4.3 ALTERNATIVE 1—RESTART FFTF

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.3.1 Alternative 1 (Restart FFTF)—Option 1

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

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

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

4.3.1.1 Operations and Transportation

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

4.3.1.1.1 Land Resources

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

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

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

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

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

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and civilian nuclear energy research and development missions. These existing structures would require no external modifications. Because the appearance of these buildings would remain unchanged, the current Visual Resource Management Class IV rating for the 300 Area would not change; thus, there would be no impact on visual resources.

4.3.1.1.2 Noise

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

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

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

4.3.1.1.3 Air Quality

There are no planned FFTF outdoor construction activities associated with the restart of FFTF. No airborne constituents are currently measured or have been required to be monitored during previous reactor operations (Nielsen 2000). Several air pollutant sources are operating at FFTF, including the gas turbine emergency generator, the diesel-driven fire pump, and the oil-fired preheaters. They would continue to operate at the existing frequency. The emergency diesel generators are not currently operated or tested. The operation of FFTF would require the emergency diesel generators to be tested approximately 30 minutes each month to ensure operability (Nielsen 2000). Criteria pollutants were modeled for a stack 9.22 meters (30.3 feet) in height at a distance of 7,200 meters (23,600 feet) east of FFTF and compared with the most stringent standards for the Hanford area. The concentrations are based on a dispersion-modeling screening analysis conducted with maximum expected emission rates and a set of worst-case meteorological conditions.

The concentrations at Hanford from FFTF attributable to this option are presented in **Table 4–13.** Only those air pollutants expected to be emitted that have ambient air quality standards are presented in the table. The concentrations were determined to be small and would be below the applicable ambient standards even when ambient monitored values and contributions from other site activities were included.

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

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

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

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]	52.1 74.4
Nitrogen dioxide	Annual	100[b]	0.0118
PM_{10}	Annual 24 hours	50[c] 150[c]	8.4×10^{-4} 9.84
Sulfur dioxide	Annual 24 hours 3 hours 1 hour	50[d] 260[d] 1,300[b] 660[d]	7.86×10^{-4} 9.1 20.5 22.8

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

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

Pollutant	Averaging Period	Allowable PSD Increment (micrograms per cubic meter)	Modeled Increment (micrograms per cubic meter)
Nitrogen dioxide	Annual	25	0.0118
Sulfur dioxide	Annual 24 hours 3 hours	20 91 512	7.86×10^{-4} 9.1 20.5

Key: PSD, Prevention of Significant Deterioration.
Source: Modeled PSD increments are based on the SCREEN3 computer code (EPA 1995).

The air pollutant concentrations at ORR attributable to this option at REDC are presented in **Table 4–15**. The concentrations are based on a dispersion-modeling screening analysis conducted with maximum expected emission rates and a set of worst-case meteorological conditions. Criteria pollutants were modeled for a stack height of 76.2 meters (250 feet) at the boundary limit of 4,988 meters (16,370 feet). Only those air pollutants expected to be emitted that have ambient air quality standards are presented in the table.

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

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

a. For comparison with ambient air quality standards.
Source: Modeled increments are based on the SCREEN3 computer code (EPA 1995).

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

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

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

4.3.1.1.4 Water Resources

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

Incremental effects on key water resource indicators under this option are summarized in **Table 4–16**. During current standby operations, annual average groundwater withdrawal by 400 Area facilities is about 197 million liters (52 million gallons). Should FFTF be restarted, FFTF operations would increase water use by about 61 million liters (16 million gallons) to a total annual withdrawal of approximately 258 million liters (68 million gallons) (Nielsen 1999:38, 41). In addition to higher process cooling demands at FFTF from cooling tower operation, this increase reflects additional staffing and associated potable and sanitary water demands in the 400 Area (DOE 2000a:11; Nielsen 1999:38, 41). This volume of 258 million liters (68 million gallons) per year is approximately 65 percent of the 400 Area groundwater production capacity of about 398 million liters (105.1 million gallons) per year (DOE 1999a:4-262). However, no impact on regional groundwater levels would be expected from increased withdrawals (Nielsen 1999:38). Resumption of groundwater withdrawals could potentially affect the direction of groundwater flow in the unconfined aquifer system on a localized basis. Surface water would not be used for operation of the 400 Area facilities; thus, there would be no impact on the availability of surface water from the Columbia River.

Table 4–16 Incremental Water Use and Wastewater Generation Associated with Operating FFTF and RPL/306–E at Hanford and REDC at ORR Under Alternative 1 (Restart FFTF)—Option 1

Indicator (million liters per year)	Hanford			
	FFTF Operations[a]	FFTF Increment Over Standby[b]	RPL/306–E	ORR REDC
Water use	258	61	~ 0.016[c]	2.86
Process wastewater generation	98	22	0.016	0.023
Sanitary wastewater generation	5.7	1.9	0	2.83

a. These estimates represent total projected operational impacts after restart.
b. Incremental impacts of FFTF restart and operation over standby operations (see Table 4–1).
c. Water use for RPL/306–E operations is estimated to be approximately equal to the process wastewater estimate, as no other additional demands on water use are expected.
Note: To convert from liters per year to gallons per year, multiply by 0.264; ~ means "approximately."
Source: DOE 2000a:11, C-3; Nielsen 1999:38, 41; Wham 1999c.

Additional staffing required to support the restart of FFTF would also increase annual sanitary wastewater generation in the 400 Area by approximately 1.9 million liters (502,000 gallons) over standby to about 5.7 million liters (1.5 million gallons) per year during operations (DOE 2000a:11). Sanitary wastewater from the 400 Area is conveyed to the Energy Northwest treatment system (Nielsen 1999:39). The Energy Northwest treatment system has a treatment capacity of approximately 235 million liters (62 million gallons) per year with sufficient excess capacity to accommodate increased flow from the 400 Area (DOE 1999a:4-41).

There are no radiological liquid effluent pathways to the environment from FFTF. Process (nonradioactive) wastewater from 400 Area facilities is discharged to the 400 Area process sewer system and ultimately to the 400 Area Pond (i.e., 4608 B/C percolation ponds). These discharges are regulated under State Waste Discharge Permit No. ST-4501. This system is further described in Section 3.4.4.1.2. Process wastewater discharges from FFTF would increase by about 22 million liters (5.8 million gallons) annually over standby to approximately 98 million liters (26 million gallons) per year during operations. Increased process wastewater volume would mainly consist of cooling tower blowdown from FFTF's eight cooling towers. However, chemical usage required to control scaling and biofouling of the cooling water systems would not increase (DOE 2000a:11; Nielsen 1999:38). Therefore, as the chemical quality of the process wastewater would not change, no impact on groundwater quality would be expected.

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

REDC 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 proposed activities similar to the current mission of REDC. As existing facilities would be used, there would be no construction-related impacts on water bodies, floodplains, or on surface water or groundwater quality. As summarized in Table 4–16, a relatively small increase in water use and sanitary wastewater generation is projected mainly to support the additional staffing required at REDC (see Section 4.3.1.1.8). The only other measurable increase would be an additional 23,000 liters (6,100 gallons) per year of process wastewater associated with target processing (Wham 1999c). Changes in the quantity or quality, if any, of process and sanitary wastewater discharges would be very small compared to that of other activities with no radiological liquid effluent discharge to the environment under normal operations (Wham 1999a; LMER 1997). Specifically, the anticipated additional 23,000 liters (6,100 gallons) of process wastewater generated per year would be negligible relative to the total volume of process wastewater generated and treated at the ORNL Process Waste Treatment Complex, approximately 2.08 million liters (550,000 gallons) per day (Section 3.2.4.1.2). All wastewaters would be discharged to designated collection and treatment systems as described in Section 3.2.4.1.2. Overall, no measurable impact on water resources at ORR is expected.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and civilian nuclear energy research and development missions. However, radiological activities would be confined to RPL, with Building 306–E providing support to activities not involving radioactive materials (DOE 2000a:C-1). As existing facilities would be used requiring no external modifications, there would be no construction-related impacts on water bodies, floodplains, or on surface water or groundwater quality. Little measurable increase in water use is anticipated to support target fabrication and processing for medical, industrial, and research and development isotope production, with no radiological liquid effluent discharge to the environment under normal operations (DOE 1997b:4-28, 4-29). Also, changes in the quantity or quality of process and sanitary wastewater discharges would be negligible compared to that of other RPL activities, with the only projected increase resulting from equipment washing of nonradiological target materials (DOE 1997b:4-30). Process wastewater discharge from washing activities at RPL is projected to increase by about 16,000 liters (4,200 gallons) per year from a current annual average of approximately 3.6 million liters (950,000 gallons) (DOE 2000a:C-3). This is an increase of less than 1 percent. The only increase in water use expected would be to support this minor increase in processing activity. Process wastewater is discharged to the 300 Area retention process sewer system (Section 3.4.4.1.2). Thus, impacts on water resources at Hanford are expected to be negligible overall.

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

4.3.1.1.5 Geology and Soils

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

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

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

4.3.1.1.6 Ecological Resources

Terrestrial resources would not be adversely affected by the restart of FFTF because it is in the highly disturbed and fenced 400 Area and no new construction is planned. Further, as noted in Section 4.3.1.1.2, there would be no change in noise impacts on wildlife. Because additional surface water would not be used and wastewater discharge chemistry would not be expected to change, there would be no change in impacts on aquatic habitat or wetlands associated with the Columbia River (Section 4.3.1.1.4). Due to the developed nature of the area and the fact that no new construction would take place, impacts on threatened and endangered species would not occur.

RPL/306–E in the 300 Area of Hanford would be used for the fabrication and processing of targets associated with the medical and industrial isotope production and civilian nuclear energy research and development missions. Because use of these buildings would not involve any new construction, direct disturbance to ecological resources would not occur. As noted in Section 4.3.1.1.2, wildlife would not be adversely affected by noise associated with target fabrication and processing activities. Because water usage and wastewater discharge would be small fractions of current values and discharge chemistry would not be expected to change, there would be no change in impacts on aquatic habitat or wetlands associated with the Columbia River

(Section 4.3.1.1.4). Due to the developed nature of the area and the fact that no new construction would take place, impacts on threatened and endangered species would not occur.

Consultation 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.

The existing REDC at ORR would be used for neptunium-237 storage, target fabrication, and processing. No new construction would take place; thus, direct disturbance to ecological resources, including wetlands, would not occur. As noted in Section 4.3.1.1.2, there would be no change in noise impacts on wildlife. Because there are no wetlands in or directly adjacent to the 7900 Area, this resource would not be affected. There would be no change in impacts on aquatic resources because no additional water would be withdrawn from or discharged to site surface waters and discharge chemistry would not be expected to change (Section 4.3.1.1.4). Threatened and endangered species would not be impacted because an existing facility in the developed area would be used.

Consultation to comply with Section 7 of the Endangered Species Act 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.

4.3.1.1.7 Cultural and Paleontological Resources

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

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

Consultation to comply with Section 106 of the National Historic Preservation Act 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.

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

Consultation to comply with Section 106 of the National Historic Preservation Act 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.

4.3.1.1.8 Socioeconomics

Operating FFTF and target fabrication and processing of all other targets at Hanford 300 Area facilities would require about 218 additional workers to operate these facilities (DOE 1997b; Hoyt et al. 1999). This level of employment would generate about 552 indirect jobs in the region around Hanford. The potential total employment increase of 770 direct and indirect jobs in the Hanford region represents an approximate 0.3 percent increase in the projected regional economic area workforce. It would have no noticeable impact on the regional economic area.

Additional employment resulting from this option would not have any noticeable impact on community services in the Hanford region of influence. Assuming that 91 percent of the new employment associated with this option would reside in Hanford's region of influence (Section 3.4.8), 701 new jobs could increase the region's population by approximately 1,346 persons. This increase, in conjunction with normal population growth forecasted by the State of Washington, would not have any noticeable impact on the availability of housing and/or the price of housing in the region of influence. Given the current population-to-student ratio in the region of influence, this would likely result in an increase of about 279 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: 17 new teachers would be needed to maintain the current student-to-teacher ratio of 16:1; 2 new police officers would be needed to maintain the current officer-to-population ratio of 1.5:1000; 5 new firefighters would need to be added to maintain the current firefighter-to-population ratio of 3.4:1000; and 2 new doctors would be needed to maintain the current doctor-to-population ratio of 1.4:1000. Thus, an additional 26 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 increase from 92.5 percent to 93.1 percent. None of these projected changes should have a major impact on the level of community services currently offered in the region of influence.

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

Additional employment resulting from this option would not have any noticeable impact on community services in the ORR region of influence. Assuming that 89.9 percent of the new employment associated with this option would reside in ORR's region of influence (Section 3.2.8), 146 total new jobs could increase the region's population by approximately 248 persons. This increase, in conjunction with normal population growth forecasted by the State of Tennessee, would have no noticeable effect on the availability of housing and/or the price of housing in the region of influence. The public would experience little or no change in the level of community services currently offered in the region of influence.

4.3.1.1.9 Public and Occupational Health and Safety—Normal Operations

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

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

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup, processing, and operations are given in **Table 4–17** for FFTF and RPL at Hanford and REDC at ORR: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

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

To represent a bounding annual dose scenario at Hanford, it is assumed that a full-year's isotopic release would occur from target processing at RPL concurrently with a full-year's release from FFTF operations at 400 megawatts; the impacts presented in Table 4–17 assume a full-year's release resulting from FFTF and RPL preoperational testing and startup activities. To represent a bounding annual dose scenario at ORR, it is assumed that a full year's release would occur from neptunium-237 target processing at REDC.

As a result of annual operations, the bounding projected total incremental population dose in the year 2020 for the populations surrounding Hanford and ORR would be 0.25 person-rem. The corresponding number of latent cancer fatalities in these populations from 35 years of operations would be 0.0044. The bounding total incremental dose to the maximally exposed member of the public from annual operations at Hanford would be 0.0054 millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 9.5×10^{-8}. The incremental dose to the maximally exposed member of the public from annual operations at ORR would be 1.9×10^{-6} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 3.3×10^{-11}.

Table 4–17 Incremental Radiological Impacts on the Public Around ORR and Hanford from Operational Facilities Under Alternative 1 (Restart FFTF)—Option 1

Receptor	ORR REDC Processing[a]	Hanford FFTF Preoper. Activities[b]	Hanford RPL Preoper. Activities[b]	Hanford FFTF Operations	Hanford RPL Target Processing[a]	Hanford Operations and Processing Total[c]
Population within 80 kilometers (50 miles) in the year 2020						
Dose (person-rem)	8.8×10^{-5}	0.028	1.0[d]	0.044	0.21	0.25
1-year latent cancer fatalities	–	1.4×10^{-5}	5.0×10^{-4}	–	–	–
35-year latent cancer fatalities	1.5×10^{-6}	–	–	7.7×10^{-4}	0.0037	0.0044
Maximally exposed individual						
Annual dose (millirem)	1.9×10^{-6}	1.4×10^{-4}	0.043[c]	4.1×10^{-4}	0.0050	0.0054
1-year latent cancer fatality risk	–	6.8×10^{-11}	2.2×10^{-8}	–	–	–
35-year latent cancer fatality risk	3.3×10^{-11}	–	–	7.2×10^{-9}	8.8×10^{-8}	9.5×10^{-8}
Average exposed individual within 80 kilometers (50 miles)						
Annual dose[e] (millirem)	7.8×10^{-8}	5.7×10^{-5}	2.0×10^{-3} [c]	8.8×10^{-5}	4.2×10^{-4}	5.0×10^{-4}
1-year latent cancer fatality risk	–	2.8×10^{-11}	9.9×10^{-10}	–	–	–
35-year latent cancer fatality risk	1.4×10^{-12}	–	–	1.5×10^{-9}	7.3×10^{-9}	8.8×10^{-9}

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

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

Incremental doses to involved workers from normal operations are given in **Table 4–18**; these workers are defined as those directly associated with all process and operational activities. The incremental annual average dose to REDC workers would be 170 millirem; the incremental annual average dose to FFTF workers (during startup) would be 3.5 millirem; the incremental annual average dose to FFTF workers (during operations) would be 6.6 millirem; the incremental annual average dose to RPL workers (during startup) would be 81 millirem; and the incremental annual average dose for RPL workers (during processing) is estimated to be approximately 160 millirem. The incremental annual dose received by the total site workforce for each of these facilities (at the different phases) would be approximately 12, 0.69, 1.3, 3.2, and 4.8 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers are included in Table 4–18. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–18 Incremental Radiological Impacts on Involved REDC, FFTF, and RPL Workers Under Alternative 1 (Restart FFTF)—Option 1

Receptor—Involved Workers[a]	ORR REDC Processing[b]	Hanford FFTF Preoper. Activities	Hanford RPL Preoper. Activities	Hanford FFTF Operations	Hanford RPL Target Processing[b]	Hanford Operations & Processing Total
Total dose (person-rem per year)	12[c]	0.69[d]	3.2[e]	1.3[d]	4.8[f]	6.1
1-year latent cancer fatalities	–	2.8×10^{-4}	0.0013	–	–	–
35-year latent cancer fatalities	0.17	–	–	0.018	0.067	0.086
Average worker dose (millirem per year)	170	3.5	81	6.6	160	NA
1-year latent cancer fatality risk	–	1.4×10^{-6}	3.2×10^{-5}	–	–	–
35-year latent cancer fatality risk	0.0023	–	–	9.2×10^{-5}	0.0022	NA

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 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. Target storage, processing, and fabrication activities are performed at this facility. Impacts, dominated by processing activities, include impacts from all facility target activities.
c. Based on an estimated 75 badged workers.
d. Based on an estimated 200 badged workers.
e. Based on an estimated 40 badged workers.
f. Based on an estimated 30 badged workers.
Key: NA, not applicable.
Source: BWHC 1999; Nielsen 1999; Wham 1999b, 2000.

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

FFTF restart would require emergency diesel generators to be tested. Hazardous chemical impacts are summarized in **Table 4–19**.

Table 4–19 Incremental Hazardous Chemical Impacts Associated with FFTF Emergency Diesel Generators at Hanford Under Alternative 1 (Restart FFTF)—Option 1

Chemical	Modeled Annual Increment (micrograms per cubic meter)	Reference Concentration (micrograms per cubic meter)	Unit Cancer Risk (risk per micrograms per cubic meter)	Hazard Quotient	Cancer Risk
Benzene	2.5×10^{-6}	NA	7.8×10^{-6}	NA	1.96×10^{-11}
Toluene	1.10×10^{-6}	400	NA	2.74×10^{-9}	NA
Propylene	6.92×10^{-6}	NA	3.7×10^{-6}	NA	2.56×10^{-11}
Formaldehyde	3.17×10^{-6}	NA	0.000013	NA	4.12×10^{-11}
Acetaldehyde	2.06×10^{-6}	NA	2.2×10^{-6}	NA	4.53×10^{-12}

Key: NA, not applicable (the chemical is not a known carcinogen or it is a carcinogen and only unit cancer risk will apply).
Source: EPA 1999; model results, using the Screen3 computer model (EPA 1995).

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

The annual concentration for each noncarcinogenic chemical was divided by the corresponding inhalation reference concentration to estimate the Hazard Quotient for each chemical. The Hazard Quotients were summed to give the Hazard Index from all noncarcinogenic chemicals associated with this option. A Hazard Index of less than one indicates that adverse health effects from non-cancer-causing agents are not expected. For carcinogens, the annual concentration was multiplied by the unit cancer risk to estimate the increased cancer risk from that chemical. Hazardous chemical health effects are summarized in **Table 4–20**.

Table 4–20 Incremental Hazardous Chemical Impacts on the Public Around ORR Under Alternative 1 (Restart FFTF)—Option 1

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

Note: For diethyl benzene, the reference concentration for ethyl benzene and the unit cancer risk for benzene were used to estimate Hazard Quotient and cancer risk because no information was available for diethyl benzene. For tributyl phosphate, the reference concentration for phosphoric acid was used to estimate the Hazard Quotient because no information was available for tributyl phosphate. Propylene oxide cancer unit was used for propylene.
Key: NA, not applicable (the chemical is not a known carcinogen or it is a carcinogen and only unit cancer risk will apply).
Source: DOE 1996a; EPA 1999; model results, using the SCREEN3 computer code (EPA 1995).

4.3.1.1.10 Public and Occupational Health and Safety—Facility Accidents

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

The accident analysis incorporates external events (e.g., earthquakes, fires) as well as internal events (e.g., equipment failure, human errors). A recent external event of concern is the threat of wildfires. While two large range fires at Hanford in 1984 and in June 2000 burned very close to FFTF, neither caused any damage or operational difficulties at the facility. Several features of FFTF make it well equipped to deal with a large range fire. A more detailed discussion is provided in Section I.1.1.4.1.

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 presented in Section 4.2.1.2.10. Consequences to involved workers are addressed in Section I.1.7.

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

Consequences and associated risks are presented in **Tables 4–21** and **4–22**, respectively.

FFTF would operate for 21 years with a mixed oxide core followed by 14 years with a highly enriched uranium core. As shown in Table 4–21, the beyond-design-basis core melt accident would result in the largest radiological consequences among FFTF accidents. To incorporate internal and external initiators, the accident frequency of 1×10^{-6} was selected for the beyond-design-basis core melt accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.23×10^{-8} and 1.20×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00127.

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

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

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

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

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

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

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

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

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

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

Table 4–22 FFTF, REDC, and RPL Accident Risks Under Alternative 1 (Restart FFTF)—Option 1

Accident (Frequency)	Maximally Exposed Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Beyond-design-basis core melt accident (MOX) (1×10^{-6})	3.40×10^{-10}	3.34×10^{-5}	2.72×10^{-10}
Beyond-design-basis core melt accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-7})	1.92×10^{-13}	6.39×10^{-8}	1.43×10^{-11}
BLTC driver fuel-handling accident (HEU) (1×10^{-7})	1.92×10^{-13}	6.17×10^{-8}	1.36×10^{-11}
BLTC neptunium-237 target-handling accident (1×10^{-7})	1.31×10^{-14}	1.29×10^{-9}	1.12×10^{-12}
BLTC isotope target-handling accident (1×10^{-7})	6.10×10^{-15}	1.37×10^{-10}	5.72×10^{-13}
35-year FFTF risk	1.23×10^{-8}	0.00127	1.20×10^{-8}
Annual REDC risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	3.06×10^{-14}	4.29×10^{-10}	2.24×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	8.79×10^{-13}	9.82×10^{-9}	6.74×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	2.34×10^{-9}	2.61×10^{-5}	1.79×10^{-10}
Plutonium-238 processing facility beyond-design-basis earthquake (1×10^{-5})	1.63×10^{-6}	0.00445	1.00×10^{-5}[c]
35-year REDC risk	5.71×10^{-5}	0.157	3.50×10^{-4}
Annual RPL risks			
Medical and industrial isotopes localized solvent fire (0.044)	2.99×10^{-7}	0.00173	8.35×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	7.60×10^{-6}	0.00675	6.00×10^{-6}
Medical and industrial isotopes glovebox explosion (1×10^{-4})	5.00×10^{-6}	0.00230	3.92×10^{-6}
35-year RPL risk	4.51×10^{-4}	0.377	3.50×10^{-4}
35-year Option risk[d]	4.51×10^{-4}	0.535	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
d. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

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

4.3.1.1.11 Public and Occupational Health and Safety—Transportation

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

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

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

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 31 person-rem; the dose to the public, 299 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.012 latent cancer fatality among transportation workers and 0.15 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.03. About half of the crew risk, about 2 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

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

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

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

4.3.1.1.12 Environmental Justice

NORMAL OPERATIONS. The number of expected latent cancer fatalities among the population residing within 80 kilometers (50 miles) of REDC at ORR and FFTF and RPL at Hanford would be less than 0.005 for 35 years of normal operations (Table 4–17). As shown in Tables 4–19 and 4–20, the release of hazardous chemicals at Hanford and ORR would pose no significant risk of cancer or toxic effects among the public. As discussed in Sections K.5.2 and K.5.3, the expected latent cancer fatalities that would result from the ingestion of food that could be radiologically contaminated due to normal operations would be approximately 0.002 at Hanford and essentially zero at ORR. No credible pattern of food consumption by persons residing in potentially affected areas would result in significant health risks due to radiological contamination of food supplies near Hanford or ORR. As discussed in Section 4.3.1.1.11, incident-free transportation would not be expected to result in fatalities.

ACCIDENTS. Expected latent cancer fatalities among populations at risk due to radiological accidents listed in Table 4–22 would be approximately 0.5. In the event a radiological accident were to occur at REDC and winds were from the southwest, the predominantly minority population of the Scarboro Community adjacent to the northern boundary of ORR would lie in the path of highest potential radiological exposure (see Figure K–6). If the winds were from the west, the predominantly minority populations in Knoxville, Tennessee, would lie in the path of exposure. Because the accidents that could occur under the implementation of this option would not be expected to result in significant offsite exposures to any exposed offsite individual or populations, neither situation would result in a disproportionately high and adverse risk to any group or individuals within the population. If a radiological accident were to occur at FFTF or the 300 Area at Hanford and northeasterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Yakama Indian Reservation (see Figure K–11). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the population or maximally exposed individual residing within the boundary of the Yakama Indian Reservation.

The number of expected latent cancer fatalities resulting from transportation accidents with radiological emissions was found to be approximately 0.5. As discussed in Appendix J, this risk is driven by accidents that could occur during air transportation of medical and industrial isotopes and the conservative assumptions used in the analysis of such accidents. Such accidents could occur anywhere along the flight paths and would not place any identifiable group within the general population at disproportionate risk. As discussed in Section 4.3.2.1.11 and Appendix J, expected fatalities due to a fatal traffic collision would be approximately 0.2.

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

4.3.1.1.13 Waste Management

The expected generation rates of waste at Hanford that would be generated from the operation of FTFF for irradiating targets and RPL/306–E for processing and fabricating target materials for the research and development support and medical and industrial isotope production are compared with Hanford's treatment, storage, and disposal capacities in **Table 4–23**. The expected generation rates of waste at ORR that would be associated with the operation of REDC to fabricate and process the neptunium-237 targets for plutonium-238 production are compared with ORR's treatment, storage, and disposal capacities in **Table 4–24**.

Table 4–23 Incremental Waste Management Impacts of Operating FFTF and RPL/306–E at Hanford Under Alternative 1 (Restart FFTF)—Option 1

Waste Type[a]	Estimated Additional Waste Generation for FFTF (cubic meters per year)	Estimated Total Waste Generation for FFTF Operation[b] (cubic meters per year)	Estimated Additional Waste Generation for RPL/306–E (cubic meters per year)	Estimated Additional Waste Generation (both FFTF and RPL/306–E) as a Percent of[c]		
				Onsite Treatment Capacity	Onsite Storage Capacity	Onsite Disposal Capacity
High-level radioactive	0	0	0	0	0	0
Transuranic	0	0	0	0	0	0
Low-level radioactive						
Liquid	0	<6	0	0	0	0
Solid	63	80	20	NA	NA	0.17
Mixed low-level radioactive	0	<0.5	4	NA	0.83	0.98
Hazardous	0	4	<1	NA	NA	NA
Nonhazardous						
Process wastewater	22,000	98,000	16	(d)	(d)	(d)
Sanitary wastewater	1,900	5,700	0	0.81[e]	NA	NA
Solid	130	250	20	NA	NA	NA

a. See definitions in Section G.9.
b. These estimates represent the sum of the standby waste generation amounts provided for the No Action Alternative (Table 4–6) and the additional waste generation amounts given in the first column of this table (Table 4–23).
c. The estimated additional amounts of waste generated annually are compared with the annual site treatment capacities. The estimated total amounts of additional waste generated over the assumed 35-year operational period are compared with the site storage and disposal capacities.
d. Refer to the text.
e. Percent of capacity of the Energy Northwest Sewage Treatment Facility.
Note: To convert from cubic meters per year to cubic yards per year, multiply by 1.308; < means "less than."
Key: NA, not applicable (i.e., the majority of this waste is not routinely treated, stored, or disposed of on site; refer to the text in this section).
Source: DOE 2000a; Nielsen 1999.

Table 4–24 Incremental Waste Management Impacts of Operating REDC at ORR Under Alternative 1 (Restart FFTF)—Option 1

Waste Type[a]	Estimated Additional Waste Generation (cubic meters per year)	Estimated Additional Waste Generation as a Percent of [b]		
		Onsite Treatment Capacity	Onsite Storage Capacity	Onsite Disposal Capacity
Transuranic/High-level radioactive[c]	11	(c)	18	NA[d]
Low-level radioactive				
Liquid	25	0.13	24[e]	46
Solid	35	NA[f]	2.6[g]	NA[h]
Mixed low-level radioactive				
Liquid	NA[i]	NA[i]	NA[i]	NA[i]
Solid	<5	<2.2[j]	<0.57[k]	NA[h]
Hazardous	6,500 kilograms	NA[l]	NA[l]	NA[l]
Nonhazardous				
Process wastewater	23	0.0017	NA[m]	NA[m]
Sanitary wastewater	2,832	0.0068	NA	NA
Solid	148	NA[n]	NA[n]	0.42

a. See definitions in Section G.9.
b. The estimated additional amounts of waste generated annually are compared with the annual site treatment capacities. The estimated total amounts of additional waste generated over the assumed 35-year operational period are compared with the site storage and disposal capacities.
c. Refer to the text for a discussion on waste classification and treatment.
d. This waste would be stored on site pending availability of a suitable repository. It is assumed this waste would be remotely handled.
e. Liquid low-level radioactive waste is processed through an evaporator for volume reduction. The evaporator bottoms are stored as a concentrated solution.
f. The solid low-level radioactive waste would not be treated on site.
g. Refer to the text for a discussion of potential limitations of the onsite storage capacity for solid low-level radioactive waste and the probable solution.
h. It is anticipated that solid low-level radioactive waste and solid mixed low-level radioactive waste would be disposed of at an off site facility.
i. Reported as low-level radioactive waste.
j. In the short-term, the Toxic Substances Control Act Incinerator would be used for the treatment of solid mixed low-level radioactive waste. If this facility is shut down, the site's management and integration contractor would identify other options for treatment of this waste.
k. Refer to the text for a discussion of potential limitations of the onsite storage capacity for solid mixed low-level radioactive waste and the probable solution.
l. Although there is some treatment and storage capacity for hazardous waste, this waste would be shipped off site to permitted commercial facilities.
m. The nonhazardous process wastewater would be discharged to a permitted outfall or otherwise disposed of off site after onsite treatment.
n. Solid nonhazardous waste would be taken to the Oak Ridge Y–12 landfill for disposal.

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

The impacts on the Hanford and ORR waste management systems in terms of managing the additional waste are discussed in this section. This analysis is consistent with policy and DOE Order 435.1, that DOE radioactive waste shall be treated, stored, and in the case of low-level waste, disposed of at the site where the waste is generated, if practical, or at another DOE facility. However, if DOE determines that use of the Hanford waste management infrastructure or other DOE sites is not practical or cost effective, DOE may issue an exemption under DOE Order 435.1 for the use of non-DOE facilities (i.e., commercial facilities) to store, treat, and dispose of such waste generated from the restart and operation of FFTF. Radiological and chemical impacts on workers and the public from waste management activities are included in the public and occupational health and safety impacts that are given in Sections 4.3.1.1.9 through 4.3.1.1.11.

Canisters used to transport neptunium-237 to ORR would constitute a very small additional amount of solid low-level radioactive waste—less than 10 cubic meters (13.1 cubic yards) over the 35-year operational period, even if no credit is taken for volume reduction by compaction (Brunson 1999a). The annual generation of this waste would fall within the range of accuracy of the generation rate of solid low-level radioactive waste given in Table 4–24, 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* (DOE 1997a) will be treated at Hanford, INEEL, ORR, and SRS and will be disposed of at Hanford and the Nevada Test Site.

No high-level radioactive waste or transuranic waste would be generated from merely operating FFTF or from target fabrication and processing in RPL/306–E.

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

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

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

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

Hazardous 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 35-year operational period would have only a minimal impact on the Hanford hazardous waste management system.

Nonhazardous solid waste would be packaged and transported in conformance with standard industrial practice. Solid 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 sanitary wastewater from FFTF operations would be discharged to the 400 Area sanitary sewer system, which connects to the Energy Northwest Sewage Treatment Facility. Nonhazardous sanitary wastewater generated at FFTF would represent about 0.81 percent of the 235,000-cubic-meter-per-year (307,000-cubic-yard-per-year) capacity of the Energy Northwest Sewage Treatment Facility.

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

The generation rates of waste at Hanford that would be associated with this option (refer to Table 4–23) 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 would be much smaller than the current waste generation rates at the 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 REDC 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 REDC. The resulting glass matrix would be stored on site pending availability of a suitable repository. This additional waste would represent approximately 18 percent of the available 2,169-cubic-meter (2,837-cubic-yard) storage capacity in facilities 7572, 7574, 7826, 7878, 7879, and 7883. The impacts of managing the additional quantities of this waste at ORR would be minimal.

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

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

Mixed low-level radioactive waste associated with neptunium-237 target fabrication and processing at ORR would be stabilized, packaged, and stored on site for treatment and disposal in a manner consistent with the site treatment plan. Liquid mixed low-level radioactive waste is reported as low-level radioactive waste; the generation and management of this waste are covered under the low-level radioactive waste discussion above. Solid mixed low-level radioactive waste generation is estimated to be less than 2.2 percent of the 227-cubic-meter-per-year (297-cubic-yard-per-year) site treatment capacity. If all the solid mixed low-level radioactive waste generated over the 35-year operational period were stored on site, the amount would represent less than 0.57 percent of the 30,780-cubic-meter (40,260-cubic-yard) storage capacity at ORR. However, if account is taken of the existing inventory of solid mixed low-level radioactive waste (24,964 cubic meters [32,700 cubic yards]) and of its present generation rate (801 cubic meters [1,050 cubic yards] per year), part or all of the storage capacity may not be available. As is the case for the solid low-level radioactive waste, arrangements are being made that would allow the solid mixed low-level radioactive waste to be disposed of off site at another DOE site or at a commercial facility, thereby eliminating any onsite storage problems, including the storage capacity limitations at ORR. A draft *Environmental Assessment for Transportation of Low-Level Radioactive Mixed Waste from the Oak Ridge Reservation to Off-Site Treatment or Disposal Facilities* (DOE 2000e) was developed by the Oak Ridge Operations Office.

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

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

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

The generation rates of waste at ORR that would be associated with this option (Table 4–24) can be compared with the current waste generation rates at the site, given in Table 3–11 (Section 3.2.11). The waste generation rates associated with plutonium-238 production would be much smaller than the current waste generation rates at the site. However, if the waste resulting from processing irradiated neptunium-237 is classified as high-level radioactive waste, although ORR does not currently manage high-level radioactive waste, the impacts to the waste management infrastructure would be minimal.

4.3.1.1.14 Spent Nuclear Fuel Management

Data on spent nuclear fuel generation and storage under all options of Alternative 1 are presented in **Table 4–25**.

Table 4–25 Data for Spent Nuclear Fuel Generation and Storage Under All Options of Alternative 1 (Restart FFTF)

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

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

The operation of FFTF would generate about 0.46 metric ton heavy metal (1,012 pounds) of spent nuclear fuel per year. For the 35-year mission at 100 megawatts, this would equate to a total of 16 metric tons of heavy metal (35,200 pounds) of spent nuclear fuel, which is less than 1 weight-percent of the total spent nuclear fuel inventory presently stored at Hanford.

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

Upon cessation of reactor operation, or earlier, the spent nuclear fuel would be packaged in acceptable containers and shipped to a geologic repository for disposal. Refer to Section 4.6.1.3.13 for further information on the geologic repository.

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

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

OPERATIONAL IMPACTS. Operation of the sodium-filled storage vessels and the dry storage casks would not result in significant releases of radionuclides to the environment. The airborne radionuclides emitted from overall FFTF operations have always been at levels practically indistinguishable from natural background radiation. During the last year of reactor operations (1992), the overall radionuclide releases from the entire FFTF complex resulted in a total effective dose equivalent to the maximally exposed member of the public of less than 1.0×10^{-4} millirem (DOE 2000a). This dose is well below EPA's Clean Air Act standard of 10 millirem per year that is cited in DOE Order 5400.5. Any dose contribution from the storage vessels would be expected to be only a small fraction of the overall dose. No radionuclide releases from the dry cask storage system would occur because the spent nuclear fuel is contained in a sealed confinement.

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

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

There would be no liquid releases to the environment associated with spent nuclear fuel management. The environmental impacts associated with the dry spent nuclear fuel storage system are summarized in **Table 4–26**. The dry spent fuel storage at the FFTF site is similar to NRC-approved methods currently being used for interim storage of commercial spent nuclear fuel.

Table 4–26 Environmental Impact of Dry Spent Nuclear Fuel Storage System Under All Options of Alternative 1 (Restart FFTF)

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

Source: BGE 1989; Duke 1988; NRC 1985; NRC 1986.

4.3.2 Alternative 1 (Restart FFTF)—Option 2

Option 2 involves operating FFTF at Hanford to irradiate all targets and materials associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating FDPF at INEEL to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and operating facilities in the Hanford 300 Area to fabricate and process the other targets and materials and to process the associated products. This option includes storage in Building CPP–651 or FDPF of the neptunium-237 transported from SRS to INEEL and storage in RPL/306–E of the other target materials transported to Hanford from other offsite facilities.

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

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

4.3.2.1 Operations and Transportation

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

4.3.2.1.1 Land Resources

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

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

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

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

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

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

4.3.2.1.2 Noise

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

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

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

4.3.2.1.3 Air Quality

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

The concentrations at INEEL attributable to FDPF operations under this option are presented in **Table 4–27**. The concentrations are based on a dispersion-modeling screening analysis conducted with maximum expected emission rates and a set of worst-case meteorological conditions. Criteria and toxic air pollutants were modeled for a stack height of 48.8 meters (160 feet) at a boundary limit of 6,800 meters (22,300 feet). Only those air pollutants expected to be emitted that have ambient air quality standards are presented in the table. The change in concentrations of these pollutants would be small and would be below applicable ambient standards even when ambient monitored values and the contribution from other site activities were included.

Table 4–27 Incremental INEEL Concentrations[a] Associated with Alternative 1 (Restart FFTF)—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.
Note: Toxic air pollutant standards apply to new or modified sources only.
Source: 40 CFR Part 50; ID DHW 1998; modeled increments are based on the SCREEN3 computer code (EPA 1995).

The concentrations at INEEL attributed to this option are compared with the Prevention of Significant Deterioration Class II increments for nitrogen dioxide and sulfur dioxide in **Table 4–28**.

Table 4–28 PSD Class II Increments Compared to INEEL Concentrations Associated with Alternative 1 (Restart FFTF)—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 PSD increments are based on the SCREEN3 computer code (EPA 1995).

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

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

4.3.2.1.4 Water Resources

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

Building CPP–651 and/or FDPF, which are both located within the INTEC area of INEEL, would be used for neptunium-237 storage with target fabrication and processing in support of plutonium-238 production conducted in FDPF. The projected incremental effects on key water resource indicators are summarized in **Table 4–29**. As existing facilities would be used, there would be no construction-related impacts on water bodies, floodplains, or on surface water or groundwater quality. A relatively small increase in water use and sanitary wastewater generation is projected mainly attributable to the additional staffing required at FDPF (see Section 4.3.2.1.8). The only other measurable increase would be an additional 23,000 liters (6,100 gallons) per year of process wastewater associated with target processing in FDPF (Kirkham 1999; Wham 1999c). All wastewater would be discharged to designated collection and treatment systems as described in Section 3.3.4.1.2. There would be no radiological liquid effluent discharge to the environment under normal operations, and no measurable impact on water resources at INEEL would be expected.

Table 4–29 Incremental Water Use and Wastewater Generation Associated with Operating FDPF at INEEL Under Alternative 1 (Restart FFTF)—Option 2

Indicator (million liters per year)	INEEL
	FDPF
Water use	1.68
Process wastewater generation	0.023
Sanitary wastewater generation	1.66

Note: To convert from liters per year to gallons per year, multiply by 0.264.
Source: Kirkham 1999; Wham 1999c.

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

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

4.3.2.1.5 Geology and Soils

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

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

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

4.3.2.1.6 Ecological Resources

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

Because no new construction is planned, the use of Building CPP–651 and/or FDPF at INEEL would not result in direct disturbance to ecological resources. As noted in Section 4.3.2.1.2, there would be little change in noise impacts on wildlife. Because additional water usage and wastewater discharge would be small fractions of current values, and discharge chemistry would not be expected to change, there would be no impact on aquatic resources (Section 4.3.2.1.4). Due to the developed nature of the area and the fact that no new construction would take place, impacts on threatened and endangered species would not occur.

Consultation 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 their 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.

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

4.3.2.1.7 Cultural and Paleontological Resources

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

No new construction is planned; therefore, direct impacts on cultural and paleontological resources at INTEC would not occur. The use of Building CPP–651 and/or FDPF to store neptunium-237 or FDPF to fabricate and process neptunium-237 targets would not change the status of six historic structures located at INTEC. Also, Native American resources occurring in the vicinity of INTEC would not be impacted.

Consultation to comply with Section 106 of the National Historic Preservation Act 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.

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

4.3.2.1.8 Socioeconomics

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

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

Additional employment resulting from this option would not have any noticeable impact on community services in the INEEL region of influence. Assuming 94 percent of the new employment associated with this alternative would reside in INEEL's region of influence (Section 3.3.8), 83 new jobs could increase the region's population by approximately 161 persons. This increase in conjunction with normal population growth forecasted by the State of Idaho would not have any noticeable effect on the availability of housing and/or the price of housing in the region of influence. The public would experience little or no change in the level of community services currently offered in the region of influence.

4.3.2.1.9 Public and Occupational Health and Safety—Normal Operations

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

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

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup, processing, and operations are given in **Table 4–30** for FFTF and RPL at Hanford and FDPF at INEEL: the population within 80 kilometers (50 miles) in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

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

To represent a bounding annual dose scenario at Hanford, it is assumed that a full-year's isotopic release would occur from target processing at RPL concurrently with a full-year's release from FFTF operations at 400 megawatts; the impacts presented in Table 4–30 also assume a full-year's release resulting from FFTF and RPL preoperational testing and startup activities. To represent a bounding annual dose scenario at INEEL, it is assumed that a full year's release would occur from neptunium-237 target processing at FDPF.

Table 4–30 Incremental Radiological Impacts on the Public Around INEEL and Hanford from Operational Facilities Under Alternative 1 (Restart FFTF)—Option 2

Receptor	INEEL FDPF Processing[a]	Hanford Preoperational Activities[b]		Hanford FFTF Operations	Hanford RPL Target Processing[a]	Hanford Operations and Processing Total[c]
		FFTF	RPL			
Population within 80 kilometers (50 miles) in the year 2020						
Dose (person-rem)	3.9×10^{-6}	0.028	1.0[d]	0.044	0.21	0.25
1-year latent cancer fatalities	–	1.4×10^{-5}	5.0×10^{-4}	–	–	–
35-year latent cancer fatalities	6.7×10^{-8}	–	–	7.7×10^{-4}	0.0037	0.0044
Maximally exposed individual						
Annual dose (millirem)	2.6×10^{-7}	1.4×10^{-4}	0.043[c]	4.1×10^{-4}	0.0050	0.0054
1-year latent cancer fatality risk	–	6.8×10^{-11}	2.2×10^{-8}	–	–	–
35-year latent cancer fatality risk	4.6×10^{-12}	–	–	7.2×10^{-9}	8.8×10^{-8}	9.5×10^{-8}
Average exposed individual within 80 kilometers (50 miles)						
Annual dose[e] (millirem)	2.0×10^{-8}	5.7×10^{-5}	0.0020[c]	8.8×10^{-5}	4.2×10^{-4}	5.0×10^{-4}
1-year latent cancer fatality risk	–	2.8×10^{-11}	9.9×10^{-10}	–	–	–
35-year latent cancer fatality risk	3.6×10^{-13}	–	–	1.5×10^{-9}	7.3×10^{-9}	8.8×10^{-9}

a. Target storage, processing, and fabrication activities are performed at the facility. Impacts are for all facility target activities and are dominated by processing activity impacts.
b. For conservatism as well as consistency with other radiological impacts evaluated in this NI PEIS, these values were assessed for the year 2020 even though these activities would commence prior to that year.
c. Represents upper-bounding values.
d. Annual emissions during preoperational activities were assumed to be the same as the 1998 releases for RPL (BWHC 1999). The majority of this dose is due to tritium releases.
e. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of the facilities in the year 2020 (about 505,000 for Hanford and 188,400 for INEEL).
Source: Model results, using the GENII computer code (Napier et al. 1988).

As a result of annual operations, the bounding projected total incremental population dose in the year 2020 for the populations surrounding Hanford and INEEL would be 0.25 person-rem. The corresponding number of latent cancer fatalities in these populations from 35 years of operations would be 0.0044. The bounding total incremental dose to the maximally exposed member of the public from annual operations at Hanford would be 0.0054 millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 9.5×10^{-8}. The incremental dose to the maximally exposed member of the public from annual operations at FDPF would be 2.6×10^{-7} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 4.6×10^{-12}.

Incremental doses to involved workers from normal operations are given in **Table 4–31**; these workers are defined as those directly associated with all process and operational activities. The incremental annual average dose to FDPF workers would be 170 millirem; the incremental annual average dose to FFTF workers (during startup) would be 3.5 millirem; the incremental annual average dose to FFTF workers (during operations) would be 6.6 millirem; the incremental annual average dose to RPL workers (during startup) would be 81 millirem; and the incremental annual average dose for RPL workers (during processing) would be approximately 160 millirem. The incremental annual dose received by the total workforce for each of these facilities (at the different phases) would be approximately 12, 0.69, 1.3, 3.2, and 4.8 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers are included in Table 4–31. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–31 Incremental Radiological Impacts on Involved FDPF, FFTF, and RPL Workers Under Alternative 1 (Restart FFTF)—Option 2

Receptor—Involved Workers[a]	INEEL FDPF Processing[b]	Hanford Preoperational Activities		Hanford		
		FFTF	RPL	FFTF Operations	RPL Target Processing[b]	Operations and Processing Total
Total dose (person-rem per year)	12[c]	0.69[d]	3.2[e]	1.3[d]	4.8[f]	6.1
1-year latent cancer fatalities	–	2.8×10^{-4}	0.0013	–	–	–
35-year latent cancer fatalities	0.17	–	–	0.018	0.067	0.086
Average worker dose (millirem per year)	170	3.5	81	6.6	160	NA
1-year latent cancer fatality risk	–	1.4×10^{-6}	3.2×10^{-5}	–	–	–
35-year latent cancer fatality risk	0.0023	–	–	9.2×10^{-5}	0.0022	NA

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

Key: NA, not applicable.
Source: BWHC 1999; Mecham 1999; Nielsen 1999; Wham 1999b, 2000.

HAZARDOUS CHEMICAL IMPACTS. Hazardous chemical impacts associated with FFTF restart and target fabrication and processing in the 300 Area at Hanford were determined to be the same as for Option 1 (Section 4.3.1.1.9). Hazardous chemical impacts associated with processing in FDPF at INEEL are presented in **Table 4–32** and show little effect from air pollutant releases associated with this option.

4.3.2.1.10 Public and Occupational Health and Safety—Facility Accidents

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

Estimates of radiological consequences have been developed for the maximally exposed 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

Table 4–32 Incremental Hazardous Chemical Impacts on the Public Around INEEL Under Alternative 1 (Restart FFTF)—Option 2

Chemical	Modeled Annual Increment (micrograms per cubic meter)	RfC (micrograms per cubic meter)	Unit Cancer Risk (risk per micrograms per cubic meter)	Hazard Quotient	Cancer Risk
Diethyl benzene	0.0165	1,000	7.80×10^{-6}	1.65×10^{-5}	1.29×10^{-7}
Methanol	6.02×10^{-4}	1,750	NA	3.44×10^{-7}	NA
Nitric acid	0.00121	122.5	NA	9.86×10^{-6}	NA
Tributyl phosphate	0.031	10	NA	0.0031	NA
			Hazard Index =	0.0031	

Note: For diethyl benzene, the reference concentration for ethyl benzene and the unit cancer risk for benzene were used. For tributyl phosphate, the reference concentration for phosphoric acid was used to estimate the Hazard Quotient because no information was available for tributyl phosphate.
Key: NA, not applicable (the chemical is not a known carcinogen); RfC, Reference Concentration.
Source: DOE 1996a; EPA 1999; model results, using the SCREEN3 computer code (EPA 1995).

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

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

Consequences and associated risks are presented in **Tables 4–33** and **4–34**, respectively.

FFTF would operate for 21 years with a mixed oxide core followed by 14 years with a highly enriched uranium core. As shown in Table 4–33, the beyond-design-basis core melt accident would result in the largest radiological consequences among FFTF accidents. To incorporate internal and external initiators, the accident frequency of 1×10^{-6} was selected for the beyond-design-basis core melt accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.23×10^{-8} and 1.20×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00127.

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

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

Table 4–33 FFTF, RPL, and FDPF Accident Consequences Under Alternative 1 (Restart FFTF)—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]
FFTF accidents						
Design-basis-accident primary sodium spill (MOX)	0.00113	5.65×10^{-7}	78.6	0.0393	0.00313	1.25×10^{-6}
Design-basis-accident primary sodium spill (HEU)	8.63×10^{-4}	4.32×10^{-7}	72.6	0.0363	0.00181	7.24×10^{-7}
Beyond-design-basis core melt accident (MOX)	0.679	3.40×10^{-4}	6.68×10^{4}	33.4	0.679	2.72×10^{-4}
Beyond-design-basis core melt accident (HEU)	0.481	2.41×10^{-4}	6.16×10^{4}	30.8	0.375	1.50×10^{-4}
BLTC driver fuel-handling accident (MOX)	0.00383	1.92×10^{-6}	1,280	0.639	0.357	1.43×10^{-4}
BLTC driver fuel-handling accident (HEU)	0.00384	1.92×10^{-6}	1,230	0.617	0.340	1.36×10^{-4}
BLTC neptunium-237 target-handling accident	2.61×10^{-4}	1.31×10^{-7}	25.8	0.0129	0.0279	1.12×10^{-5}
BLTC isotope target-handling accident	1.22×10^{-4}	6.10×10^{-8}	2.74	0.00137	0.0143	5.72×10^{-6}
FDPF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.01×10^{-9}	1.01×10^{-12}	2.49×10^{-5}	1.24×10^{-8}	7.26×10^{-9}	2.91×10^{-12}
Target dissolver tank failure during plutonium-238 separation	6.11×10^{-8}	3.05×10^{-11}	5.65×10^{-4}	2.82×10^{-7}	2.17×10^{-7}	8.69×10^{-11}
Ion exchange explosion during plutonium-238 separation	1.63×10^{-5}	8.13×10^{-9}	0.150	7.51×10^{-5}	5.79×10^{-5}	2.31×10^{-8}
Plutonium-238 processing facility beyond-design-basis earthquake	42.5	0.0425	1.64×10^{5}	82.0	1,200	1.0[c]
RPL accidents						
Medical and industrial isotopes localized solvent fire	0.0135	6.74×10^{-6}	77.8	0.0389	0.0047	1.88×10^{-6}
Medical and industrial isotopes unlikely seismic event	1.52	7.60×10^{-4}	1,350	0.675	1.50	6.00×10^{-4}
Medical and industrial isotopes glovebox explosion	50.0	0.050	4.60×10^{4}	23.0	49.0	0.0392

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

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

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

Table 4–34 FFTF, RPL, and FDPF Accident Risks Under Alternative 1 (Restart FFTF)—Option 2

Accident (Frequency)	Maximally Exposed Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Beyond-design-basis core melt accident (MOX) (1×10^{-6})	3.40×10^{-10}	3.34×10^{-5}	2.72×10^{-10}
Beyond-design-basis core melt accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-7})	1.92×10^{-13}	6.39×10^{-8}	1.43×10^{-11}
BLTC driver fuel-handling accident (HEU) (1×10^{-7})	1.92×10^{-13}	6.17×10^{-8}	1.36×10^{-11}
BLTC neptunium-237 target-handling accident (1×10^{-7})	1.31×10^{-14}	1.29×10^{-9}	1.12×10^{-12}
BLTC isotope target-handling accident (1×10^{-7})	6.10×10^{-15}	1.37×10^{-10}	5.72×10^{-13}
35-year FFTF risk	1.23×10^{-8}	0.00127	1.20×10^{-8}
Annual FDPF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	1.24×10^{-10}	2.91×10^{-14}
Target dissolver tank failure during plutonium-238 separation (0.01)	3.05×10^{-13}	2.82×10^{-9}	8.69×10^{-13}
Ion exchange explosion during plutonium-238 separation (0.01)	8.13×10^{-11}	7.51×10^{-7}	2.31×10^{-10}
Plutonium-238 processing facility beyond-design-basis earthquake (1×10^{-5})	4.25×10^{-7}	8.20×10^{-4}	1.00×10^{-5}[c]
35-year FDPF risk	1.49×10^{-5}	0.0287	3.50×10^{-4}
Annual RPL risks			
Medical and industrial isotopes localized solvent fire (0.044)	2.99×10^{-7}	0.00173	8.35×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	7.60×10^{-6}	0.00675	6.00×10^{-6}
Medical and industrial isotopes glovebox explosion (1×10^{-4})	5.00×10^{-6}	0.00230	3.92×10^{-6}
35-year RPL risk	4.51×10^{-4}	0.377	3.50×10^{-4}
35-year Option risk[d]	4.51×10^{-4}	0.407	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
d. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

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

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

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

The maximum distances, in meters, needed to reach the ERPG values for nitric acid releases at FDPF for Stability Classes D and F are shown in **Table 4–35.** 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 [3.6 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 4–35 ERPG Distances for Nitric Acid Releases at FDPF

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

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

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

For FDPF, the maximum distances needed to reach the level of concern for nitric oxide releases for Stability Classes D and F are 500 and 2,000 meters (1,640 and 6,560 feet), respectively. The number of involved and noninvolved workers potentially exposed would vary with a number of factors such as the time of day and whether they are sheltered within buildings at the time of release. Individuals at the nearest 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 onsite.

The impacts associated with the accidental release of nitric acid and nitric oxide at FDPF are presented in **Table 4–36**.

Table 4–36 FDPF Hazardous Chemical Accident Impacts Under Alternative 1 (Restart FFTF)—Option 2

Receptor	Evaluation Parameter	Nitric Acid		Nitric Oxide	
		Stability Class D	Stability Class F	Stability Class D	Stability Class F
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.

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

4.3.2.1.11 Public and Occupational Health and Safety—Transportation

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

Approximately 38,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 6.2 million kilometers (3.9 million miles); at sea by ships carrying mixed oxide fuel, 96,000 kilometers (52,000 nautical miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

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

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 21 person-rem; the dose to the public, 88 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 0.044 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.024. About half of the crew risk, about 8 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

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

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

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

4.3.2.1.12 Environmental Justice

NORMAL OPERATIONS. The number of expected latent cancer fatalities among the populations residing within 80 kilometers (50 miles) of FDPF at INEEL and FFTF and RPL at Hanford would be less than 0.005 for 35 years of normal operations (Table 4–30). As shown in Table 4–32, the release of hazardous chemicals at INEEL would pose no significant risk of cancer or toxic effects among the public. As discussed in Sections K.5.1 and K.5.3, the expected latent cancer fatalities that would result from the ingestion of food that could be radiologically contaminated due to normal operations would be approximately 0.002 at Hanford and essentially zero at INEEL. No credible pattern of food consumption by persons residing in potentially affected areas would result in significant health risks due to radiological contamination of food supplies near Hanford or INEEL. As shown in Section 4.3.2.1.11, incident-free transportation would not be expected to result in fatalities.

ACCIDENTS. The number of expected latent cancer fatalities among populations at risk due to radiological accidents listed in Table 4–34 would be approximately 0.41. In the event a radiological accident were to occur at FDPF and northwesterly winds prevailed at the time of the accident, radiological contamination would be directed toward the Fort Hall Indian Reservation (see Figure K–2). If a radiological accident were to occur at FFTF or the 300 Area at Hanford and northeasterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Yakama Indian Reservation (see Figure K–11). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the populations or a maximally exposed individuals residing within the boundaries of the Fort Hall Indian Reservation or Yakama Indian Reservation.

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

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

4.3.2.1.13 Waste Management

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

The expected generation rates of waste that would be associated with the operation of FDPF to fabricate and process neptunium-237 targets are compared with INEEL's treatment, storage, and disposal capacities in **Table 4–37**. The impacts on the INEEL 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 4.3.2.1.9 through 4.3.2.1.11.

Canisters used to transport neptunium-237 to INEEL would constitute a very small additional amount of solid low-level radioactive—less than 10 cubic meters (13.1 cubic yards) over the 35-year operational period, even if no credit is taken for volume reduction by compaction (Brunson 1999a). The annual generation of this waste would fall within the range of accuracy of the generation rate of solid low-level radioactive waste given in Table 4–37, 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 INEEL 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

Table 4–37 Incremental Waste Management Impacts of Operating FDPF at INEEL Under Alternative 1 (Restart FFTF)—Option 2

Waste Type[a]	Estimated Additional Waste Generation (cubic meters per year)	Estimated Additional Waste Generation as a Percent of [b]		
		Onsite Treatment Capacity	Onsite Storage Capacity	Onsite Disposal Capacity
Transuranic waste/High-level radioactive[c]	7	(c)	(c)	NA
Low-level radioactive				
Liquid[d]	30	0.23	(e)	(e)
Solid	35	(e)	NA	0.093
Mixed low-level radioactive				
Liquid	(d)	(d)	(d)	(d)
Solid	<5	<0.077	<0.099	NA
Hazardous	6,500 kilograms	NA	2.4	NA
Nonhazardous				
Process wastewater	23	NA	NA	0.14[f]
Sanitary wastewater	1,658	0.00052	NA	NA
Solid	148	NA	NA	0.31

a. See definitions in Section G.9.
b. Estimated additional annual waste generation is compared with annual site treatment and disposal capacities. Additional waste generation over the assumed 35-year operational period is compared with site storage capacities.
c. Refer to the text for a discussion on waste classification, treatment, and storage. This waste would be stored on site pending availability of a suitable repository. It is assumed this waste would be remotely handled.
d. Mixed liquid low-level radioactive waste is included under liquid low-level radioactive waste because these wastes are processed together.
e. Refer to the text. The impact on the waste management system would be minimal.
f. Percent of capacity of the two INTEC percolation ponds.

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

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

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

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 FDPF would generate a total of 245 cubic meters (320 cubic yards) of transuranic or high-level radioactive waste over the 35-year operational period. As described in Sections 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 FDPF. The resulting glass matrix would be stored at FDPF pending availability of the suitable repository. The impacts of managing the additional quantities of this waste at INEEL would be minimal.

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

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

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

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

Nonhazardous solid waste would be packaged and transported in conformance with standard industrial practice. Solid 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 to the onsite landfill. This additional waste load would have only a minimal impact on the nonhazardous solid waste management system at INEEL. The annual amount of nonhazardous solid waste that would be generated is estimated to represent 0.31 percent of the 48,000-cubic-meter-per-year (63,000-cubic-yard-per-year) capacity of the Central Facilities Area Landfill Complex.

At INEEL, nonhazardous process wastewater generated by FDPF would be discharged to the INTEC service waste system, which then discharges to the two INTEC percolation ponds. Nonhazardous process wastewater generated as the result of neptunium-237 target fabrication and processing is estimated to be 0.14 percent of the 16,700-cubic-meter-per-year (21,800-cubic-yard-per-year) capacity of the INTEC percolation ponds. Nonhazardous sanitary wastewater from FDPF operations would be discharged to the INTEC Sewage Treatment Plant. Sanitary wastewater generated is estimated to be 0.00052 percent of the 3,200,000-cubic-meter-per-year (4,200,000-cubic-yard-per-year) capacity of the INTEC Sewage Treatment Plant. Therefore, management of nonhazardous liquid waste at INEEL would have only a minimal impact on the management system.

The generation rates of waste at INEEL that would be associated with this option (Table 4–37) can be compared with the current waste generation rates at the site, given in Table 3–25 (Section 3.3.11). Except for transuranic waste, which currently is not being generated at INEEL, the waste generation rates associated with plutonium-238 production would be much smaller than the current waste generation rates at the site.

4.3.2.1.14 Spent Nuclear Fuel Management

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

4.3.3 Alternative 1 (Restart FFTF)—Option 3

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

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

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

4.3.3.1 Operations and Transportation

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

4.3.3.1.1 Land Resources

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

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

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

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

4.3.3.1.2 Noise

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

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

4.3.3.1.3 Air Quality

The restart and operation of FFTF under this option would have the same air quality impacts as under Option 1 (Section 4.3.1.1.3), and are presented in **Table 4–38**. The concentrations at Hanford from FMEF attributable to this option are also presented in Table 4–38. Changes in concentrations were determined to be small and would be below the applicable ambient standards even when ambient monitored values and the contributions from the other site activities were included. Hazardous chemical impacts are addressed in Section 4.3.3.1.9.

The concentrations at Hanford attributable to this option are compared with the Prevention of Significant Deterioration Class II increments for sulfur dioxide and nitrogen dioxide in **Table 4–39**.

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

Table 4–38 Incremental Hanford Concentrations Associated with Alternative 1 (Restart FFTF)—Option 3

Pollutant	Averaging Period	Most Stringent Standard or Guideline (micrograms per cubic meter)[a]	Modeled Increment (micrograms per cubic meter)	
			FFTF	FMEF
Criteria pollutants				
Carbon monoxide	8 hours 1 hour	10,000[b] 40,000[b]	52.1 74.4	0 0
Nitrogen dioxide	Annual	100[b]	0.0118	4.43×10^{-5}
PM_{10}	Annual 24 hours	50[c] 150[c]	8.4×10^{-4} 9.84	0 0
Sulfur dioxide	Annual 24 hours 3 hours 1 hour	50[d] 260[d] 1,300[b] 660[d]	7.86×10^{-4} 9.1 20.5 22.8	0.0087 0.069 0.16 0.17
Toxic air pollutants				
Methanol	24 hours	870	0	0.0018
Nitric acid	24 hours	17	0	0.0022
Paraffin hydrocarbons	24 hours	7	0	0.16
Tributyl phosphate	24 hours	7.3	0	0.090

a. The more stringent of the Federal and state standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The 24-hour PM_{10} (particulate matter with an aerodynamic diameter less than or equal to 10 micrometers) standard is attained when the expected number of days with a 24-hour average concentration above the standard is 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: 40 CFR Part 50; WDEC 1998; modeled increments are based on the SCREEN3 computer code (EPA 1995); additional data from Nielsen 2000.

Table 4–39 PSD Class II Increments Compared to Hanford Concentrations Associated with FMEF Under Alternative 1 (Restart FFTF)—Option 3

Pollutant	Averaging Period	Allowable PSD Increment (micrograms per cubic meter)	Modeled Increment (micrograms per cubic meter)
Nitrogen dioxide	Annual	25	0.0118
Sulfur dioxide	Annual 24 hours 3 hours	20 91 512	0.00949 9.17 20.6

Key: PSD, Prevention of Significant Deterioration.
Source: Modeled increments are based on the SCREEN3 computer code (EPA 1995).

4.3.3.1.4 Water Resources

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

Operational impacts on water resources associated with the restart of FFTF would be substantially the same as those discussed in Section 4.3.1.1.4, with only a small incremental impact associated with FMEF operations. Total projected 400 Area and incremental effects of this option on key water resource indicators are summarized in **Table 4–40**. Annual average groundwater withdrawal during standby by 400 Area facilities is about 197 million liters (52 million gallons) (Section 4.3.1.1.4). The restart of FFTF combined with the use of FMEF would increase annual water use to a total of 277 million liters (73 million gallons). This is a total increase of about 80 million liters (21 million gallons) per year. This includes some 15 million liters (4 million gallons) per year to support FMEF cooling needs and approximately 3.8 million liters (1 million gallons) per year for increased sanitary and potable water needs (Chapin 2000). This volume of 277 million liters (73 million gallons) per year is approximately 70 percent of the 400 Area groundwater production capacity of about 398 million liters (105.1 million gallons) per year (DOE 1999a:4-262).

Table 4–40 Incremental Water Use and Wastewater Generation Associated with Operating FFTF and FMEF at Hanford Under Alternative 1 (Restart FFTF)—Option 3

Indicator (million liters per year)	Hanford			
	Total 400 Area[a]	FFTF Operations[b]	FFTF Increment Over Standby[c]	FMEF Increment[d]
Water use	277	258	61	19
Process wastewater generation	113	98	22	15
Sanitary wastewater generation	9.5	5.7	1.9	3.8

a. Total projected operational impacts in the Hanford 400 Area (FFTF and FMEF operations combined).
b. These estimates represent total projected operational impacts after restart (FFTF only).
c. Incremental impacts of FFTF restart and operation over standby operations (see Table 4–1).
d. Incremental impacts of FMEF operations only.
Note: To convert from liters per year to gallons per year, multiply by 0.264.
Source: Chapin 2000; DOE 2000a:11; Nielsen 1999:38, 41.

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

Process (nonradioactive) wastewater discharge from the 400 Area (mainly FFTF and FMEF) would increase by a total of approximately 37 million liters (9.8 million gallons) over standby to about 113 million liters (29.8 million gallons) per year as a result of FFTF and FMEF operations. FMEF would contribute about 15 million liters (4 million gallons) annually based on a conservative estimate of cooling water discharges and blowdown from FMEF's three cooling towers (currently inactive) (Chapin 2000; Nielsen 1999:38). This additional volume includes approximately 38,000 liters (10,000 gallons) per year of process wastewater resulting from target fabrication and processing activities (Chapin 2000). This wastewater would be discharged to the 400 Area process sewer system and ultimately to the 400 Area Pond, with no impact on groundwater quality expected for the same reasons cited in Section 4.3.1.1.4.

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

4.3.3.1.5 Geology and Soils

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

FMEF would be used for target material storage, target fabrication, and processing. Additionally, a new 76-meter (250-foot) stack would be constructed (Nielsen 1999:24). Because FMEF is an existing facility and the stack would be located on previously disturbed land, impacts on geologic resources and soils would be negligible. As referenced above, and in Section 4.2.4.2.5, hazards from large-scale geologic conditions at

Hanford were previously evaluated and were reviewed in this NI PEIS and found to present a low risk to FMEF. As necessary, the need to evaluate and upgrade existing DOE facilities with regard to natural geologic hazards would be assessed in accordance with DOE Order 420.1, which is described in Section 4.2.1.2.5.

4.3.3.1.6 Ecological Resources

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

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

4.3.3.1.7 Cultural and Paleontological Resources

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

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

4.3.3.1.8 Socioeconomics

The irradiation of all isotopes at FFTF, and the fabrication and processing of all targets at FMEF would annually require about 292 additional workers at Hanford (Hoyt et al. 1999; DOE 1997b). This level of employment would generate about 739 indirect jobs in the region around Hanford. The potential total employment increase of 1,031 direct and indirect jobs in the Hanford region represents a less than 0.5 percent increase in the projected regional economic area workforce. It would have no noticeable impact on the regional economic area.

Additional employment resulting from this option would not have any noticeable impact on community services in the Hanford region of influence. Assuming that 91 percent of the new employment would reside in Hanford's region of influence (refer to Section 3.4.8), 938 new jobs could increase the region's population by approximately 1,803 persons. This increase, in conjunction with the normal population growth forecasted by the State of Washington, would not have any noticeable impact on the availability of housing and/or the price of housing in the region of influence. Given the current population-to-student ratio in the region of influence, this would likely result in an increase of about 373 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: 23 new teachers would be needed to maintain the current student-to-teacher ratio of 16:1; 3 new police officers would need to be added to maintain the current officer-to-population ratio of 1.5:100; 6 new firefighters would need to be added to maintain the current firefighter-to-population ratio of 3.4:1000; and 3 new doctors would be added to maintain the current physician-to-population ratio of 1.4:1000. Thus, an additional 35 positions would have to be created to maintain community services at current levels. Hospitals in the region of influence would not experience any change from the 2.1 beds per 1,000 persons currently available. Moreover, average school enrollment would increase to 94.5 percent from the current 92.5 percent unless additional classrooms were built. None of these projected changes should have a major impact on the level of community services currently offered in the region of influence.

4.3.3.1.9 Public and Occupational Health and Safety—Normal Operations

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

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

RADIOLOGICAL IMPACTS. Incremental radiological doses to three receptor groups from startup, processing, and operations are given in **Table 4–41**: the population within 80 kilometers (50 miles) of FFTF and FMEF in the year 2020, the maximally exposed member of the public, and the average exposed member of the public. The projected number of latent cancer fatalities in the surrounding population and the latent cancer fatality risk to the maximally and average exposed individuals are also presented in the table.

Table 4–41 Incremental Radiological Impacts on the Public Around Hanford from Operational Facilities Under Alternative 1 (Restart FFTF)—Option 3

Receptor	FFTF Preoperational Activities[a]	FFTF Operations	FMEF Target Processing[b]	Operations and Processing Total[c]
Population within 80 kilometers (50 miles) in the year 2020				
Dose (person-rem)	0.028	0.044	0.085	0.13
1-year latent cancer fatalities	1.4×10^{-5}	–	–	–
35-year latent cancer fatalities	–	7.7×10^{-4}	0.0015	0.0023
Maximally exposed individual				
Annual dose (millirem)	1.4×10^{-4}	4.1×10^{-4}	3.0×10^{-4}	7.0×10^{-4}
1-year latent cancer fatality risk	6.8×10^{-11}	–	–	–
35-year latent cancer fatality risk	–	7.2×10^{-9}	5.3×10^{-9}	1.2×10^{-8}
Average exposed individual within 80 kilometers (50 miles)				
Annual dose[d] (millirem)	5.7×10^{-5}	8.8×10^{-5}	1.7×10^{-4}	2.6×10^{-4}
1-year latent cancer fatality risk	2.8×10^{-11}	–	–	–
35-year latent cancer fatality risk	–	1.5×10^{-9}	3.0×10^{-9}	4.5×10^{-9}

a. For conservatism as well as consistency with other radiological impacts evaluated in this NI PEIS, these values were assessed for the year 2020 even though these activities would commence prior to that year.
b. Target storage, processing, and fabrication activities are performed at the facility. Impacts are for all facility target activities and are dominated by processing activity impacts.
c. Represents upper-bounding values.
d. Obtained by dividing the population dose by the number of people projected to live within 80 kilometers (50 miles) of FFTF and FMEF in the year 2020 (about 500,000).
Source: Model results, using the GENII computer code (Napier et al. 1988).

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

To represent a bounding annual dose scenario, it is assumed that a full-year's isotopic release would occur from target processing at FMEF concurrently with a full-year's release from FFTF operations at 400 megawatts. The impacts presented in Table 4–41 assume a full-year's release resulting from FFTF preoperational testing and startup activities. As a result of annual operations, the bounding projected total incremental population dose in the year 2020 would be 0.13 person-rem. The corresponding number of latent cancer fatalities in the population surrounding Hanford from 35 years of operations would be 2.3×10^{-3}. The bounding total incremental dose to the maximally exposed member of the public from annual operations of FFTF and FMEF would be 7.0×10^{-4} millirem. From 35 years of operations, the corresponding risk of a latent cancer fatality to this individual would be 1.2×10^{-8}.

Incremental doses to involved workers from normal operations are given in **Table 4–42**; these workers are defined as those directly associated with all process and operational activities. The incremental annual average dose to FFTF workers during startup would be 3.5 millirem; the incremental annual average dose during operations, 6.6 millirem. For FMEF workers, the incremental annual average dose is estimated to be approximately 160 millirem. The incremental annual dose received by the total site workforce for each of these facilities would be approximately 0.69, 1.3, and 17 person-rem, respectively. The risks and numbers of latent cancer fatalities among the different workers are included in Table 4–42. Doses to individual workers would be kept to minimal levels by instituting badged monitoring and ALARA programs.

Table 4–42 Incremental Radiological Impacts on Involved FFTF and FMEF Workers Under Alternative 1 (Restart FFTF)—Option 3

Receptor—Involved Workers[a]	FFTF Preoperational Activities	FFTF Operations	FMEF Target Processing[b]	Operations and Processing Total
Total dose (person-rem per year)	0.69[c]	1.3[c]	17[d]	18
1-year latent cancer fatalities	2.8×10^{-4}	–	–	–
35-year latent cancer fatalities	–	0.018	0.24	0.26
Average worker dose (millirem per year)	3.5	6.6	160	NA
1-year latent cancer fatality risk	1.4×10^{-6}	–	–	–
35-year latent cancer fatality risk	–	9.2×10^{-5}	0.0023	NA

a. The radiological limit for an individual worker is 5,000 millirem per year (10 CFR Part 835). However, the maximum dose to a worker involved with operations would be kept below the DOE Administrative Control Level of 2,000 millirem per year (DOE 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. Doses are based on a weighted average from historical data associated with plutonium processing and other radiochemical processing. Target storage, processing, and fabrication activities are performed at this facility. Impacts, dominated by processing activities, include impacts from all facility target activities.

c. Based on an estimated 200 badged workers.

d. Based on an estimated 105 badged workers.

Key: NA, not applicable.

Source: BWHC 1999; Mecham 1999; Nielsen 1999; Wham 1999b, 2000.

HAZARDOUS CHEMICAL IMPACTS. At FMEF, both carcinogenic and noncarcinogenic health effects from exposure to hazardous chemicals were evaluated and are presented in **Table 4–43**. It was assumed that under normal operating conditions, the primary exposure pathway for members of the public would be from airborne emissions released through the new 76-meter (250-foot) stack. Emissions of chemicals were estimated based on anticipated chemical usage. A worst-case dispersion-modeling screening analysis was performed to estimate annual concentrations for each chemical.

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

Table 4–43 Incremental Hazardous Chemical Impacts on the Public at Hanford Under Alternative 1 (Restart FFTF)—Option 3

Chemical	Modeled Annual Increment (micrograms per cubic meter)	Reference Concentration (micrograms per cubic meter)	Unit Cancer Risk (risk per micrograms per cubic meter)	Hazard Quotient	Cancer Risk
FFTF emergency diesel generators					
Benzene	2.5×10^{-6}	NA	7.8×10^{-6}	NA	1.96×10^{-11}
Toluene	1.10×10^{-6}	400	NA	2.74×10^{-9}	NA
Propylene	6.92×10^{-6}	NA	3.7×10^{-6}	NA	2.56×10^{-11}
Formaldehyde	3.17×10^{-6}	NA	1.3×10^{-5}	NA	4.12×10^{-11}
Acetaldehyde	2.06×10^{-6}	NA	2.2×10^{-6}	NA	4.53×10^{-12}
FMEF					
Nitric acid	2.73×10^{-4}	122.5	NA	2.22×10^{-6}	NA
Diethyl benzene	0.00601	1000	7.8×10^{-6}	6.01×10^{-6}	4.69×10^{-8}
Methanol	2.19×10^{-4}	1750	NA	1.25×10^{-7}	NA
Tributyl phosphate	0.0113	10	NA	0.00113	NA
			Hazard Index =	0.00114	

Note: For diethyl benzene, the reference concentration for ethyl benzene and the unit cancer risk for benzene were used. For tributyl phosphate, the reference concentration for phosphoric acid was used to estimate the Hazard Quotient because no information was available for tributyl phosphate. The propylene oxide unit cancer risk factor was used for propylene.
Key: NA, not applicable (the chemical is not a known carcinogen or it is a carcinogen and only unit risk will apply).
Source: DOE 1996a; EPA 1999; model results, using the SCREEN3 computer code (EPA 1995).

4.3.3.1.10 Public and Occupational Health and Safety—Facility Accidents

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

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

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

Consequences and associated risks are presented in **Tables 4–44** and **4–45**, respectively.

Table 4–44 FFTF and FMEF Accident Consequences Under Alternative 1 (Restart FFTF)—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]
FFTF accidents						
Design-basis-accident primary sodium spill (MOX)	0.00113	5.65×10^{-7}	78.6	0.0393	0.00313	1.25×10^{-6}
Design-basis-accident primary sodium spill (HEU)	8.63×10^{-4}	4.32×10^{-7}	72.6	0.0363	0.00181	7.24×10^{-7}
Beyond-design-basis core melt accident (MOX)	0.679	3.40×10^{-4}	6.68×10^{4}	33.4	0.679	2.72×10^{-4}
Beyond-design-basis core melt accident (HEU)	0.481	2.41×10^{-4}	6.16×10^{4}	30.8	0.375	1.50×10^{-4}
BLTC driver fuel-handling accident (MOX)	0.00383	1.92×10^{-6}	1,280	0.639	0.357	1.43×10^{-4}
BLTC driver fuel-handling accident (HEU)	0.00384	1.92×10^{-6}	1,230	0.617	0.340	1.36×10^{-4}
BLTC neptunium-237 target-handling accident	2.61×10^{-4}	1.31×10^{-7}	25.8	0.0129	0.0279	1.12×10^{-5}
BLTC isotope target-handling accident	1.22×10^{-4}	6.10×10^{-8}	2.74	0.00137	0.0143	5.72×10^{-6}
FMEF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.02×10^{-9}	1.01×10^{-12}	7.26×10^{-5}	3.63×10^{-8}	6.65×10^{-10}	2.66×10^{-13}
Target dissolver tank failure during plutonium-238 separation	4.64×10^{-8}	2.32×10^{-11}	0.00169	8.47×10^{-7}	1.95×10^{-8}	7.81×10^{-12}
Ion exchange explosion during plutonium-238 separation	1.24×10^{-5}	6.18×10^{-9}	0.451	2.25×10^{-4}	5.20×10^{-6}	2.08×10^{-9}
Medical and industrial isotopes localized solvent fire	0.00276	1.38×10^{-6}	56.2	0.0281	9.51×10^{-5}	3.80×10^{-8}
Medical and industrial isotopes glovebox explosion	1.00	5.00×10^{-4}	2.95×10^{4}	14.8	24.0	0.0192
Processing facility beyond-design-basis earthquake	16.5	0.00825	6.42×10^{5}	321	922	1.00[c]

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

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

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

Table 4–45 FFTF and FMEF Accident Risks Under Alternative 1 (Restart FFTF)—Option 3

Accident (Frequency)	Maximally Exposed Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Beyond-design-basis core melt accident (MOX) (1×10^{-6})	3.40×10^{-10}	3.34×10^{-5}	2.72×10^{-10}
Beyond-design-basis core melt accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-7})	1.92×10^{-13}	6.39×10^{-8}	1.43×10^{-11}
BLTC driver fuel-handling accident (HEU) (1×10^{-7})	1.92×10^{-13}	6.17×10^{-8}	1.36×10^{-11}
BLTC neptunium-237 target-handling accident (1×10^{-7})	1.31×10^{-14}	1.29×10^{-9}	1.12×10^{-12}
BLTC isotope target-handling accident (1×10^{-7})	6.10×10^{-15}	1.37×10^{-10}	5.72×10^{-13}
35-year FFTF risk	1.23×10^{-8}	0.00127	1.20×10^{-8}
Annual FMEF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	3.63×10^{-10}	2.66×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	2.32×10^{-13}	8.47×10^{-9}	7.81×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	6.18×10^{-11}	2.25×10^{-6}	2.08×10^{-11}
Medical and industrial isotopes localized solvent fire (0.044)	6.13×10^{-8}	0.00125	1.69×10^{-9}
Medical and industrial isotopes glovebox explosion (1×10^{-4})	5.00×10^{-8}	0.00148	1.92×10^{-6}
Processing facility beyond-design-basis earthquake (1×10^{-5})	8.25×10^{-8}	0.00321	1.00×10^{-5}[c]
35-year FMEF risk	6.79×10^{-6}	0.208	4.17×10^{-4}
35-year Option Risk[d]	6.80×10^{-6}	0.209	4.17×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
d. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

FFTF would operate for 21 years with a mixed oxide core followed by 14 years with a highly enriched uranium (HEU) core. As shown in Table 4–44, the beyond-design-basis core melt accident would result in the largest radiological consequences among FFTF accidents. In order to incorporate internal and external initiators, the accident frequency of 1×10^{-6} was selected for the beyond-design-basis core melt accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.23×10^{-8} and 1.20×10^{-8}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00127.

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

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

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

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

The maximum distances, in meters, needed to reach the ERPG values for nitric acid releases at the FMEF for Stability Classes D and F are shown in **Table 4–46**. 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 4–46 ERPG Distances for Nitric Acid Releases at FMEF

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

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

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

For FMEF, the maximum distances needed to reach the level of concern for nitric oxide releases for Stability Classes D and F are 500 and 1,900 meters (1,640 and 6,560 feet), respectively. The number of involved and noninvolved workers potentially exposed would vary with a number of factors such as the time of day and whether they are sheltered within buildings at the time of release. Individuals at the nearest 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 4–47**.

Table 4–47 FMEF Hazardous Chemical Accident Impacts Under Alternative 1 (Restart FFTF)—Option 3

Receptor	Evaluation Parameter	Nitric Acid		Nitric Oxide	
		Stability Class D	Stability Class F	Stability Class D	Stability Class F
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.

4.3.3.1.11 Public and Occupational Health and Safety—Transportation

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

Approximately 38,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 5.6 million kilometers (3.5 million miles); at sea by ships carrying mixed oxide fuel, 96,000 kilometers (52,000 nautical miles); and in the air by aircraft carrying medical isotopes, 23 million kilometers (14 million miles).

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

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 18 person-rem; the dose to the public, 19 person-rem.

Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0072 latent cancer fatality among transportation workers and 0.009 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.023. About half of the crew risk, about 40 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

IMPACTS OF ACCIDENTS DURING TRANSPORTATION. The maximum foreseeable offsite transportation accident under this option (probability of occurrence: 1 in 10 million per year) is a shipment of mixed oxide fuel to FFTF with a severity Category V accident in a suburban population zone under neutral (average) weather conditions. The accident could result in a dose of 0.40 person-rem to the public with an associated 2.0×10^{-4} latent cancer fatality, and 3.3 millirem to the hypothetical maximally exposed individual with a latent cancer fatality risk of 1.7×10^{-6}. No fatalities would be expected to occur. The probability of more severe accidents, different weather conditions at the time of the accident, or occurrence while carrying neptunium-237 (unirradiated), irradiated targets or plutonium-238 was also evaluated and estimated to have a probability of less than 1 in 10 million per year.

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

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

4.3.3.1.12 Environmental Justice

NORMAL OPERATIONS. The number of expected latent cancer fatalities among the population residing within 80 kilometers (50 miles) of FFTF and FMEF would be less than 0.003 for 35 years of normal operations (Table 4–41). As shown in Table 4–43, the release of hazardous chemicals at FFTF and FMEF would pose no significant risk of cancer or toxic effects among the public. As discussed in Section K.5.3, the expected latent cancer fatalities that would result from the ingestion of food that could be radiologically contaminated due to normal operations at FFTF and FMEF would be approximately 0.001. No credible pattern of food consumption by persons residing in potentially affected areas would result in significant health risks due to radiological contamination of food supplies near Hanford. As discussed in Section 4.3.1.1.11, incident-free transportation would not be expected to result in fatalities.

ACCIDENTS. The number of expected latent cancer fatalities among the populations at risk due to radiological accidents listed in Table 4–45 would be approximately 0.2. If a radiological accident were to occur at FFTF or FMEF at Hanford and northeasterly winds prevailed at the time of the accident, radiological contamination from the accident would be directed toward the Yakama Indian Reservation (see Figure K–11). However, accidents that could occur under the implementation of this option would not be expected to result in a latent cancer fatality among the population or maximally exposed individual residing within the boundary of the Yakama Indian Reservation.

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

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

4.3.3.1.13 Waste Management

The expected generation rates of waste at Hanford that would be generated from the operation of FFTF for irradiating targets and with the operation of FMEF for target fabrication and processing are compared with Hanford's treatment, storage, and disposal capacities in **Table 4–48**. 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 4.3.3.1.9 through 4.3.3.1.11.

Canisters used to transport neptunium-237 to the site would constitute a very small additional amount of solid low-level radioactive waste—less than 10 cubic meters (13.1 cubic yards) over the 35-year operational period, even if no credit is taken for volume reduction by compaction (Brunson 1999a). The annual generation of this waste would fall within the range of accuracy of the generation rate of solid low-level radioactive waste given in Table 4–48, 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 the disposal of low-level radioactive waste. Mixed low-level radioactive waste analyzed in the *Waste Management PEIS* will be treated at Hanford, INEEL, ORR, and SRS and will be disposed of at Hanford and the Nevada Test Site.

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

Table 4–48 Incremental Waste Management Impacts of Operating FFTF and FMEF at Hanford Under Alternative 1 (Restart FFTF)—Option 3

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

a. See definitions in Section G.9.
b. These estimates represent the sum of the standby waste generation amounts provided for the No Action Alternative (Table 4–6) and the additional waste generation amounts given in the first column of this table (Table 4–48).
c. The estimated additional amounts of waste generated annually are compared with the annual site treatment capacities. The estimated total amounts of additional waste generated over the assumed 35-year operational period are compared with the site storage and disposal capacities.
d. Refer to the text 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.
e. Refer to the text.
f. Percent of capacity of the Energy Northwest Sewage Treatment Facility.
Note: To convert from cubic meters per year to cubic yards per year, multiply by 1.308; < means "less than."
Key: NA, not applicable (i.e., the majority of this waste is not routinely treated, stored, or disposed of on site).
Source: Chapin 2000; DOE 2000a; Nielsen 1999.

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.

No high-level radioactive or transuranic waste would be generated from merely operating FFTF. The waste described above would result from processing targets that had been irradiated in FFTF.

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

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

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

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

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

Hazardous 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 35-year operational period would have only a minimal impact on the Hanford hazardous waste management system.

Nonhazardous solid waste would be packaged and transported in conformance with standard industrial practice. Solid 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 at FFTF from target irradiation and at FMEF from target fabrication and processing would represent 2.4 percent of the 235,000-cubic-meter-per-year (307,000-cubic-yard-per-year) capacity of the Energy Northwest Sewage Treatment Facility.

The generation rates of waste at Hanford that would be associated with this option (refer to Table 4–48) 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 this alternative would be much smaller than the current waste generation rates at the site.

4.3.3.1.14 Spent Nuclear Fuel Management

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

4.3.4 Alternative 1 (Restart FFTF)—Option 4

Option 4 involves operating FFTF at Hanford to irradiate all targets and materials associated with plutonium-238 production, medical and industrial isotope production, and research and development; operating REDC at ORR to fabricate and process neptunium-237 targets and to process the plutonium-238 product; and operating facilities in RPL/306–E to fabricate and process the other targets and materials and to process the associated products. This option includes storage in REDC of the neptunium-237 transported from SRS to ORR and storage in RPL/306–E of the other target materials transported from other offsite facilities to Hanford.

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

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

4.3.4.1 Operations and Transportation

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

4.3.4.1.1 Land Resources

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

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

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

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

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

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

4.3.4.1.2 Noise

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

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

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

4.3.4.1.3 Air Quality

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

4.3.4.1.4 Water Resources

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

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

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

4.3.4.1.5 Geology and Soils

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

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

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

4.3.4.1.6 Ecological Resources

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

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

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

4.3.4.1.7 Cultural and Paleontological Resources

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

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

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

4.3.4.1.8 Socioeconomics

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

4.3.4.1.9 Public and Occupational Health and Safety—Normal Operations

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

4.3.4.1.10 Public and Occupational Health and Safety—Facility Accidents

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

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

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

Consequences and associated risks are presented in **Tables 4–49** and **4–50**, respectively.

FFTF would operate for 6 years with a mixed oxide core followed by 29 years with a highly enriched uranium core. As shown in Table 4–49, the beyond-design-basis core melt accident would result in the largest radiological consequences among FFTF accidents. In order to incorporate internal and external initiators, the accident frequency of 1×10^{-6} was selected for the beyond-design-basis core melt accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.06×10^{-8} and 9.37×10^{-9}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00122.

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

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

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

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

4.3.4.1.11 Public and Occupational Health and Safety—Transportation

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

Table 4–49 FFTF, REDC, and RPL Accident Consequences Under Alternative 1 (Restart FFTF)—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]
FFTF accidents						
Design-basis-accident primary sodium spill (MOX)	0.00113	5.65×10^{-7}	78.6	0.0393	0.00313	1.25×10^{-6}
Design-basis-accident primary sodium spill (HEU)	8.63×10^{-4}	4.32×10^{-7}	72.6	0.0363	0.00181	7.24×10^{-7}
Beyond-design-basis core melt accident (MOX)	0.679	3.40×10^{-4}	6.68×10^{4}	33.4	0.679	2.72×10^{-4}
Beyond-design-basis core melt accident (HEU)	0.481	2.41×10^{-4}	6.16×10^{4}	30.8	0.375	1.50×10^{-4}
BLTC driver fuel-handling accident (MOX)	0.00383	1.92×10^{-6}	1,280	0.639	0.357	1.43×10^{-4}
BLTC driver fuel-handling accident (HEU)	0.00384	1.92×10^{-6}	1,230	0.617	0.340	1.36×10^{-4}
BLTC neptunium-237 target-handling accident	2.61×10^{-4}	1.31×10^{-7}	25.8	0.0129	0.0279	1.12×10^{-5}
BLTC isotope target-handling accident	1.22×10^{-4}	6.10×10^{-8}	2.74	0.00137	0.0143	5.72×10^{-6}
REDC accidents						
Ion exchange explosion during neptunium-237 target fabrication	6.13×10^{-9}	3.06×10^{-12}	8.58×10^{-5}	4.29×10^{-8}	5.60×10^{-10}	2.24×10^{-13}
Target dissolver tank failure during plutonium-238 separation	1.76×10^{-7}	8.79×10^{-11}	0.00196	9.82×10^{-7}	1.69×10^{-8}	6.74×10^{-12}
Ion exchange explosion during plutonium-238 separation	4.68×10^{-4}	2.34×10^{-7}	5.23	0.00261	4.49×10^{-5}	1.79×10^{-8}
Processing facility beyond-design-basis earthquake	163	0.163	8.91×10^{5}	445	1,310	1.00[c]
RPL accidents						
Medical and industrial isotopes localized solvent fire	0.0135	6.74×10^{-6}	77.8	0.0389	0.0047	1.88×10^{-6}
Medical/industrial isotopes unlikely seismic event	1.52	7.60×10^{-4}	1,350	0.675	1.50	6.00×10^{-4}
Medical and industrial isotopes glovebox explosion	50.0	0.050	4.60×10^{4}	23.0	49.0	0.0392

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

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–50 FFTF, REDC, and RPL Accident Risks Under Alternative 1 (Restart FFTF)—Option 4

Accident (Frequency)	Maximally Exposed Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Beyond-design-basis core melt accident (MOX) (1×10^{-6})	3.40×10^{-10}	3.34×10^{-5}	2.72×10^{-10}
Beyond-design-basis core melt accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-7})	1.92×10^{-13}	6.39×10^{-8}	1.43×10^{-11}
BLTC driver fuel-handling accident (HEU) (1×10^{-7})	1.92×10^{-13}	6.17×10^{-8}	1.36×10^{-11}
BLTC neptunium-237 target-handling accident (1×10^{-7})	1.31×10^{-14}	1.29×10^{-9}	1.12×10^{-12}
BLTC isotope target-handling accident (1×10^{-7})	6.10×10^{-15}	1.37×10^{-10}	5.72×10^{-13}
35-year FFTF risk	1.06×10^{-8}	0.00122	9.37×10^{-9}
Annual REDC risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	3.06×10^{-14}	4.29×10^{-10}	2.24×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	8.79×10^{-13}	9.82×10^{-9}	6.74×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	2.34×10^{-9}	2.61×10^{-5}	1.79×10^{-10}
Plutonium-238 processing facility beyond-design-basis earthquake (1×10^{-5})	1.63×10^{-6}	0.00445	1.00×10^{-5}[c]
35-year REDC risk	5.71×10^{-5}	0.157	3.50×10^{-4}
Annual RPL risks			
Medical and industrial isotopes localized solvent fire (0.044)	2.99×10^{-7}	0.00173	8.35×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	7.60×10^{-6}	0.00675	6.00×10^{-6}
Medical and industrial isotopes glovebox explosion (1×10^{-4})	5.00×10^{-6}	0.00230	3.92×10^{-6}
35-year RPL risk	4.51×10^{-4}	0.377	3.50×10^{-4}
35-year Option risk[d]	4.51×10^{-4}	0.535	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
d. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Approximately 38,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 7.9 million kilometers (4.9 million miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

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

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 31 person-rem; the dose to the public, 298 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.012 latent cancer fatality among transportation workers and 0.15 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.029. About half of the crew risk, about 2 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

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

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting in 0.18 traffic fatality. Nearly all of the radiological and traffic accident risk would result from shipping medical and industrial isotopes.

4.3.4.1.12 Environmental Justice

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

4.3.4.1.13 Waste Management

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

4.3.4.1.14 Spent Nuclear Fuel Management

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

4.3.5 Alternative 1 (Restart FFTF)—Option 5

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

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

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

4.3.5.1 Operations and Transportation

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

4.3.5.1.1 Land Resources

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

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

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

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

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

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

4.3.5.1.2 Noise

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

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

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

4.3.5.1.3 Air Quality

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

4.3.5.1.4 Water Resources

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

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

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

4.3.5.1.5 Geology and Soils

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

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

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

4.3.5.1.6 Ecological Resources

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

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

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

4.3.5.1.7 Cultural and Paleontological Resources

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

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

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

4.3.5.1.8 Socioeconomics

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

4.3.5.1.9 Public and Occupational Health and Safety—Normal Operations

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

4.3.5.1.10 Public and Occupational Health and Safety—Facility Accidents

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

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

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

Consequences and associated risks are presented in **Tables 4–51** and **4–52**, respectively.

Table 4–51 FFTF, FDPF, and RPL Accident Consequences Under Alternative 1 (Restart FFTF)—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]
FFTF accidents						
Design-basis-accident primary sodium spill (MOX)	0.00113	5.65×10^{-7}	78.6	0.0393	0.00313	1.25×10^{-6}
Design-basis-accident primary sodium spill (HEU)	8.63×10^{-4}	4.32×10^{-7}	72.6	0.0363	0.00181	7.24×10^{-7}
Beyond-design-basis core melt accident (MOX)	0.679	3.40×10^{-4}	6.68×10^{4}	33.4	0.679	2.72×10^{-4}
Beyond-design-basis core melt accident (HEU)	0.481	2.41×10^{-4}	6.16×10^{4}	30.8	0.375	1.50×10^{-4}
BLTC driver fuel-handling accident (MOX)	0.00383	1.92×10^{-6}	1,280	0.639	0.357	1.43×10^{-4}
BLTC driver fuel-handling accident (HEU)	0.00384	1.92×10^{-6}	1,230	0.617	0.340	1.36×10^{-4}
BLTC neptunium-237 target-handling accident	2.61×10^{-4}	1.31×10^{-7}	25.8	0.0129	0.0279	1.12×10^{-5}
BLTC isotope target-handling accident	1.22×10^{-4}	6.10×10^{-8}	2.74	0.00137	0.0143	5.72×10^{-6}
FDPF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.01×10^{-9}	1.01×10^{-12}	2.49×10^{-5}	1.24×10^{-8}	7.26×10^{-9}	2.91×10^{-12}
Target dissolver tank failure during plutonium-238 separation	6.11×10^{-8}	3.05×10^{-11}	5.65×10^{-4}	2.82×10^{-7}	2.17×10^{-7}	8.69×10^{-11}
Ion exchange explosion during plutonium-238 separation	1.63×10^{-5}	8.13×10^{-9}	0.150	7.51×10^{-5}	5.79×10^{-5}	2.31×10^{-8}
Processing facility beyond-design-basis earthquake	42.5	0.0425	1.64×10^{5}	82.0	1,200	1.0[c]
RPL accidents						
Medical and industrial isotopes localized solvent fire	0.0135	6.74×10^{-6}	77.8	0.0389	0.0047	1.88×10^{-6}
Medical and industrial isotopes unlikely seismic event	1.52	7.60×10^{-4}	1,350	0.675	1.50	6.00×10^{-4}
Medical and industrial isotopes glovebox explosion	50.0	0.050	4.60×10^{4}	23.0	49.0	0.0392

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

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

Table 4–52 FFTF, FDPF, and RPL Accident Risks Under Alternative 1 (Restart FFTF)—Option 5

Accident (Frequency)	Maximally Exposed Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Beyond-design-basis core melt accident (MOX) (1×10^{-6})	3.40×10^{-10}	$3,34\times10^{-5}$	2.72×10^{-10}
Beyond-design-basis core melt accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-7})	1.92×10^{-13}	6.39×10^{-8}	1.43×10^{-11}
BLTC driver fuel-handling accident (HEU) (1×10^{-7})	1.92×10^{-13}	6.17×10^{-8}	1.36×10^{-11}
BLTC neptunium-237 target-handling accident (1×10^{-7})	1.31×10^{-14}	1.29×10^{-9}	1.12×10^{-12}
BLTC isotope target-handling accident (1×10^{-7})	6.10×10^{-15}	1.37×10^{-10}	5.72×10^{-13}
35-year FFTF risk	1.06×10^{-8}	0.00122	9.37×10^{-9}
Annual FDPF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	1.24×10^{-10}	2.91×10^{-14}
Target dissolver tank failure during plutonium-238 separation (0.01)	3.05×10^{-13}	2.82×10^{-9}	8.69×10^{-13}
Ion exchange explosion during plutonium-238 separation (0.01)	8.13×10^{-11}	7.51×10^{-7}	2.31×10^{-10}
Plutonium-238 processing facility beyond-design-basis earthquake (1×10^{-5})	4.25×10^{-7}	8.20×10^{-4}	1.00×10^{-5}[c]
35-year FDPF risk	1.49×10^{-5}	0.0287	3.50×10^{-4}
Annual RPL risks			
Medical and industrial isotopes localized solvent fire (0.044)	2.99×10^{-7}	0.00173	8.35×10^{-8}
Medical and industrial isotopes unlikely seismic event (0.01)	7.60×10^{-6}	0.00675	6.00×10^{-6}
Medical and industrial isotopes glovebox explosion (1×10^{-6})	5.00×10^{-6}	0.00230	3.92×10^{-6}
35-year RPL risk	4.51×10^{-4}	0.377	3.50×10^{-4}
35-year Option risk[d]	4.51×10^{-4}	0.407	3.50×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
d. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

FFTF would operate for 6 years with a mixed oxide core followed by 29 years with a highly enriched uranium core. As shown in Table 4–51, the beyond-design-basis core melt accident would result in the largest radiological consequences among FFTF accidents. In order to incorporate internal and external initiators, the accident frequency of 1×10^{-6} was selected for the beyond-design-basis core melt accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.06×10^{-8} and 9.37×10^{-9}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00122.

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

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

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

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

4.3.5.1.11 Public and Occupational Health and Safety—Transportation

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

Approximately 38,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 6.1 million kilometers (3.8 million miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

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

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 21 person-rem; the dose to the public, 88 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 0.044 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.023. About half of the crew risk, about 8 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

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

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

4.3.5.1.12 Environmental Justice

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

4.3.5.1.13 Waste Management

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

4.3.5.1.14 Spent Nuclear Fuel Management

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

4.3.6 Alternative 1 (Restart FFTF)—Option 6

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

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

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

4.3.6.1 Operations and Transportation

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

4.3.6.1.1 Land Resources

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

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

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

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

4.3.6.1.2 Noise

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

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

4.3.6.1.3 Air Quality

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

4.3.6.1.4 Water Resources

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

4.3.6.1.5 Geology and Soils

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

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

4.3.6.1.6 Ecological Resources

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

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

4.3.6.1.7 Cultural and Paleontological Resources

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

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

4.3.6.1.8 Socioeconomics

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

4.3.6.1.9 Public and Occupational Health and Safety—Normal Operations

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

4.3.6.1.10 Public and Occupational Health and Safety—Facility Accidents

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

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

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

Consequences and associated risks are presented in **Tables 4–53** and **4–54**, respectively.

Table 4–53 FFTF and FMEF Accident Consequences Under Alternative 1 (Restart FFTF)—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]
FFTF accidents						
Design-basis-accident primary sodium spill (MOX)	0.00113	5.65×10^{-7}	78.6	0.0393	0.00313	1.25×10^{-6}
Design-basis-accident primary sodium spill (HEU)	8.63×10^{-4}	4.32×10^{-7}	72.6	0.0363	0.00181	7.24×10^{-7}
Beyond-design-basis core melt accident (MOX)	0.679	3.40×10^{-4}	6.68×10^{4}	33.4	0.679	2.72×10^{-4}
Beyond-design-basis core melt accident (HEU)	0.481	2.41×10^{-4}	6.16×10^{4}	30.8	0.375	1.50×10^{-4}
BLTC driver fuel-handling accident (MOX)	0.00383	1.92×10^{-6}	1,280	0.639	0.357	1.43×10^{-4}
BLTC driver fuel-handling accident (HEU)	0.00384	1.92×10^{-6}	1,230	0.617	0.340	1.36×10^{-4}
BLTC neptunium-237 target-handling accident	2.61×10^{-4}	1.31×10^{-7}	25.8	0.0129	0.0279	1.12×10^{-5}
BLTC isotope target-handling accident	1.22×10^{-4}	6.10×10^{-8}	2.74	0.00137	0.0143	5.72×10^{-6}
FMEF accidents						
Ion exchange explosion during neptunium-237 target fabrication	2.02×10^{-9}	1.01×10^{-12}	7.26×10^{-5}	3.63×10^{-8}	6.65×10^{-10}	2.66×10^{-13}
Target dissolver tank failure during plutonium-238 separation	4.64×10^{-8}	2.32×10^{-11}	0.00169	8.47×10^{-7}	1.95×10^{-8}	7.81×10^{-12}
Ion exchange explosion during plutonium-238 separation	1.24×10^{-5}	6.18×10^{-9}	0.451	2.25×10^{-4}	5.20×10^{-6}	2.08×10^{-9}
Medical and industrial isotopes localized solvent fire	0.00276	1.38×10^{-6}	56.2	0.0281	9.51×10^{-5}	3.80×10^{-8}
Medical and industrial isotopes glovebox explosion	1.00	5.00×10^{-4}	2.95×10^{4}	14.8	24.0	0.0192
Processing facility beyond-design-basis earthquake	16.5	0.00825	6.42×10^{5}	321	922	1.00[c]

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

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

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

Table 4–54 FFTF and FMEF Accident Risks Under Alternative 1 (Restart FFTF)—Option 6

Accident (Frequency)	Maximally Exposed Individual[a]	Population to 80 Kilometers (50 Miles)[b]	Noninvolved Worker[a]
Annual FFTF risks			
Design-basis-accident primary sodium spill (MOX) (1×10^{-4})	5.65×10^{-11}	3.93×10^{-6}	1.25×10^{-10}
Design-basis-accident primary sodium spill (HEU) (1×10^{-4})	4.32×10^{-11}	3.63×10^{-6}	7.24×10^{-11}
Beyond-design-basis core melt accident (MOX) (1×10^{-6})	3.40×10^{-10}	3.34×10^{-5}	2.72×10^{-10}
Beyond-design-basis core melt accident (HEU) (1×10^{-6})	2.41×10^{-10}	3.08×10^{-5}	1.50×10^{-10}
BLTC driver fuel-handling accident (MOX) (1×10^{-7})	1.92×10^{-13}	6.39×10^{-8}	1.43×10^{-11}
BLTC driver fuel-handling accident (HEU) (1×10^{-7})	1.92×10^{-13}	6.17×10^{-8}	1.36×10^{-11}
BLTC neptunium-237 target-handling accident (1×10^{-7})	1.31×10^{-14}	1.29×10^{-9}	1.12×10^{-12}
BLTC isotope target-handling accident (1×10^{-7})	6.10×10^{-15}	1.37×10^{-10}	5.72×10^{-13}
35-year FFTF risk	1.06×10^{-8}	0.00122	9.37×10^{-9}
Annual FMEF risks			
Ion exchange explosion during neptunium-237 target fabrication (0.01)	1.01×10^{-14}	3.63×10^{-10}	2.66×10^{-15}
Target dissolver tank failure during plutonium-238 separation (0.01)	2.32×10^{-13}	8.47×10^{-9}	7.81×10^{-14}
Ion exchange explosion during plutonium-238 separation (0.01)	6.18×10^{-11}	2.25×10^{-6}	2.08×10^{-11}
Medical and industrial isotopes localized solvent fire (0.044)	6.13×10^{-8}	1.25×10^{-3}	1.69×10^{-9}
Medical and industrial isotopes glovebox explosion (1×10^{-4})	5.00×10^{-8}	0.00148	1.92×10^{-6}
Processing facility beyond-design-basis earthquake (1×10^{-5})	8.25×10^{-8}	0.00321	1.00×10^{-5}[(c)]
35-year FMEF risk	6.79×10^{-6}	0.208	4.17×10^{-4}
35-year Option risks[d]	6.80×10^{-6}	0.209	4.17×10^{-4}

a. Increased likelihood of a latent cancer fatality.
b. Increased number of latent cancer fatalities.
c. Risk of an early fatality.
d. Individual risks are summed only for colocated individuals. The highest individual risk was used to represent the 35-year option risk.

Key: BLTC, bottom-loading transfer cask; HEU, highly enriched uranium core; MOX, mixed oxide core.
Source: Model results, using the MACCS2 (Chanin and Young 1997) and GENII (Napier et al. 1988) computer codes.

FFTF would operate for 6 years with a mixed oxide core followed by 29 years with a highly enriched uranium core. As shown in Table 4–53, the beyond-design-basis core melt accident would result in the largest radiological consequences among FFTF accidents. In order to incorporate internal and external initiators, the accident frequency of 1×10^{-6} was selected for the beyond-design-basis core melt accident. For 35 years of operation, the increased risk of a latent cancer fatality to the maximally exposed individual and to a noninvolved worker would be 1.06×10^{-8} and 9.37×10^{-9}, respectively. The increased number of latent cancer fatalities in the surrounding population would be 0.00122.

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

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

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

4.3.6.1.11 Public and Occupational Health and Safety—Transportation

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

Approximately 38,000 shipments of radioactive materials would be made by DOE. The total distance traveled on public roads by trucks carrying radioactive materials would be 5.5 million kilometers (3.4 million miles); and in the air carrying medical isotopes, 23 million kilometers (14 million miles).

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

IMPACTS OF INCIDENT-FREE TRANSPORTATION. The dose to transportation workers from all transportation activities entailed by this option has been estimated at 18 person-rem; the dose to the public, 18 person-rem. Accordingly, incident-free transportation of radioactive material associated with this option would result in 0.0071 latent cancer fatality among transportation workers and 0.009 latent cancer fatality in the total affected population over the duration of the transportation activities. The estimated number of nonradiological fatalities from vehicular emissions associated with this option would be 0.023. About half of the crew risk, about 40 percent of the public risk, and most of the emissions risk would result from shipping medical and industrial isotopes.

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

Estimates of the total transportation accident risks under this option are as follows: a radiological dose to the population of 1,063 person-rem, resulting in 0.53 latent cancer fatality; and traffic accidents resulting in 0.11 traffic fatality. Nearly all of the radiological and traffic accident risk would result from shipping medical and industrial isotopes.

4.3.6.1.12 Environmental Justice

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

4.3.6.1.13 Waste Management

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

4.3.6.1.14 Spent Nuclear Fuel Management

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