cancer fatalities in the populations surrounding INEEL and ORR from 35 years of operations would be 6.7×10^{-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}.

Table 4–108 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	6.7×10^{-8}	6.7×10^{-8}	6.7×10^{-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	2.0×10^{-8}	2.0×10^{-8}	NA[a]
35-year latent cancer fatality risk	0	0	3.6×10^{-13}	3.6×10^{-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).

Incremental doses to involved workers from normal operations are given in **Table 4–109**; 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 170 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0, 0, and approximately 12 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–109. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–109 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		Total
		ATR	FDPF	
Total dose (person-rem per year)	0	0	12[b]	12
35-year latent cancer fatalities	0	0	0.17	0.17
Average worker dose (millirem per year)	0	0	170	NA[c]
35-year latent cancer fatality risk	0	0	0.0023	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 1999j). Further, DOE recommends that facilities adopt a more limiting, 500 millirem per year, Administrative Control Level (DOE 1999j). 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: Mecham 1999; Wham 1999b, 2000.

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.

Estimates of radiological consequences have been developed for the maximally exposed 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, summing 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 4–110** and **4–111**, 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^{-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 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.

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.

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.

Table 4–110 ATR, HFIR, and FDPF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 8

Accident	Maximally Exposed 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.

Table 4–111 ATR, HFIR, and FDPF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 8

Accident (Frequency)	Maximally Exposed 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}
Large-break LOCA incremental risks[c]	4.20×10^{-9}	2.00×10^{-5}	5.50×10^{-8}
Neptunium-237 target handling with 3 kg/yr plutonium-238 production[d] (0.001)	6.15×10^{-11}	3.93×10^{-8}	7.80×10^{-10}
35-year ATR risk[e]	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}
Large-break LOCA incremental risks[c]	0.0	1.00×10^{-6}	0.0
Neptunium-237 target handling with 2 kg/yr plutonium-238 production[d] (0.001)	2.48×10^{-10}	1.68×10^{-7}	9.80×10^{-10}
35-year HFIR risk[e]	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}[f]
35-year FDPF risk	1.49×10^{-5}	0.0287	3.50×10^{-4}
35-year Option risk[g]	1.50×10^{-5}	0.0295	3.52×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. The incremental 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.
d. There would be no neptunium-237 targets for the zero-production case. Thus, the (3 kg/yr at ATR, 2 kg/yr at HFIR) production rate target-handling risks are the incremental risks.
e. The 35-year risk is determined by summing the incremental annual risks and then multiplying by 35.
f. Risk of an early fatality.
g. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

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.

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 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 4–112**. 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 highway (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 4–112 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

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 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 highway (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 a noninvolved worker, 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 highway access.

The impacts associated with the accidental release of nitric acid and nitric oxide at FDPF are presented in **Table 4–113**.

Table 4–113 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
Noninvolved worker (640 meters)	Parts per million Level of concern Potential health effects	3.3 <ERPG-2 Mild, transient	8.4 <ERPG-2 Mild, transient	4.2 <LOC Mild, transient	67.5 >LOC Serious
Nearest highway maximally exposed 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
Site boundary maximally exposed 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.

4.4.8.1.11 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 311 intersite shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 0.99 million kilometers (0.62 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 6 person-rem; the dose to the public, 103 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0024 latent cancer fatality among transportation workers and 0.052 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 0.0030.

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 0.088 person-rem, resulting in 4.4×10^{-5} latent cancer fatality; and traffic accidents resulting in 0.024 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 4–108). 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 19, and the likelihood of a nonradiological fatality due to vehicular emissions would be approximately 1 in 330 (derived from information in Section 4.4.8.1.11).

ACCIDENTS. The number of expected latent cancer fatalities among the populations at risk due to accidents listed in Table 4–111 would be approximately 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. 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 0.052 latent cancer fatality and the risk of a fatal traffic collision during 35 years of shipments would be approximately 0.024 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 waste 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 waste from ATR operations is discussed in Section 4.4.1.1.13. The anticipated incremental generation of waste 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 waste 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 the same as those described for Option 1 (Section 4.4.1.1.4).

Impacts for this option at ORR would be the same as 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 4–114** 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.

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 4–114 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	8.3×10^{-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).

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 8.3×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–115**; 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 170 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be 0, 0, and approximately 12 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers from 35 years of operations are included in Table 4–115. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–115 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	12[b]	12
35-year latent cancer fatalities	0	0	0.17	0.17
Average worker dose (millirem per year)	0	0	170	NA[c]
35-year latent cancer fatality risk	0	0	0.0023	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 1999j). Further, DOE recommends that facilities adopt a more limiting, 500 millirem per year, Administrative Control Level (DOE 1999j). 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: Mecham 1999; Wham 1999b, 2000.

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 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, summing 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 4–116** and **4–117**, 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}.

Table 4–116 ATR, HFIR, and FMEF Accident Consequences Under Alternative 2 (Use Only Existing Operational Facilities)—Option 9

Accident	Maximally Exposed 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	0.00823	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 4–117 ATR, HFIR, and FMEF Accident Risks Under Alternative 2 (Use Only Existing Operational Facilities)—Option 9

Accident (Frequency)	Maximally Exposed 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}
Large-break LOCA incremental risks[c]	4.20×10^{-9}	2.00×10^{-5}	5.50×10^{-8}
Neptunium-237 target handling with 3 kg/yr plutonium-238 production[d] (0.001)	6.15×10^{-11}	3.93×10^{-8}	7.80×10^{-10}
35-year ATR risk[e]	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}
Large-break LOCA incremental risks[c]	0.0	1.00×10^{-6}	0.0
Neptunium-237 target handling with 2 kg/yr plutonium-238 production[d] (0.001)	2.48×10^{-10}	1.68×10^{-7}	9.80×10^{-10}
35-year HFIR risk[e]	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}[(f)]
35-year FMEF risk	2.88×10^{-6}	0.112	3.50×10^{-4}
35-year Option risk[g]	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. The incremental 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.
d. There would be no neptunium-237 targets for the zero-production case. Thus, the (3 kg/yr at ATR, 2kg/yr at HFIR) production rate target-handling risks are the incremental risks.
e. The 35-year risk is determined by summing the incremental annual risks and then multiplying by 35.
f. Risk of an early fatality.
g. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

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 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 4–118**. 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 highway (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 4–118 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 1,900 meters (0.31 and 1.18 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 highway (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 a noninvolved worker, 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 highway access.

The impacts associated with the accidental release of nitric acid and nitric oxide at FMEF are presented in **Table 4–119**.

Table 4–119 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**
Noninvolved worker (640 meters)	Parts per million Level of concern Potential health effects	3.3 <ERPG-2 Mild, transient	8.4 <ERPG-2 Mild, transient	4.2 <LOC Mild, transient	66 >LOC Serious
Nearest highway maximally exposed 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
Site boundary maximally exposed 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 689 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 1.6 million kilometers (0.99 million miles).

IMPACTS OF INCIDENT-FREE TRANSPORTATION. 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, 167 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0036 latent cancer fatality among transportation workers and 0.084 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 0.0037.

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 4–114). 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, 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 expected latent cancer fatalities among populations at risk due to accidents listed in Table 4–117 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). 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 waste 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 waste from ATR operations is discussed in Section 4.4.1.1.13. The anticipated incremental generation of waste 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 waste 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.