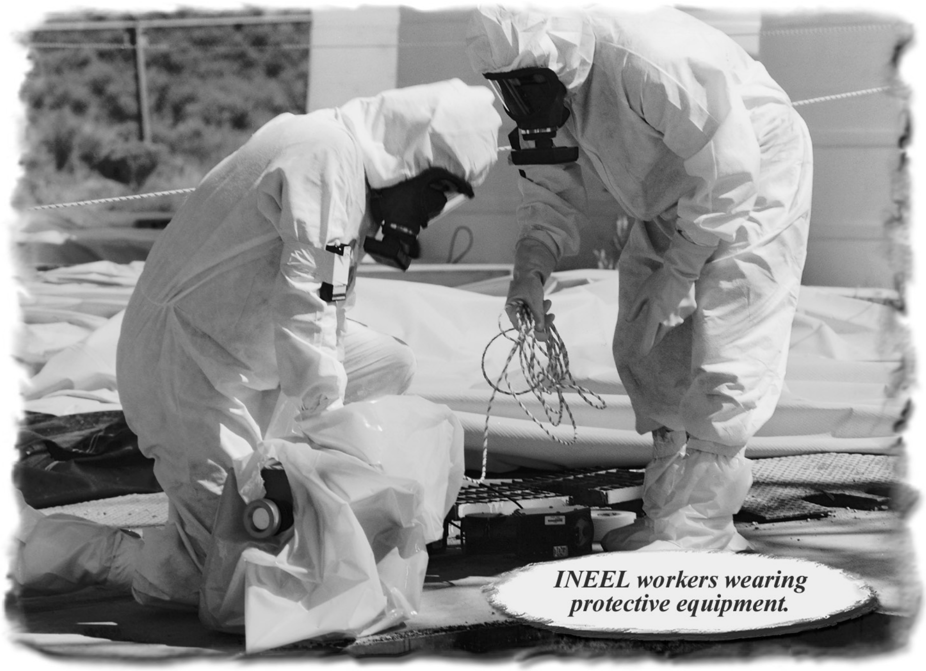

INEEL workers wearing protective equipment.

tion dose to the noninvolved worker and maximally exposed offsite individual and the collective dose to the population residing within 50 miles of INTEC. The radiation dose values for the various alternatives were then multiplied by the dose-to-risk conversion factors, which are based on the 1993 *Limitations of Exposure to Ionizing Radiation* (NCRP 1993). DOE has adopted these risk factors of 0.0005 and 0.0004 latent cancer fatality (LCF) for each person-rem of radiation exposure to the general public and worker population, respectively, for doses less than 20 rem. The factor for the population is slightly higher due to the presence of infants and children who are more sensitive to radiation than the adult worker population.

DOE used radiation dose information provided in the project data sheets (see Appendix C.6) for projects comprising each option to estimate the potential health effects to involved workers (i.e., workers performing construction and operations under each alternative) from construction and operations activities. Radiation dose was calculated as annual average and total campaign dose summed for the projects to estimate health effects by option.

For nonradiological health impacts from atmospheric releases, DOE used toxic air pollutant emissions data for each project under an alternative to estimate air concentrations at the INEEL site boundary. For the evaluation of occupational health effects, the modeled chemical concentration was compared with the applicable occupational standard which provides levels at which no adverse effects are expected, yielding a hazard quotient. The hazard quotient is a ratio between the calculated concentration in air and the applicable standard. For noncarcinogenic toxic air pollutants, if the hazard quotient is less

5.2.10 HEALTH AND SAFETY

This section presents potential health and safety impacts to INEEL workers and the offsite public from implementing the waste processing alternatives described in Chapter 3. The estimates of health impacts are based on projected radioactive and nonradioactive releases to the environment and radiation exposure to facility workers. As discussed in Section 5.2.7, releases to surface water would be minimal and would not be expected to result in adverse health impacts. This section also summarizes worker illness, injury, and fatality incidence rates based on historical INEEL occupational safety data.

Because the Minimum INEEL Processing ***Alternative*** would involve shipment of mixed HLW to the Hanford Site for processing, this section briefly describes potential health and safety impacts to workers and the offsite public from treating INEEL waste at the Hanford Site. A more detailed discussion of health and safety impacts from treating INEEL waste at the Hanford Site is presented in Appendix C.8.

5.2.10.1 Methodology

DOE used data on airborne emissions of radioactive materials (Section 5.2.6) to calculate radiathan 1, then no adverse health effects would be expected. If the hazard quotient is greater than 1, additional investigation would be warranted. For carcinogenic toxic air pollutants, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen.

5.2.10.2 Radiological and Nonradiological Construction Impacts

Under all alternatives there would be some amount of radiation exposure to construction workers. Construction workers involved in upgrade and expansion of HLW facilities would be exposed to low levels of radioactive contamination. For more information on specific projects for each alternative, see Appendix C.6.

Table 5.2-1***9*** provides summaries of the number of involved workers, total collective dose, and estimated increase in number of LCFs for the total construction phase for each alternative. Most of the waste processing alternatives result in similar levels of total collective worker dose ranging from ***37*** to ***200*** person-rem. The highest collective dose of ***200*** person-rem occurs under ***the*** Planning Basis, ***Hot Isostatic Pressed Waste and Direct Cement Waste Options***. The corresponding increase in number of latent cancer fatalities for any of these options would be ***0.078***.

Nonradiological emissions associated with construction activities would result primarily from the disturbance of land, which generates fugitive dust, and from the combustion of fossil fuels in construction equipment. As stated in Section 5.2.6, dust generation would be mitigated by the application of water, use of soil additives, and possibly administrative controls. Emissions of criteria pollutants from construction equipment may also cause localized impacts to air quality. Construction-related impacts to workers from criteria pollutant emissions are expected to fall within applicable standards (see Section 5.2.6).

5.2.10.3 Radiological and Nonradiological Operational Impacts

Radiological Air Emissions - As stated in Section 5.2.6, Air Resources, waste processing and related activities at INTEC would result in releases of radionuclides to the atmosphere. No future discharge of radioactive liquid effluents that would result in offsite radiation doses would occur under any of the alternatives (see Section 5.2.7). Therefore, DOE only calculated potential health effects from airborne releases of radioactivity.

Table 5.2-***20*** provides summaries of radiation doses and health impacts from atmospheric emissions from the waste processing options. Health effects are presented for (a) the maximally exposed individual at an offsite location; (b) noninvolved onsite workers at the INEEL areas of highest predicted radioactivity level; and (c) the offsite population (adjusted for future growth) within a 50-mile radius of the INTEC. The annual doses represent the maximum value predicted over any one year the waste processing occurs. Doses over periods which involve only interim storage of waste would be much less. The annual average project doses were multiplied by the project duration and summed for all projects within a given option to determine the integrated dose and resultant health effects for each option. Modeling indicated that the dose due to ground contamination did not contribute significantly to the total dose for the primary nuclides and pathways of concern.

In all cases for air emissions, the dose to the maximally exposed offsite individual is a small fraction of that received from natural background sources and is well below the EPA airborne emissions dose limit of 10 millirem per year (40 CFR 61.92). The highest annual dose of 1.8×10^{-3} millirem to the maximally exposed offsite individual would occur from the Planning Basis and Hot Isostatic Pressed Waste Options. This estimated annual maximally exposed offsite individual dose is slightly higher than the esti-

Table 5.2-19. Estimated radiological impacts to involved workers by alternative during construction activities.

Receptor	No Action Alternative	Continued Current Operations Alternative	Separations Alternative: Full Separations Option	Separations Alternative: Planning Basis Option	Separations Alternative: Transuranic Separations Option	Non-Separations Alternative: Hot Isostatic Pressed Waste Option	Non-Separations Alternative: Direct Cement Waste Option	Non-Separations Alternative: Early Vitrification Option	Non-Separations Alternative: Steam Reforming Option	Minimum INEEL Processing Alternative: At INEEL	Minimum INEEL Processing Alternative: At Hanford[a]	Direct Vitrification Alternative: Vitrification without Calcine Separations Option	Direct Vitrification Alternative: Vitrification with Calcine Separations Option
Number of involved worker - years	150	390	690	780	690	780	780	540	540	690	NA[b]	540	540
Total construction phase worker dose (person-rem)[c]	37	97	170	200	170	200	200	140	140	170	NA[b]	140	140
Total increase in number of latent cancer fatalities	0.015	0.039	0.069	0.078	0.069	0.078	0.078	0.054	0.054	0.069	NA[b]	0.054	0.054

a. Construction activities associated with this alternative would consist of building three canister storage buildings and a calcine dissolution facility. As shown in Appendix C.8, Sections C.8.5.1 and C.8.5.2, there would be no radiological dose associated with construction of these facilities.

b. NA = Not applicable

c. Total construction phase dose is based on the average annual dose for each project that comprises each alternative multiplied by the duration for each project and then summed for each alternative.

Table 5.2-*20*. Estimated public and occupational radiological impacts from atmospheric emissions.

			Separations Alternative			Non-Separations Alternative				Minimum INEEL Processing Alternative		***Direct Vitrification Alternative***	
Receptor	No Action Alternative	Continued Current Operations Alternative	Full Separations Option	Planning Basis Option	Transuranic Separations Option	Hot Isostatic Pressed Waste Option	Direct Cement Waste Option	Early Vitrification Option	***Steam Reforming Option***	At INEEL	At Hanford[a]	***Vitrification without Calcine Separations Option***	***Vitrification with Calcine Separations Option***
Maximally exposed offsite individual dose (millirem/year)[b]	6.0×10^{-4}	1.7×10^{-3}	1.2×10^{-4}	1.8×10^{-3}	6.0×10^{-5}	1.8×10^{-3}	1.7×10^{-3}	8.9×10^{-4}	***6.2×10^{-4}***	9.5×10^{-4}	2.8×10^{-5}	***6.5×10^{-4}***	***6.8×10^{-4}***
Integrated maximally exposed offsite individual dose (millirem)[c]	0.022	0.019	2.5×10^{-3}	6.3×10^{-3}	1.3×10^{-3}	***0.020***	0.019	0.031	***0.022***	0.024	5.0×10^{-5}	***0.022***	***0.023***
Estimated probability of latent cancer fatality for the maximally exposed offsite individual	1.0×10^{-8}	1.0×10^{-8}	1.2×10^{-9}	3.2×10^{-9}	6.5×10^{-10}	1.0×10^{-8}	1.0×10^{-8}	1.5×10^{-8}	***1.1×10^{-8}***	1.0×10^{-8}	2.5×10^{-11}	***1.1×10^{-8}***	***1.2×10^{-8}***
Noninvolved worker dose (millirem/year)[d]	7.0×10^{-6}	1.8×10^{-5}	4.4×10^{-5}	9.0×10^{-5}	3.4×10^{-5}	3.6×10^{-5}	3.0×10^{-5}	4.8×10^{-5}	***2.2×10^{-5}***	1.0×10^{-4}	1.3×10^{-5}	***2.3×10^{-5}***	***2.3×10^{-5}***
Integrated noninvolved worker dose (millirem)[c]	2.5×10^{-4}	2.0×10^{-4}	9.2×10^{-4}	8.6×10^{-4}	7.1×10^{-4}	5.8×10^{-4}	3.6×10^{-4}	1.3×10^{-3}	***4.8×10^{-4}***	1.4×10^{-3}	2.3×10^{-5}	***4.8×10^{-4}***	***4.8×10^{-4}***
Estimated probability of latent cancer fatality for the noninvolved worker	1.0×10^{-10}	***8.0×10^{-11}***	***3.7×10^{-10}***	***3.4×10^{-10}***	***2.8×10^{-10}***	***2.3×10^{-10}***	***1.4×10^{-10}***	***5.2×10^{-10}***	***1.9×10^{-10}***	***5.6×10^{-10}***	***9.2×10^{-12}***	***1.9×10^{-10}***	***1.9×10^{-10}***
Dose to population within 50 miles of INTEC (person-rem per year)[e]	***0.038***	***0.11***	***6.6×10^{-3}***	***0.11***	***3.6×10^{-3}***	***0.11***	***0.11***	***0.056***	***0.040***	***0.056***	1.3×10^{-3}[(f)]	***0.045***	***0.047***

Table 5.2-*20*. Estimated public and occupational radiological impacts from atmospheric emissions (continued).

Receptor	No Action Alternative	Continued Current Operations Alternative	Separations Alternative			Non-Separations Alternative				Minimum INEEL Processing Alternative		***Direct Vitrification Alternative***	
			Full Separations Option	Planning Basis Option	Transuranic Separations Option	Hot Isostatic Pressed Waste Option	Direct Cement Waste Option	Early Vitrification Option	***Steam Reforming Option***	At INEEL	At Hanford[a]	***Vitrification without Calcine Separations Option***	***Vitrification with Calcine Separations Option***
Integrated collective dose to population (person-rem)[c]	***1.4***	***1.2***	***0.14***	***0.39***	***0.075***	***1.3***	***1.3***	***2.0***	***1.4***	***1.4***	2.3×10^{-3}	***1.5***	***1.5***
Estimated number of latent cancer fatalities to population	$\boldsymbol{7.0\times10^{-4}}$	$\boldsymbol{6.0\times10^{-4}}$	$\boldsymbol{7.0\times10^{-5}}$	$\boldsymbol{2.0\times10^{-4}}$	$\boldsymbol{3.8\times10^{-5}}$	$\boldsymbol{6.5\times10^{-4}}$	$\boldsymbol{6.5\times10^{-4}}$	$\boldsymbol{1.0\times10^{-3}}$	$\boldsymbol{7.0\times10^{-4}}$	$\boldsymbol{7.0\times10^{-4}}$	1.1×10^{-6}	$\boldsymbol{7.5\times10^{-4}}$	$\boldsymbol{7.5\times10^{-4}}$

a. Data based on analysis of the Interim Storage Shipping Scenario which has higher impacts than the Just-in-Time Shipping Scenario. See Appendix C.8.

b. Doses are maximum values over any single year during which waste processing occurs; annual doses from waste stored on an interim basis after waste processing is completed would be much less.

c. The annual average project doses were multiplied by the project duration and summed for all projects within a given option to determine the integrated dose and resultant health effects for each option.

d. Location of highest onsite dose is Central Facilities Area.

e. Population dose assumes growth rate of 6 percent per decade between 1990 and 2035.

f. Dose to population within 50 miles of Hanford Site (person-rem per year).

mated doses for the Continued Current Operations Alternative ***and*** the Direct Cement Waste Option. The highest integrated offsite maximally exposed individual dose of ***0.031*** millirem occurs under the Early Vitrification Option. The noninvolved worker doses from facility emissions would also be a small fraction of the allowable limit. The Federal occupational dose limit is 5,000 millirem per year, as established in 10 CFR 835.202. The highest predicted onsite worker annual dose of 1.0×10^{-4} millirem and integrated dose of 1.4×10^{-3} millirem would occur from the Minimum INEEL Processing Alternative. No applicable standards exist for collective population doses; however, DOE policy requires that doses resulting from radioactivity in effluents be reduced to levels as low as reasonably achievable. The highest annual collective dose to the population within 50 miles of INTEC of ***0.11*** person-rem would occur for the ***Continued Current Operations Alternative and the Planning Basis,*** Hot Isostatic Pressed Waste, ***and Direct Cement Waste Options***. The highest total collective population dose of ***2.0*** person-rem would occur from the Early Vitrification Option and corresponds to $\boldsymbol{1.0\times10^{-3}}$ LCF for the entire operations period. The total integrated collective population doses associated with the other options are lower and range from ***0.075*** to ***1.5*** person-rem.

Involved Worker Impacts - Table 5.2-2***1*** provides a summary of radiological impacts to involved workers from facility operations. This table provides the number of involved ***worker-years***, total campaign collective worker dose, and estimated increased lifetime number of LCFs for each alternative. The highest collective worker dose, integrated over the entire campaign would occur from the Direct Cement Waste Option. The total collective worker dose is projected to be $\boldsymbol{1.1\times10^{3}}$ person-rem, which corresponds to ***0.43*** LCF.

Table 5.2-2***2*** presents annual radiological impacts for interim storage after the year 2035. Impacts are presented in terms of annual average worker dose for radiological workers and the resultant increase in LCFs. There are no toxic air pollutants or criteria pollutant emissions expected with interim storage activities after the year 2035. The Transuranic Separations ***and Steam Reforming*** Option***s are*** not listed in this table because there would be no interim storage of final waste forms produced under ***these*** options.

Nonradiological Air Emissions - Table 5.2-2***3*** presents hazard quotients for concentrations of noncarcinogenic toxic air pollutants at the INEEL site boundary for the option with the maximum value. The locations of these modeled concentrations are dependent on different points and times of release, so no single individual could be exposed to all of these chemicals at once. Therefore, these chemical hazard quotients are evaluated separately and not summed. For the individual noncarcinogens, the maximum concentrations for each of the pollutants occur most frequently from the Planning Basis Option. However, all hazard quotients are much less than 1, indicating no expected adverse health effects.

Table 5.2-2***4*** presents hazard quotients for concentrations of carcinogenic toxic air pollutants at the INEEL site boundary by option. As with noncarcinogens, the locations of these modeled maximum concentrations are dependent on different points and times of release so the risks are not summed. The results of this evaluation indicate that the hazard quotients for each chemical range from $\boldsymbol{4.7\times10^{-6}}$ for ***dioxins and furans*** to ***0.10*** for nickel. As stated in Section 5.2.6, the highest carcinogenic air pollutant impacts are projected for those options that involve the greatest amount of fossil fuel combustion, most notably the Planning Basis Option. For the Planning Basis Option, nickel concentrations could be as high as ***10*** percent of the State of Idaho standard at the INEEL boundary. Projected carcinogenic concentrations are based on the conservative assumption that all toxic pollutant sources are operating concurrently, and no credit is taken for reductions by air pollution control equipment. All other carcinogens are expected to be at very low ambient levels with negligible health impacts. As stated in Section 5.2.6, concentrations of all carcinogenic and noncarcinogenic substances at INEEL facility areas are less than 1 percent of occupational exposure limits in all cases. Ambient concentrations of carcinogenic and noncarcinogenic toxic pollutants at other public access locations, such as public roads and Craters of the Moon Wilderness Area are presented in Appendix C.2.5.2.

Table 5.2-21. Estimated radiological impacts to involved workers by alternative during facility operations.

Receptor	No Action Alternative	Continued Current Operations Alternative	Separations Alternative: Full Separations Option[a]	Separations Alternative: Planning Basis Option	Separations Alternative: Transuranic Separations Option[b]	Non-Separations Alternative: Hot Isostatic Pressed Waste Option	Non-Separations Alternative: Direct Cement Waste Option	Non-Separations Alternative: Early Vitrification Option	Non-Separations Alternative: Steam Reforming Option	Minimum INEEL Processing Alternative: At INEEL	Minimum INEEL Processing Alternative: At Hanford[c]	Direct Vitrification Alternative: Vitrification without Calcine Separations Option	Direct Vitrification Alternative: Vitrification with Calcine Separations Option
Number of involved worker - years	1.8×10^3	2.1×10^3	4.1×10^3	5.1×10^3	3.6×10^3	4.1×10^3	5.7×10^3	3.8×10^3	3.3×10^3	3.6×10^3	1.8×10^3	2.6×10^3	3.4×10^3
Total campaign collective worker dose (person-rem)[d]	350	410	780	980	680	790	1.1×10^3	710	630	690	350	500	650
Total number of latent cancer fatalities	0.14	0.16	0.31	0.39	0.27	0.31	0.43	0.29	0.25	0.27	0.14	0.20	0.26

a. Assumes LLW Class A type grout disposal in INEEL disposal facility (P35D and P27).
b. Assumes LLW Class C type grout disposal in INEEL disposal facility (P49D and P27).
c. Data based on analysis of the Interim Storage Shipping scenario which has higher impacts than the Just-in-Time Shipping Scenario. See Appendix C.8.4.11.
d. Total campaign dose is based on the average annual dose for each project that comprises each alternative multiplied by the duration for each project and then summed for each alternative.

Table 5.2-22. Estimated radiological impacts to involved workers from interim storage operations post-2035.

Alternatives/***Options***[a]	Radiological workers/year	Annual average worker dose (rem)	Annual average collective dose (person-rem)	Estimated ***increase in*** annual latent cancer fatalities
Full Separations Option (P24)	5	0.19	0.95	3.8×10^{-4}
Planning Basis Option (P24)	5	0.19	0.95	3.8×10^{-4}
Hot Isostatic Pressed Waste Option (P72)	2.5	0.19	0.48	1.9×10^{-4}
Direct Cement Waste Option (P81)	4.5	0.19	0.86	3.4×10^{-4}
Early Vitrification Option (P61)	4.5	0.19	0.86	3.4×10^{-4}
Minimum INEEL Processing Alternative (P24)	5	0.19	0.95	3.8×10^{-4}
Vitrification without Calcine Separations Option (P61)	***4.5***	***0.19***	***0.86***	***3.4×10^{-4}***
Vitrification with Calcine Separations Option (P24)	***5***	***0.19***	***0.95***	***3.8×10^{-4}***

a. Project Titles: P1D - No Action; P4- Long-Term Storage of Calcine in Bin Sets; P24 - Vitrified Product Interim Storage; P72 - Interim Storage of Hot Isostatic Pressed Waste; P81 - Unseparated Cementitious HLW Interim Storage; P61 - Vitrified Product Interim Storage; P24 - Interim Storage of Vitrified Waste at INEEL.

Table 5.2-23. Projected noncarcinogenic toxic pollutant maximum concentrations at the site boundary for the proposed waste processing alternatives.[a,b]

Pollutant[c]	Maximum concentration option	Concentration ($\mu g/m^3$)[d,e]	Idaho standard ($\mu g/m^3$)[f]	Hazard quotient
Antimony	Planning Basis Option	***4.7×10^{-4}***	25	***1.9×10^{-5}***
Chloride	Planning Basis Option	***0.032***	150	***2.1×10^{-4}***
Cobalt	Planning Basis Option	***5.4×10^{-4}***	2.5	***2.2×10^{-4}***
Copper	Planning Basis Option	***1.6×10^{-4}***	10	***1.6×10^{-5}***
Fluorides (as F)	***Planning Basis Option***	***1.7×10^{-4}***	125	***1.4×10^{-6}***
Lead	Planning Basis Option	***1.3×10^{-4}***	1.5	***8.7×10^{-5}***
Manganese (as Mn)	Planning Basis Option	***2.7×10^{-4}***	50	***5.4×10^{-6}***
Mercury	Planning Basis Option	***1.2×10^{-5}***	5	***2.4×10^{-6}***
Phosphorus	Planning Basis Option	***8.4×10^{-4}***	5	***1.7×10^{-4}***
Vanadium	Planning Basis Option	***2.8×10^{-3}***	2.5	***1.1×10^{-3}***

a. Emissions include chemical processing and fossil fuel combustion.
b. Only site boundary conditions are listed, conditions at public access on site roads can be found in Appendix C.2.
c. Pollutants listed are those that account for more than 95 percent of health risk.
d. $\mu g/m^3$ = micrograms per cubic meter.
e. All concentrations are 24 hour maximum values, except for lead which is a quarterly value.
f. Standards for each pollutant other than lead are toxic air pollutant increments specified in IDAPA 58.01.01.585; lead standard is primary ambient air quality standard from IDAPA 58.01.01.577.

Table 5.2-24. Projected carcinogenic toxic pollutant maximum concentrations at the site boundary for the proposed waste processing alternatives.[a,b]

Pollutant[c]	Maximum concentration option	Concentration (μg/m^3)[d,e]	Idaho standard (μg/m^3)	Hazard quotient
Arsenic	Planning Basis Option	***6.8×10^{-6}***	2.3×10^{-4}	***0.030***
Beryllium	Planning Basis Option	***1.4×10^{-7}***	4.2×10^{-3}	***3.3×10^{-5}***
Cadmium compounds	Planning Basis Option	***2.1×10^{-6}***	5.6×10^{-4}	***3.7×10^{-3}***
Chromium (hexavalent forms)	Planning Basis Option	***1.3×10^{-6}***	8.3×10^{-5}	***0.016***
Dioxins and furans	Hot Isostatic Pressed Waste Option	***1.0×10^{-13}***	2.2×10^{-8}	***4.7×10^{-6}***
Formaldehyde	Planning Basis Option	***1.7×10^{-4}***	0.08	***2.1×10^{-3}***
Hydrazine	***Early Vitrification*** Option	***1.1×10^{-7}***	3.4×10^{-4}	***3.2×10^{-4}***
Nickel	Planning Basis Option	***4.4×10^{-4}***	4.2×10^{-3}	***0.10***

a. Emissions include chemical processing and fossil fuel combustion.
b. Only site boundary conditions are listed. Conditions at public access on site roads can be found in Appendix C.2.
c. Pollutants listed are those that account for more than 95 percent of health risk.
d. μg/m^3 = micrograms per cubic meter.
e. All concentrations are ***annual average*** values.

For each alternative, maximum incremental impacts of carcinogenic air pollutants are projected to occur at or just beyond the southern site boundary, while maximum noncarcinogenic air pollutant levels would occur along U.S. Highway 20.

5.2.10.4 Occupational Safety Impacts

Estimated occupational injury rates for waste processing alternatives are presented in Tables 5.2-2***5*** and 5.2-2***6***. The projected rates for injury are based on observed historic rates at the INEEL. Table 5.2-2***5*** provides estimates of the number of lost work days and total recordable cases that would occur during a peak employment year and for the entire period during construction for each of the alternatives. Table 5.2-2***6*** provides similar data for the operations phase for each of the alternatives. The projected injury rates are based on historic injury rates for ***INEEL*** workers over a 5-year period from ***1996*** through ***2000*** multiplied by the employment levels for each alternative. The data for lost work days represents the number of workdays, beyond the day of injury or onset of illness, the employee was away from work or limited to restricted work activity because of an occupational injury or illness. The total recordable cases value includes work-related death, illness, or injury which resulted in loss of consciousness, restriction from work or motion, transfer to another job, or required medical treatment beyond first aid.

As shown in Table 5.2-2***5***, the highest occurrences of lost work days and total recordable cases during a peak construction year are projected to occur for the Planning Basis Option. This is due to the larger number of employees and work hours associated with these options during a peak year. The highest total number of cases of lost work days and total recordable cases would be likely to occur for the Planning Basis Option followed by the Full Separations Option due to the larger number of total worker hours associated with these options.

As shown in Table 5.2-2***6***, the highest occurrences of lost work days and total recordable cases during a peak operations year are projected to occur for the ***Direct Cement Waste*** Option followed by the ***Planning Basis*** Option. This is due to the larger number of employees and work hours associated with these options during a peak year. The highest total number of lost work days and total recordable cases would be likely

Table 5.2-25. Estimated worker injury impacts during construction at INEEL by alternative (peak year and total cases).

			Separations Alternative			Non-Separations Alternative				Minimum INEEL Processing Alternative		Direct Vitrification Alternative	
Receptor	No Action Alternative	Continued Current Operations Alternative	Full Separations Option	Planning Basis Option	Transuranic Separations Option	Hot Isostatic Pressed Waste Option	Direct Cement Waste Option	Early Vitrification Option	Steam Reforming Option	At INEEL	At Hanford[a]	Vitrification without Calcine Separations Option	Vitrification with Calcine Separations Option
Number of workers during peak year	21	89	850	870	680	360	400	330	550	200	NR[b]	350	670
Peak year lost workdays[c]	6.0	25	240	250	190	100	110	93	160	56	NR	100	190
Peak year total recordable cases[d]	0.78	3.3	32	32	25	13	15	12	20	7.3	NR	13	25
Total lost workdays	30	110	1.5×10^3	1.5×10^3	1.1×10^3	520	620	530	770	620	NR	710	1.3×10^3
Total recordable cases	3.9	14	190	200	150	67	81	69	100	81	230	93	170

a. Data based on analysis of the Interim Storage Scenario.

b. NR = Not reported.

c. The number of workdays, beyond the day of injury or onset of illness, the employee was away from work or limited to restricted work activity because of an occupational injury or illness.

d. A recordable case includes work-related death, illness, or injury which resulted in loss of consciousness, restriction of work or motion, transfer to another job, or required medical treatment beyond first aid.

Table 5.2-26. Estimated worker injury impacts at INEEL by alternative during operations (peak year and total cases).

Receptor	No Action Alternative	Continued Current Operations Alternative	Separations Alternative			Non-Separations Alternative				Minimum INEEL Processing Alternative		Direct Vitrification Alternative	
			Full Separations Option	Planning Basis Option	Transuranic Separations Option	Hot Isostatic Pressed Waste Option	Direct Cement Waste Option	Early Vitrification Option	Steam Reforming Option	At INEEL	At Hanford[a]	Vitrification without Calcine Separations Option	Vitrification with Calcine Separations Option
Number of workers during peak year	73	280	440	480	320	460	530	330	170	330	NR[b]	310	440
Peak year lost workdays[c]	21	79	130	140	90	130	150	93	49	93	NR	87	130
Peak year total recordable cases[d]	2.7	10	16	18	12	17	19	12	6.4	12	NR	11	16
Total lost workdays	850	1.1×10^3	3.0×10^3	3.7×10^3	2.3×10^3	2.5×10^3	2.9×10^3	2.5×10^3	1.4×10^3	2.0×10^3	NR	1.9×10^3	2.5×10^3
Total recordable cases	110	150	400	480	300	320	380	330	180	270	27	250	330

a. Data based on analysis of the Interim Storage Scenario. See Appendix C.8.4.11, Table C.8-17.

b. NR = Not reported.

c. The number of workdays, beyond the day of injury or onset of illness, the employee was away from work or limited to restricted work activity because of an occupational injury or illness.

d. A recordable case includes work-related death, illness, or injury which resulted in loss of consciousness, restriction of work or motion, transfer to another job, or required medical treatment beyond first aid.

- New Information -

to occur for the Planning Basis Option followed by the Full Separations Option due to the larger number of total worker hours associated with these options.

Table 5.2-27 presents the occurrences of lost work days and total recordable cases for interim storage activities after the year 2035. Impacts are highest for the Direct Cement Option due to the larger number of employees during interim storage operations. ***The Transuranic Separations and Steam Reforming Options are not listed in this table because there would be no interim storage of final waste forms produced under these options.***

5.2.11 ENVIRONMENTAL JUSTICE

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs each Federal agency to "make…achieving environmental justice part of its mission" and to identify and address "…disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations." The Presidential Memorandum that accompanied Executive Order 12898 emphasized the importance of using existing laws, including the National Environmental Policy Act, to identify and address environmental justice concerns, "including human health, economic, and social effects, of Federal actions."

The Council on Environmental Quality, which oversees the Federal government's compliance with Executive Order 12898 and the National Environmental Policy Act, subsequently developed guidelines to assist Federal agencies in incorporating the goals of Executive Order 12898 in the NEPA process. This guidance, published in 1997, was intended to "…assist Federal agencies with their NEPA procedures so that environmental justice concerns are effectively identified and addressed."

As part of this process, DOE identified (in Section 4.12) minority and low-income populations within a 50-mile radius of INTEC, which was defined as the region of influence for the environmental justice analysis. The section that follows discusses whether implementing the proposed waste processing alternatives described in Chapter 3 would result in disproportionately high or adverse impacts to minority and low-income populations. Section C.8.4.19 discusses the environmental justice analysis at the Hanford Site under the Minimum INEEL Processing Alternative.

5.2.11.1 Methodology

The Council on Environmental Quality guidance (CEQ 1997) does not provide a standard approach or formula for identifying and addressing environmental justice issues. Instead, it offers Federal agencies general principles for conducting an environmental justice analysis under NEPA:

- Federal agencies should consider the population structure in the region of influence to determine whether minority populations, low-income populations, or Indian tribes are present, and if so, whether there may be disproportionately high and adverse human health or environmental effects on any of these groups.

- Federal agencies should consider relevant public health and industry data concerning the potential for multiple or cumulative exposure to human health or environmental hazards in the affected population and historical patterns of exposure to environmental hazards, to the extent such information is available.

- Federal agencies should recognize the interrelated cultural, social, occupational, historical, or economic factors that may amplify the effects of the proposed agency action. These would include the physical sensitivity of the community or population to particular impacts.

- Federal agencies should develop effective public participation strategies that seek to overcome linguistic, cultural, institutional, and geographic barriers to

Table 5.2-27. Estimated annual worker injury impacts to involved workers from interim storage operations post-2035.

Alternative	Workers per year	Lost workdays per year	Total recordable cases per year
Full Separations Option	6.5	***1.8***	***0.24***
Planning Basis Option	6.5	***1.8***	***0.24***
Hot Isostatic Pressed Waste Option	13	***3.7***	***0.48***
Direct Cement Waste Option	18	***5.0***	***0.65***
Early Vitrification Option	6.5	***1.8***	***0.24***
Minimum INEEL Processing Alternative	6.5	***1.8***	***0.24***
Vitrification without Calcine Separations Option[a]	***6.5***	***1.8***	***0.24***
Vitrification with Calcine Separations Option[a]	***6.5***	***1.8***	***0.24***

a. Impacts were estimated assuming that the vitrified SBW would be managed as HLW and placed in interim storage pending disposal in a geologic repository. If DOE determines through the waste incidental to reprocessing process that the SBW can be managed as mixed transuranic waste, interim storage of vitrified SBW would not be required and the impacts would be reduced from those reported above.

meaningful participation, and should incorporate active outreach to affected groups.

- Federal agencies should assure meaningful community representation in the process, recognizing that diverse constituencies may be present.

- Federal agencies should seek tribal representation in the process in a manner that is consistent with the government-to-government relationship between the United States and tribal governments, the Federal government's trust responsibility to Federally-recognized tribes, and any treaty rights.

The environmental justice analysis was based on the assessment of potential impacts associated with the various waste processing alternatives to determine if there were high and adverse human health or environmental impacts. In this assessment, DOE reviewed potential impacts arising under the major disciplines and resource areas including socioeconomics, cultural resources, air resources, water resources, ecological resources, health and safety, and waste and materials during both the construction and operations work phases. Regarding health effects, both normal facility operations and postulated accident conditions were analyzed, with accident scenarios evaluated in terms of risk to the public. Likewise, the analysis of transportation impacts included both normal and potential accident conditions for the transportation of materials.

Although no high and adverse impacts were predicted for the activities analyzed in this EIS, DOE nevertheless considered whether there were any means for minority or low-income populations to be disproportionately affected. The basis for making this determination would be a comparison of areas predicted to experience human health or environmental impacts with areas in the region of influence known to contain high percentages of minority or low-income populations as reported by the U.S. Bureau of the Census.

Environmental justice guidance developed by the Council on Environmental Quality defines members of a "minority" as individuals who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic (CEQ 1997). The Council defines these groups as minority populations when either the minority population of the affected area exceeds 50 percent or the percentage of minority population in the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis.

Low-income populations are identified using statistical poverty thresholds from the Bureau of Census Current Population Reports, Series P-60 on Income and Poverty. In identifying low-income populations, a community may be considered either as a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect.

Any disproportionately high and adverse human health or environmental effects on minority or low-income populations that could result from the waste processing alternatives are assessed for a 50-mile area surrounding INTEC, as discussed in Section 4.12.

5.2.11.2 Construction Impacts

For environmental justice concerns to be implicated, high and adverse human health or environmental impacts must disproportionately affect minority populations or low-income populations. As shown in Section 5.2.2, Socioeconomics, construction under all the waste processing alternatives would generate temporary increases in employment and earnings in the region of interest.

None of the alternatives is expected to significantly affect land use (see Section 5.2.1), cultural resources (see Section 5.2.3), or ecological resources (see Section 5.2.8) because no previously-undisturbed onsite land would be required and no offsite lands are affected. Sections 5.2.6, Air Resources, and 5.2.10, Health and Safety, discuss potential impacts of construction on human health (both workers and the offsite population) and the environment.

Because construction impacts would not significantly impact the surrounding population, and no means were identified for minority or low-income populations to be disproportionately affected, no disproportionately high and adverse impacts would be expected for minority or low-income populations.

5.2.11.3 Operational Impacts

For environmental justice concerns to be implicated, high and adverse human health or environmental impacts must disproportionately affect minority populations or low-income populations. As shown in Section 5.2.2, Socioeconomics, waste processing operations under all alternatives would either maintain (No Action) or increase employment and earnings in the region of influence. None of the alternatives would result in significantly adverse land use or cultural resources impacts.

Sections 5.2.6, Air Resources, 5.2.8, Ecological Resources, and 5.2.10, Health and Safety, discuss potential impacts of operational releases on human health (both workers and the offsite population) and the environment. As shown in these environmental consequences sections, none of the alternatives would result in significantly adverse impacts.

Impacts from high-consequence, low-probability accident scenarios (Section 5.2.14) would be significant should they occur; however, the impacts to specific population locations would be subject to meteorological conditions at the time of the accident. Whether or not such impacts would have disproportionately high and adverse effects with respect to any particular segment of the population would be subject to natural forces, including random meteorological factors. However, the probability of one of these accidents occurring is extremely low (see Section 5.2.14).

Because the impacts from routine facility operations (see Sections 5.2.6 and 5.2.7) and reasonably-foreseeable accidents (see Section 5.2.14) would be low for the surrounding population and no means were identified for minority or low-income populations to be disproportionately affected, no disproportionately high and adverse impacts would be expected for minority or low-income populations.

Unlike fixed-facility accidents, it is impossible to predict where a transportation accident may occur and, accordingly, who might be affected.

In addition to the variability of meteorological conditions, the random nature of accidents with respect to location and timing make it impossible to predict who could be affected by a severe accident. Although adverse impacts could occur in the unlikely event of a high-consequence transportation accident, any potential disproportionate impacts to these populations would be subject to the randomness of these factors. Routine transportation would be carried out over existing roads and highways. The impacts would be expected to be low on the population as a whole. Because the impacts of routine transportation would be expected to be the same on minority or low-income populations as on populations as a whole, no disproportionately high and adverse impacts on minority or low-income populations would be expected from transportation activities.

As noted in Section 5.2.10, public health impacts from waste processing activities are based on projected airborne releases of radioactive and nonradioactive contaminants. Because prevailing winds are out of the southwest and northeast (see Section 4.7.1), contaminants released to the atmosphere from INTEC tend to be carried to the northeast (into the interior of the INEEL) or southwest (into the sparsely-populated area south and west of the INEEL). Minority populations tend to be concentrated south and east of INTEC, in urban areas like Pocatello and Idaho Falls and along the Interstate 15 corridor (see Figure 4-***18***). The Fort Hall Indian Reservation is also some 40 miles southeast of INTEC (see Figure 4-***20***). This suggests that minority and low-income populations would not experience higher exposure rates than the general population and that disproportionately high and adverse human health effects would not be expected to occur as a result of HLW processing activities. Releases to surface water would be small ***compared to airborne releases***, and would not be expected to result in adverse health impacts.

5.2.11.4 Subsistence Consumption of Fish, Wildlife, and Game

Section 4-4 of Executive Order 12898 directs Federal agencies "whenever practical and appropriate, to collect and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence and that Federal governments communicate to the public the risks of these consumption patterns." There is no evidence to suggest that minority or low-income populations in the region of influence are dependent on subsistence fishing, hunting, or gathering on the INEEL. DOE nevertheless considered whether there were any means for minority or low-income populations to be disproportionately affected by examining levels of contaminants in crops, livestock, and game animals on the INEEL and from adjacent lands.

Controlled hunting is permitted on INEEL land but is restricted to a very small portion of the northern half of the INEEL. The hunts are intended to assist the Idaho Department of Fish and Game in reducing crop damage on private agricultural lands adjacent to the INEEL. In addition to the limited hunting on the INEEL, several game species and birds live on and migrate through the INEEL. DOE routinely samples game species residing on the INEEL, sheep that have grazed on the INEEL, locally grown foodstuffs and milk around the INEEL for radionuclides (ESRF 1996). Concentrations of radionuclides in the samples have been small and are seldom higher than concentrations observed at control locations distant from the INEEL. The principal source of non-natural radionuclides at these control locations is very small amounts of residual atmospheric fallout from past nuclear weapons tests. Data from programs monitoring these sources of food are reported annually in the *INEEL Site Environmental Report* (ESRF 1996).

Based on DOE monitoring results (ESRF 1996), concentrations of contaminants in crops, livestock, and game animals in areas surrounding the INEEL are low, seldom above background levels. Moreover, the impact analyses conducted for this EIS (see Section 5.2.8) indicate that native plants and wildlife in the region of influence would not be harmed by any of the actions being proposed. Consequently, no disproportionately high and adverse human health impacts would be expected in minority or low-income populations in the region as a result of subsistence consumption of fish, wildlife, native plants, or crops.

5.2.12 UTILITIES AND ENERGY

This section presents the potential impacts on the projected demand for electricity, process and potable water, fossil fuels, and wastewater treatment from implementing the proposed waste processing alternatives. The analysis includes potential impacts associated with increased demand and usage during construction and operation. The data represent the bounding (or highest potential impact) case for each alternative or option; the data have been totaled for all projects supporting the option and do not take into account the fact that all facilities may not be operating simultaneously. Because one of the alternatives (Minimum INEEL Processing) involves shipment of mixed HLW to the Hanford Site for treatment, possible changes in utility and energy use at Hanford were also evaluated (see Appendix C.8).

5.2.12.1 Construction Impacts

There would be a small amount of construction under the No Action Alternative. It would be necessary to build a Calcine Retrieval and Transport System to retrieve calcine from bin set 1 and transport it to another existing bin set. Implementation of the other waste management alternatives would require DOE to construct new waste management and support facilities as described in Chapter 3. New facilities (additional Canister Storage Buildings and a Calcine Dissolution Facility) would be built within the 200-East Area at the Hanford Site under the Minimum INEEL Processing Alternative (Interim Storage Scenario). Appendix C.8 examines the impacts to utility and energy usage for the Hanford Site.

Construction activities would result in increased power and water consumption and wastewater generation. Water usage would include potable water for workers and process water for dust control and other construction-related activities. Domestic and process water would be supplied from existing wells. The use of heavy equipment (e.g., bulldozers, earth movers, dump trucks, compactors) and portable generators during construction would result in the consumption of fossil (diesel) fuel. Table 5.2-2***8*** presents projected utility and energy usage for each alternative. The existing INTEC capacity would adequately support any of the alternatives.

As discussed in Section 3.1.5 under the Minimum INEEL Processing Alternative, DOE would retrieve and transport calcine to a packaging facility, where it would be placed into shipping containers. The containers would then be shipped to DOE's Hanford Site where the HLW would be separated into mixed high- and low-level waste fractions. Each fraction would be vitrified. The vitrified high- and low-level waste fractions would be returned to INEEL. There are two scenarios for shipping INEEL's calcine to the Hanford Site, the Interim Storage Shipping Scenario and the Just-in-Time Shipping Scenario. The data in Table 5.2-2***8*** for the Minimum INEEL Processing Alternative (at INEEL) includes the construction impacts to resources from the Interim Storage Shipping Scenario which is considered the base case in this EIS.

5.2.12.2 Operational Impacts

DOE analyzed the utility and energy requirements for operation of the facilities, projects, and components associated with each of the ***twelve*** options under the ***six*** alternatives discussed in the EIS for the period 2000 through 2035. DOE evaluated the impacts associated with each option relative to existing or historic INEEL capacity and usage.

Operation of INEEL waste processing facilities under any alternative would result in water usage and wastewater generation. Water usage would include potable water for workers and process water for operation of facilities. Domestic and process water would be supplied from existing INTEC wells. Wastewater would be treated at new or existing INEEL facilities. The existing percolation ponds (or their replacements) are capable of handling the service wastewater for all waste processing alternatives.

The existing percolation ponds will be replaced on a like-for-like basis and will be placed approximately 10,200 feet from the southwest corner of INTEC. The environmental impacts for the replacement percolation ponds are discussed in the Waste Area Group 3 CERCLA

Table 5.2-28. Utility and energy requirements for construction by waste processing alternative.[a]

Waste Processing Alternative	Annual electricity usage (megawatt-hours per year)	Annual fossil fuel use (million gallons per year)	Annual potable water use (million gallons per year)	Annual non-potable water use (million gallons per year)	Annual sanitary wastewater discharges (million gallons per year)
INTEC Baseline (1996 usage)	8.8×10^{4}	0.98	55	400	55
No Action Alternative	180	6.6×10^{-3}	0.12	0.041	0.12
Continued Current Operations Alternative	3.4×10^{3}	0.036	0.77	0.11	0.77
Separations Alternative					
Full Separations Option	3.3×10^{3}	0.43	6.6	0.38	6.6
Planning Basis Option	6.5×10^{3}	0.41	6.8	0.41	6.8
Transuranic Separations Option	2.9×10^{3}	0.45	4.7	0.27	4.7
Non-Separations Alternative					
Hot Isostatic Pressed Waste Option	4.0×10^{3}	0.35	3.0	0.28	3.0
Direct Cement Waste Option	4.0×10^{3}	0.39	3.2	0.46	3.2
Early Vitrification Option	900	0.30	2.5	0.30	2.5
Steam Reforming Option	***3.1×10^{3}***	***0.26***	***4.1***	***0.15***	***4.1***
Minimum INEEL Processing Alternative					
At INEEL	1.1×10^{3}	0.23	2.9	0.29	2.9
At Hanford Site[b]	2.9×10^{3}	0.092	1.8	0.040	1.8
Direct Vitrification Alternative					
Vitrification without Calcine Separations Option	***1.1×10^{3}***	***0.67***	***2.4***	***0.31***	***2.4***
Vitrification with Calcine Separations Option	***3.5×10^{3}***	***0.81***	***4.7***	***0.31***	***4.7***

a. INTEC baseline data from LMITCO (1998); remainder of data from the project data sheets identified in Appendix C.6. Values represent incremental increases from the baseline quantities.

b. Data from Project Data Sheets contained in Appendix C.8.

Record of Decision (DOE/ID-10660). Following the selection of the preferred alternative for waste processing, the requirements for the service wastewater system would be determined. Depending on system requirements, service wastewater system alternatives would be analyzed and a determination to provide supplemental NEPA documentation would be made.

The use of steam generators and backup electrical power generators during operations would consume diesel fuel. Table 5.2-2***9*** presents the operational utility and energy requirements for each alternative or option. ***The number of years of operations varies by individual project comprising the alternatives and options. The values presented in Table 5.2-29 are a summation of the individual project values. The calculation is conservative (i.e., it presents a peak consumption of utilities assuming that all projects comprising an alternative or option occur at the same time).*** The existing INTEC infrastructure would be adequate to support these demands. Utility and energy requirements for operation of facilities at the Hanford Site under the Minimum INEEL Processing Alternative are discussed in Appendix C.8.

There are three methods for disposal of the grouted low-level waste fraction under the Separations Alternative. These methods include (1) disposal in an onsite INEEL disposal facility; (2) disposal in an offsite disposal facility; and (3) disposal in two INEEL facilities, the Tank Farm and the bin sets, after they are closed. The data presented in Table 5.2-2***9*** for the Full Separations and Transuranic Separations Options are for disposal of grout in an onsite INEEL disposal facility, which is considered the base case for this EIS. Resource consumption under other disposal methods is similar (for most resources) to the onsite disposal method.

The waste processing alternatives include projects that would provide interim HLW storage, packaging, and loading. The No Action and Continued Current Operations Alternatives would be similar due to continuing waste generation as a result of long-term storage and monitoring of the calcine in the bin sets. Depending on the alternative, the duration of these activities is shown extending beyond the year 2035. Annual utility and energy requirements during this interim storage period is shown in Table 5.2-***30***. ***The Transuranic Separations and Steam Reforming Options are not listed in this table because there would be no interim storage of final waste forms produced under these options.***

Table 5.2-29. Utility and energy requirements for operations by waste processing alternative.[a]

Waste Processing Alternative	Annual electricity usage (megawatt-hours per year)	Annual fossil fuel use (million gallons per year)	Annual potable water use (million gallons per year)	Annual non-potable water use (million gallons per year)	Annual sanitary wastewater discharges (million gallons per year)
INTEC Baseline (1996 usage)	8.8×10^4	0.10	55	400	55
No Action Alternative	1.2×10^4	0.64	1.4	14	1.4
Continued Current Operations Alternative	1.8×10^4	1.9	2.7	62	2.7
Separations Alternative					
Full Separations Option	4.0×10^4	4.5	4.0	5.0	4.0
Planning Basis Option	5.0×10^4	6.3	5.8	69	5.8
Transuranic Separations Option	2.9×10^4	2.2	2.8	53	2.8
Non-Separations Alternative					
Hot Isostatic Pressed Waste Option	3.3×10^4	2.8	3.8	89	3.8
Direct Cement Waste Option	2.8×10^4	2.5	4.8	62	4.8
Early Vitrification Option	3.9×10^4	1.1	2.9	6.3	2.9
Steam Reforming Option	2.4×10^4	***0.40***	***2.0***	***6.1***	***2.0***
Minimum INEEL Processing Alternative					
At INEEL	2.5×10^4	0.49	2.8	6.3	2.8
At Hanford Site[b]	6.6×10^5	1.3	4.8	500	4.8
Direct Vitrification Alternative					
Vitrification without Calcine Separations Option	3.9×10^4	***1.3***	***2.9***	***6.3***	***2.9***
Vitrification with Calcine Separations Option	5.2×10^4	***5.0***	***4.4***	***11***	***4.4***

a. INTEC baseline data from LMITCO (1998); remainder of data from the project data sheets identified in Appendix C.6 (Project Summaries). Values represent incremental increases from the baseline quantities.

b. Data from Project Data Sheets contained in Appendix C.8.

Table 5.2-30. Annual utility and energy requirements from interim storage operations after the year 2035.

Waste Processing Alternative	Annual electricity usage (megawatt-hours per year)	Annual fossil fuel use (million gallons per year)	Annual potable water usage (million gallons per year)	Annual non-potable water usage (million gallons per year)	Annual sanitary wastewater discharges (million gallons per year)
Separations Alternative					
Full Separations Option	290	None	0.059	None	0.059
Planning Basis Option	290	None	0.059	None	0.059
Non-Separations Alternative					
Hot Isostatic Pressed Waste Option	4.4×10^{3}	None	0.059	None	0.059
Direct Cement Waste Option	4.6×10^{3}	None	0.059	None	0.059
Early Vitrification Option	4.4×10^{3}	None	0.059	None	0.059
Minimum INEEL Processing Alternative	290	None	0.059	None	0.059
Direct Vitrification Alternative[a]					
Vitrification without Calcine Separations Option	***4.4×10^{3}***	***None***	***0.059***	***None***	***0.059***
Vitrification with Calcine Separations Option	***290***	***None***	***0.059***	***None***	***0.059***

a. Impacts were estimated assuming that the vitrified SBW would be managed as HLW and placed in interim storage pending disposal in a geologic repository. If DOE determines through the waste incidental to reprocessing process that the SBW can be managed as mixed transuranic waste, interim storage of vitrified SBW would not be required and the impacts would be reduced from those reported above.

5.2.13 WASTE AND MATERIALS

This section presents the potential impacts from implementing the proposed waste processing alternatives described in Chapter 3 on the generation and management of wastes that would result from modifications or expansions to facilities, and from new facilities being constructed at the INEEL as part of the proposed action. This information is presented for each of the alternatives, including the No Action Alternative, to support comparisons where appropriate. The information is presented first for the construction phase, then for operations. The operations phase discussion also presents a summary of the key ingredient materials that would be dedicated to treatment processes involved in each of the waste processing alternatives in order to obtain disposable waste products. Finally, this section provides an overview of the potential impacts to treatment, storage, or disposal facilities that would receive waste from the proposed action.

5.2.13.1 Methodology

Each of the alternatives (and, where appropriate, options within the alternatives) being considered has been broken down into a series of projects or activities that would have to be completed if the alternative were to be implemented. Project descriptions and data sheets developed for each project include projections of waste generation (by quantity and type) and ***are*** the source of the waste and material data summarized in this section. For example, waste generation was tabulated for each project making up an alternative and the totals, by waste type, are presented in this section. Additionally, the data sheets provide waste projections by project phase, which normally consists of construction, operations, and decontamination and decommissioning. Although waste volumes as provided in the project descriptions and data sheets have generally been conservatively estimated, they are based on current regulations and laws which determine waste types and to some extent waste volumes. Future regulations and laws could change predicted waste volumes and in the worst case, could require some reanalysis to show that predicted impacts are bounding. Such analyses would generally be provided as an addendum to this EIS at some future date.

In general, the types of waste discussed in this section are industrial waste, hazardous waste, mixed low-level waste, low-level waste, transuranic waste, and HLW. Industrial waste, in this case, is used to designate all the non-hazardous and non-radiological waste that might be generated during a project. The waste summaries presented in this section also use another category: "product waste." This term is being used for waste that is derived directly from the waste materials being addressed by the proposed action; that is the mixed HLW and the mixed transuranic waste (SBW and newly generated liquid waste). Product wastes are the direct result of the management or processing of these materials and would be generated only during the operations phase of a project. Product wastes are further categorized as HLW, transuranic waste, and low-level waste fraction. The "process" waste (that is, all other waste) is produced indirectly as a result of the waste processing activities and would include, for example, waste from offgas treatment, as well as waste generated from normal facility operation and maintenance, and construction wastes. ***This EIS further describes product and process wastes in terms of their classification (e.g., hazardous constituents, radioactive waste classification in accordance with DOE Order 435.1 and Manual 435.1-1) and associated management requirements.*** Although more likely to be encountered during the facility disposition phase, any waste identified in the project descriptions as being CERCLA or environmental restoration program waste is not included in these discussions.

Planned disposition of the product waste is defined under the various alternatives, while plans for the ultimate disposition of the process wastes generated from the proposed action are conceptual in nature. In general, the ultimate treatment or disposal strategies for the various waste types would be as follows:

- Industrial waste would be managed onsite, with material not recycled or retrieved ultimately being disposed of at the INEEL disposal facility.
- Hazardous waste would be shipped offsite to commercial facilities.

- Mixed low-level waste would be treated onsite or shipped offsite to commercial facilities or another DOE site.

- Low-level waste would be disposed of onsite or shipped offsite to commercial facilities or another DOE site. Per Section 4.14.4, DOE expects ***to stop accepting contact-handled low-level waste and remote-handled low-level waste*** at the Radioactive Waste Management Complex in ***2020***.

- Transuranic waste would be sent to the Waste Isolation Pilot Plant.

- HLW would be sent to a geologic repository.

- The low-level waste fraction would be disposed of onsite in a facility prepared as part of the applicable alternative (i.e., either in a new near-surface disposal facility or in emptied Tank Farm and bin sets) or would be shipped offsite.

Because there is limited information on the ultimate disposition of much of the waste identified in this section, the discussion on impacts to facilities that would receive waste from the various waste processing alternatives (5.2.13.4) is also limited.

5.2.13.2 Construction Impacts

Waste would be produced as a result of modifying or constructing new HLW management facilities. Table 5.2-3***1*** summarizes the annual average and total volumes of waste that would be generated during construction. The annual average values represent the average over the duration of all projects generating the specific waste type.

The Full Separations Option includes three separate disposal options for the low-level waste Class A type grout that would be produced: (1) construction of a near-surface disposal facility at the INEEL, (2) use of existing INTEC facilities such as the Tank Farm and bin sets, and (3) transportation to an offsite disposal location. The larger amount of industrial waste associated with disposal in the near-surface disposal facility is attributed directly to the construction of that facility. The disposal option involving use of the Tank Farm and bin sets would require that these facilities be closed prior to receiving the low-level Class A type grout. This action would involve the production of waste that is not included in Table 5.2-3***1*** because it is addressed as part of the overall facility disposition process in Section 5.3.10.

The Transuranic Separations Option includes two disposal options for the low-level Class C type grout that would be produced: (1) construction of a new near-surface disposal facility at the INEEL and (2) use of existing INTEC facilities such as the Tank Farm and bin sets. Again, the larger amount of industrial waste associated with disposal in the new near-surface disposal facility is from the construction of that facility.

Table 5.2-3***2*** is based on the same project information used to generate Table 5.2-3***1*** but presents estimated waste generation in terms of peak annual volumes. It also shows the year or years in which the peaks would occur.

5.2.13.3 Operational Impacts

This section describes the waste generation that would be expected as a result of the operation of waste processing facilities. Discussions of wastes that would be generated indirectly as a result of the waste processing activities are presented separately from the product waste itself. Also discussed in this section are the key input materials that would be dedicated to treatment processes involved in each of the waste processing alternatives. The input or process feed materials are either consumed or become part of the product wastes during treatment.

Process Waste - Table 5.2-3***3*** summarizes the annual average and total process waste volumes generated indirectly during the operations phase of the waste processing alternatives. The annual average values represent the average over the duration of the projects generating the specific waste type. For example, if a single project within the alternative or option is the only one that would generate hazardous waste, the average is over the duration of that project even if its duration is shorter than that of the overall alter-

Table 5.2-31. Annual average and total process waste volumes (cubic meters) generated during construction.[a]

Alternatives	Schedule[b]	Industrial waste		Hazardous waste		Mixed low-level waste		Low-level waste	
		Average	Total	Average	Total	Average	Total	Average	Total
No Action Alternative	2005-2011	220	1.4×10^3	0	0	35	220	0	0
Continued Current Operations Alternative	2005-2014	680	6.8×10^3	3	30	38	240	3	20
Separations Alternative									
Full Separations Option									
New INEEL disposal option	2005-2034	3.6×10^3	5.5×10^4	52	790	180	1.1×10^3	30	330
Tank Farm, bin set disposal option	2005-2015	4.4×10^3	4.8×10^4	71	780	180	1.1×10^3	30	320
Offsite facility disposal option	2005-2015	4.4×10^3	4.9×10^4	71	790	180	1.1×10^3	30	330
Planning Basis Option									
Offsite facility disposal option	2006-2020	3.7×10^3	6.0×10^4	55	880	99	1.1×10^3	13	210
Transuranic Separations Option									
New INEEL disposal option	2005-2034	2.6×10^3	3.9×10^4	19	280	180	1.1×10^3	21	210
Tank Farm, bin set disposal option	2005-2014	3.2×10^3	3.2×10^4	27	270	180	1.1×10^3	20	200
Offsite facility disposal option	2005-2014	3.3×10^3	3.3×10^4	28	280	180	1.1×10^3	21	210
Non-Separations Alternative									
Hot Isostatic Pressed Waste Option	2005-2014	2.6×10^3	2.6×10^4	79	790	99	1.1×10^3	26	260
Direct Cement Waste Option	2005-2014	3.0×10^3	3.0×10^4	56	560	99	1.1×10^3	34	340
Early Vitrification Option	2005-2014	2.3×10^3	2.3×10^4	64	640	180	1.1×10^3	31	310
Steam Reforming Option	***2006-2015***	2.4×10^3	2.4×10^4	***20***	***200***	***110***	1.1×10^3	***0***	***0***
Minimum INEEL Processing Alternative									
At INEEL	2005-2020	1.7×10^3	2.6×10^4	22	340	270	1.1×10^3	10	110
At Hanford[c]	2010-2027	NA[d]	1.9×10^4	NA	20	0	0	0	0
Direct Vitrification Alternative									
Vitrification without Calcine Separations Option	***2005-2022***	1.4×10^3	2.3×10^4	***33***	***570***	***63***	1.1×10^3	***97***	1.6×10^3
Vitrification with Calcine Separations Option	***2005-2022***	2.5×10^3	4.3×10^4	***49***	***840***	***62***	1.1×10^3	***100***	1.7×10^3

a. Source: Project Data Sheets in Appendix C.6.
b. Schedules shown include construction and systems operations testing performed prior to releasing the facility for operations.
c. Source: Project Data Sheets in Appendix C.8.
d. NA = not applicable because annual generation varies greatly due to intermittent construction activity.

Table 5.2-32. Peak annual process waste volumes (cubic meters) generated during construction and the year(s) they would occur.[a]

Alternatives	Industrial waste		Hazardous waste		Mixed low-level waste		Low-level waste	
	Peak	Year(s)	Peak	Year(s)	Peak	Year(s)	Peak	Year(s)
No Action Alternative	220	2005-2010	0	NA[b]	35	2005-2010	0	NA[b]
Continued Current Operations Alternative	1.2×10^3	2008-2010	5	2008-2010	39	2006-2010	3	2008-2014
Separations Alternative								
Full Separations Option								
New INEEL disposal option	8.5×10^3	2011-2014	140	2011-2014	180	2010-2015	48	2011-2014
Tank Farm, bin set disposal option	7.7×10^3	2011-2014	140	2011-2014	180	2010-2015	47	2011-2014
Offsite facility disposal option	7.9×10^3	2011-2014	140	2011-2014	180	2010-2015	48	2011-2014
Planning Basis Option								
Offsite facility disposal option	8.5×10^3	2016-2019	140	2016-2019	180	2014-2019	24	2016-2019
Transuranic Separations Option								
New INEEL disposal option	6.1×10^3	2011-2014	63	2011-2014	180	2009-2014	29	2011-2014
Tank Farm, bin set disposal option	5.3×10^3	2011-2014	62	2011-2014	180	2009-2014	28	2011-2014
Offsite facility disposal option	5.5×10^3	2011-2014	63	2011-2014	180	2009-2014	29	2011-2014
Non-Separations Alternative								
Hot Isostatic Pressed Waste Option	3.9×10^3	2011-2014	140	2011-2014	180	2009-2014	40	2011-2014
Direct Cement Waste Option	4.5×10^3	2011-2014	98	2011-2014	180	2009-2014	53	2011-2014
Early Vitrification Option	3.8×10^3	2011-2014	110	2011-2014	180	2009-2014	46	2011-2014
Steam Reforming Option	4.1×10^3	***2010***	***42***	***2010***	***180***	***2010-2015***	***0***	***-***
Minimum INEEL Processing Alternative								
At INEEL	2.8×10^3	2007-2008	59	2011-2014	270	2007-2010	20	2007-2008
At Hanford[c]	3.4×10^3	2024-2027	3	2009-2010[d]	0	NA	0	NA
Direct Vitrification Alternative								
Vitrification without Calcine Separations Option	2.7×10^3	***2012***	***94***	***2012-2013***	***180***	***2017-2022***	***220***	***2017-2022***
Vitrification with Calcine Separations Option	5.9×10^3	***2019-2020***	***92***	***2012-2013***	***180***	***2017-2022***	***240***	***2019-2022***

a. Source: Project Data Sheets in Appendix C.6.
b. NA = Not applicable.
c. Source: Project Data Sheets in Appendix C.8.
d. Peak hazardous waste generation also occurs during 2014-2015 and 2019-2020 construction periods.

Table 5.2-33. Annual average and total process waste volumes (cubic meters) generated during operations through the year 2035.[a]

Alternatives	Industrial waste		Hazardous waste		Mixed low-level waste		Low-level waste	
	Average	Total	Average	Total	Average	Total	Average	Total
No Action Alternative	390	1.4×10^4	0	0	37	1.3×10^3	5	190
Continued Current Operations Alternative	660	1.9×10^4	0	0	110	3.2×10^3	330	9.5×10^3
Separations Alternative								
Full Separations Option								
New INEEL disposal option	2.0×10^3	5.3×10^4	58	1.6×10^3	210	5.8×10^3	45	1.2×10^3
Tank Farm, bin set disposal option	1.9×10^3	5.0×10^4	58	1.6×10^3	220	5.9×10^3	45	1.2×10^3
Offsite facility disposal option	1.9×10^3	5.1×10^4	58	1.6×10^3	210	5.8×10^3	45	1.2×10^3
Planning Basis Option								
Offsite facility disposal option	2.0×10^3	5.2×10^4	57	1.2×10^3	300	7.9×10^3	400	1.0×10^4
Transuranic Separations Option								
New INEEL disposal option	1.6×10^3	4.3×10^4	36	960	190	5.2×10^3	36	960
Tank Farm, bin set disposal option	1.5×10^3	4.1×10^4	35	940	200	5.3×10^3	36	960
Offsite facility disposal option	1.5×10^3	4.2×10^4	36	960	190	5.2×10^3	36	960
Non-Separations Alternative								
Hot Isostatic Pressed Waste Option	1.6×10^3	4.3×10^4	<1	4	230	6.4×10^3	370	1.0×10^4
Direct Cement Waste Option	1.9×10^3	5.0×10^4	<1	4	320	8.6×10^3	370	1.0×10^4
Early Vitrification Option	1.2×10^3	4.2×10^4	<1	4	170	6.0×10^3	21	750
Steam Reforming Option	***690***	2.5×10^4	***2***	***58***	***110***	4.1×10^3	***16***	***560***
Minimum INEEL Processing Alternative								
At INEEL	960	3.5×10^4	1	40	160	5.7×10^3	20	700
At Hanford Site[b]	NA[c]	6.7×10^3	NA	23	0	0	NA	1.5×10^3
Direct Vitrification Alternative								
Vitrification without Calcine Separations Option	***850***	3.0×10^4	***0.11***	***4.0***	***170***	6.0×10^3	***21***	***700***
Vitrification with Calcine Separations Option	1.2×10^3	4.2×10^4	***41***	1.4×10^3	***210***	7.5×10^3	***37***	1.3×10^3

a. Source: Project Data Sheets in Appendix C.6.
b. Source: Project Data Sheets in Appendix C.8.
c. NA = not applicable. Except for Canister Storage Buildings, the operating period for the Hanford Site facilities is short (about 2 years), making average annual values not applicable.

native. The average and total values shown in the table are, however, restricted by the period of analysis, which ends in the year 2035. In some cases, project descriptions include work that extends beyond the year 2035. These projects are primarily those involving interim storage of HLW and its eventual transportation to the national geologic repository. Those projects show an extended duration to address the possibility that the repository may be unable to receive the waste as it is produced. The amounts of waste that would be produced from these post-2035 activities are discussed on an annual, rather than total basis later in this section.

Table 5.2-3*4* is based on the same project information as Table 5.2-3*3* but presents estimated waste generation in terms of peak annual volumes. It also shows the year or years in which the peaks would occur.

Several of the projects that make up the alternatives and their options show durations that extend beyond the 2035 period of analysis. Each of the options under the Separations, Non-Separations, and Minimum INEEL Processing alternatives include a laboratory project that would continue its operations into 2040. This activity is projected to continue production of industrial waste, mixed low-level waste, and low-level waste during these post-2035 years in the amounts of 580, 56, and 1 cubic meters per year, respectively. Some of the alternatives and options that would produce disposable HLW forms at the INEEL include projects that would provide interim storage, packaging and loading for that HLW. The No Action and Continued Current Operations Alternatives would each have a similar situation due to continuing industrial waste production (approximately 17 cubic meters per year) as a result of long-term storage and monitoring of the calcine in the bin sets. Depending on the alternative, the duration of these activities is shown extending to some point beyond the year 2050. Annual production of waste during this interim storage period is shown in Table 5.2-3*5*. ***The Transuranic Separations and Steam Reforming Options are not listed in this table because there would be no interim storage of final waste forms produced under these options.*** Packaging and shipping activities that would ultimately remove waste from interim storage under the Separations, Non-Separations, and Minimum INEEL Processing Alternatives would produce waste types and quantities very similar to those shown in Table 5.2-3*5*.

Product Wastes - Table 5.2-3*6* summarizes the estimated volumes of product wastes that would be generated for each of the alternatives that would produce disposable waste forms. No product waste generation is shown for the No Action Alternative because it is not configured to treat the waste materials of primary concern into disposable waste forms. The Continued Current Operations Alternative would include processing of tank-heel waste from the Tank Farm, which would result in the generation of 7,000 cubic meters of low-level waste (included in the process waste summaries in Tables 5.2-3*3* and 5.2-3*4*, and 110 cubic meters of remote-handled transuranic waste (included in Table 5.2-3*6*). The other waste processing alternatives would result in varying amounts of product waste that would be classified as low-level waste, transuranic waste, or high-level waste as shown in Table 5.2-3*6*.

Process Feed Materials - The waste processing approaches described in the different options would require the addition of various materials to support the processes and enable the production of a stable, disposable form for the product waste. Table 5.2-3*7* provides a summary of the key feed materials that would be committed to each of the alternatives.

5.2.13.4 Impacts to Facilities that Would Receive Waste from the Waste Processing Alternatives

This section addresses possible impacts resulting from the disposition of wastes at facilities that are not part of the Idaho HLW & FD EIS waste processing alternatives. This includes waste that would go to other INEEL facilities such as the industrial waste disposal facility, as well as waste that would go offsite for final disposition at commercial facilities or other DOE-operated sites such as the Waste Isolation Pilot Plant. DOE assumes that facilities receiving these wastes would be operated in full compliance with all existing agreements and regulations. Therefore, the impacts of primary concern are whether appropriate facilities exist and have adequate capacity to support disposition of the waste. With the exception of the offsite disposal

Table 5.2-34. Peak annual waste volumes (cubic meters) generated during operations and the year(s) they would occur.[a]

	Industrial waste		Hazardous waste		Mixed low-level waste		Low-level waste	
Alternatives	Peak	Year(s)	Peak	Year(s)	Peak	Year(s)	Peak	Year(s)
No Action Alternative	630	2012	0	–	100	2012	17	2012
Continued Current Operations Alternative	1.4×10^3	2015-2016	0	–	250	2015-2016	1.3×10^3	2015-2016
Separations Alternative								
Full Separations Option								
New INEEL disposal option	2.5×10^3	2016-2035	76	2016-2035	260	2016-2035	57	2016-2035
Tank Farm, bin set disposal option	2.4×10^3	2027-2035	76	2016-2035	270	2016-2035	57	2016-2035
Offsite facility disposal option	2.4×10^3	2016-2035	76	2016-2035	260	2016-2035	57	2016-2035
Planning Basis Option								
Offsite facility disposal option	2.8×10^3	2021-2035	80	2021-2035	390	2021-2035	1.0×10^3	2020
Transuranic Separations Option								
New INEEL disposal option	2.0×10^3	2015-2035	46	2015-2035	230	2015-2035	45	2015-2035
Tank Farm, bin set disposal option	1.9×10^3	2015-2035	45	2015-2035	240	2015-2035	45	2015-2035
Offsite facility disposal option	1.9×10^3	2015-2035	46	2015-2035	230	2015-2035	45	2015-2035
Non-Separations Alternative								
Hot Isostatic Pressed Waste Option	2.6×10^3	2015-2016	<1	2009-2035	390	2015-2016	1.4×10^3	2015-2016
Direct Cement Waste Option	2.9×10^3	2015-2016	<1	2009-2035	500	2015-2016	1.4×10^3	2015-2016
Early Vitrification Option	1.8×10^3	2015-2035	<1	2009-2035	240	2015-2035	37	2015-2035
Steam Reforming Option	***930***	***2012***	***29***	***2012***	***160***	***2012***	***42***	***2012***
Minimum INEEL Processing Alternative								
At INEEL	1.8×10^3	2015-2025	2	2016-2035	300	2015-2025	42	2015-2025
At Hanford[b]	4.1×10^3	2029	2	2029	0	–	1.0×10^3	2029
Direct Vitrification Alternative								
Vitrification without Calcine Separations Option	$\boldsymbol{1.5\times10^3}$	***2023-2035***	***0.67***	***2012-2017***	***420***	***2015***	***42***	***2023-2035***
Vitrification with Calcine Separations Option	$\boldsymbol{2.5\times10^3}$	***2023-2035***	***110***	***2023-2035***	***420***	***2015***	***84***	***2023-2035***

a. Source: Project Data Sheets in Appendix C.6
b. Source: Project Data Sheets in Appendix C.8

Table 5.2-35. Annual production of process waste (cubic meters) from storage operations after the year 2035.[a]

Alternatives	Industrial waste	Hazardous waste	Mixed low-level waste	Low-level waste
Separations Alternative				
Full Separations Option	36	2	0	0
Planning Basis Option	36	2	0	0
Non-Separations Alternative				
Hot Isostatic Pressed Waste Option	36	0	0	0
Direct Cement Waste Option	36	0	0	0
Early Vitrification Option	36	0	0	0
Minimum INEEL Processing Alternative				
At INEEL	36	2	0	0
At Hanford	NA[b]	NA	NA	NA
Direct Vitrification Alternative[c]				
Vitrification without Calcine Separations Option	***36***	–	–	–
Vitrification with Calcine Separations Option	***36***	***36***	–	–

a. Source: Project Data Sheets in Appendix C.6.

b. NA = not applicable. There is no storage of HLW associated with this alternative.

c. Impacts were estimated assuming that the vitrified SBW would be managed as HLW and placed in interim storage pending disposal in a geologic repository. If DOE determines through the waste incidental to reprocessing process that the SBW can be managed as mixed transuranic waste, interim storage of vitrified SBW would not be required and the impacts would be reduced from those reported above.

options for the low-level waste Class A and C type grout under the Separations Alternative and the vitrified low-level waste fraction under the Minimum INEEL Processing Alternative, final disposal facilities or sites are identified for each of the product waste types that are put into a disposable form (i.e., product wastes generated from alternatives that include waste processing). For the non-product wastes, a specific disposition site is currently identified only for the industrial waste category. The following paragraphs discuss each of the product (low-level waste, transuranic waste, and HLW) and process (industrial, hazardous, low-level, and mixed low-level waste) waste types that would be produced from the proposed action.

Product Low-Level Waste Fraction – The product low-level waste consists of the Class A and Class C type grout that would be produced under the Full Separations and Planning Basis Options and Transuranic Separations Option, respectively. Both the Full and Transuranic Separations Options include disposal options where the grout would be disposed of either in a newly constructed disposal facility (the base case), or in the emptied Tank Farm and bin sets. If either of these alternatives/option combinations were to be implemented, the waste would not adversely affect the disposal facility because the facility would have been planned specifically for the proposed usage. Under all three Separations Alternative options, a disposal option for the low-level waste Class A or Class C type grout would call for its disposal at an off-site facility. Currently, DOE has not identified a specific receiving facility for the grout under this disposal option. DOE has evaluated transportation-related impacts based on the Envirocare of Utah, Inc. disposal site, 80 miles west of Salt Lake City for the low-level waste Class A type grout and the Chem-Nuclear Systems disposal site in Barnwell, South Carolina for the low-

Table 5.2-36. Total volumes (cubic meters) of product waste that would result from the alternatives.[a]

Alternatives	Low-level waste	Transuranic Waste: Contact-handled	Transuranic Waste: Remote-handled	High-level waste
No Action Alternative	NA[b]	NA	NA	NA
Continued Current Operations Alternative	0	0	110	0
Separations Alternative				
Full Separations Option	2.7×10^4	0	0	470
Planning Basis Option	3.0×10^4	0	110	470
Transuranic Separations Option	2.3×10^4	0	220	0
Non-Separations Alternative				
Hot Isostatic Pressed Waste Option	0	0	110	3.4×10^3
Direct Cement Waste Option	0	0	110	1.3×10^4
Early Vitrification Option	0	0	360	8.5×10^3
Steam Reforming Option	***0***	***0***	***2.6×10^3***	***4.4×10^3***
Minimum INEEL Processing Alternative				
At INEEL	0	7.5×10^3	0	0
At Hanford[c]	1.4×10^4	0	0	***3.5×10^3***
Direct Vitrification Alternative				
Vitrification without Calcine Separations Option	–	–	–	***8.9×10^{3}[d]***
Vitrification with Calcine Separations Option	***2.4×10^4***	–	–	***910[d]***

a. Source: Project Data Sheets in Appendix C.6, Russell et al. (1998), Fewell (1999), McDonald (1999), Barnes (2000).
b. NA = not applicable.
c. Source: Facilities and projects associated with the Hanford option of this alternative are described in Appendix C.8.
d. Value contains 440 cubic meters of vitrified SBW that could be managed as remote-handled transuranic waste, depending on the outcome of the waste incidental to reprocessing determination.

level waste Class C type grout. DOE assumes that the grout could be managed as low-level waste. Therefore, its potential impact could be estimated by comparing it to the amount of other low-level waste that would be managed within the DOE complex. According to DOE estimates, future waste management activities require the management of approximately 1.5 million cubic meters of low-level waste generated over the next 20 years (DOE 1997a). The 27,000 and 30,000 cubic meters of low-level waste Class A type grout that would be produced under the Full Separations and Planning Basis Options and the 23,000 cubic meters of low-level waste Class C type grout that would be produced under the Transuranic Separations Option, although a sizable quantity, is still a minor portion of the DOE low-level waste that would require disposal independently of the alternatives.

A product low-level waste fraction would also be produced under the Minimum INEEL Processing Alternative. Under this alternative, about 14,400 cubic meters of vitrified low-level waste would be transported from the Hanford Site to the INEEL for disposal in a newly constructed disposal facility at INTEC or at an off-site disposal facility. DOE has evaluated transportation-related impacts based on the Envirocare of Utah, Inc. disposal site. This vitrified low-level waste would represent a minor portion of the DOE low-level waste that would require disposal independently of the waste processing alternatives.

Table 5.2-37. Summary of key material quantities (cubic meters) that would be committed to each of the alternative processes.

Alternatives	Total material quantities (cubic meters)[a]													
	Oxygen gas	Argon gas	Boiler or blast furnace slag	Cement	Clay	Fly ash	Glass frit	***Calcium Oxide***	Silica	***Nitric Acid***	Sodium hydroxide	Titanium or aluminum powder	***Sucrose***	***Carbon***
No Action Alternative	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Continued Current Operations Alternative	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Separations Alternative														
Full Separations Option	–	–	5.6×10^3	5.1×10^3	–	5.4×10^3	420	–	–	–	–	–	–	–
Planning Basis Option[b]	–	–	5.6×10^3	5.1×10^3	–	5.4×10^3	420	–	–	–	–	–	–	–
Transuranic Separations Option	–	–	6.4×10^3	5.8×10^3	–	6.1×10^3	–	–	–	–	–	–	–	–
Non-Separations Alternative														
Hot Isostatic Pressed Waste Option	–	1.2×10^3	–	–	–	–	–	–	2.3×10^3	–	–	240	–	–
Direct Cement Waste Option	–	–	1.3×10^3	–	8.5×10^3	–	–	–	–	–	500	–	–	–
Early Vitrification Option	–	–	–	–	–	–	7.8×10^3	–	–	–	–	–	–	–
Steam Reforming Option	***1.6×10^6***	–	***140***	***38***	***130***	–	–	***130***	***34***	***500***	–	–	***250***	***2.5×10^3***
Minimum INEEL Processing Alternative[c]	–	–	–	–	–	–	9.2×10^3	–	–	–	7.6×10^3	–	–	–
Direct Vitrification Alternative														
Vitrification without Calcine Separations Option	–	–	–	–	–	–	***7.9×10^3***	–	–	–	–	–	–	–
Vitrification with Calcine Separations Option	–	–	***4.9×10^3***	***4.5×10^3***	–	***4.7×10^3***	***810***	–	–	–	–	–	–	–

a. Source: ***Adapted from*** Helm (1998). ***Materials quantities are assumed to be scaleable based on estimated product waste volumes.***

b. Materials quantities committed under the Planning Basis Option are assumed to be identical to those committed under the Full Separations Option.

c. Materials quantities committed under this alternative at the Hanford Site based on Project Data Sheets in Appendix C.8.

Product Transuranic Waste - Other product waste types identified in this section would be transported offsite for disposal (Waste Isolation Pilot Plant for transuranic waste and a geologic repository for HLW). A primary objective of the processes that would produce these wastes would be to generate a waste form that would meet acceptance criteria for the appropriate repository. These facilities would, therefore, be expected to accept these types of waste unless content or concentration type concerns might exist. The remaining concern would be whether waste from the waste processing alternative would pose capacity issues.

According to the *Waste Isolation Pilot Plant Disposal Phase Final Supplemental EIS*, current limits and agreements place the capacity of the Waste Isolation Pilot Plant repository at 175,600 cubic meters, of which 7,080 cubic meters can be remote handled. DOE (1997b) presents an estimate for the projected amount of transuranic waste that would be sent to the Waste Isolation Pilot Plant which puts the total quantity of remote-handled transuranic waste at slightly less than 5,000 cubic meters and slightly more than 140,000 cubic meters for the contact-handled transuranic waste. Based on these figures, the Waste Isolation Pilot Plant would have adequate capacity for the contact-handled transuranic waste that, depending on the alternative and option selected, could result in as much as 7,500 cubic meters (Minimum INEEL Processing Alternative). ***Under the Steam Reforming Option, DOE could produce up to 2,600 cubic meters of remote-handled transuranic waste. The combination of this waste volume and other remote-handled transuranic waste identified for disposal in DOE (1997b) would exceed by 4 percent the disposal capacity for remote-handled transuranic waste authorized by DOE's Consultation and Cooperation Agreement with the State of New Mexico. The Waste Isolation Pilot Plant would have adequate disposal capacity for the amount of remote-handled transuranic waste produced under the other alternatives and options (up to 360 cubic meters under the Early Vitrification Option).***

Additional restrictions on remote-handled transuranic waste under the Waste Isolation Pilot Plant Land Withdrawal Act (Public Law 102-579) could present problems for transuranic waste generated under the waste processing alternatives. These additional restrictions are as follows:

- Remote-handled transuranic waste containers shall not exceed 23 curies of radioactivity per liter maximum activity level averaged over the volume of the container.

- The total curies of remote-handled transuranic waste shall not exceed 5,100,000 curies of radioactivity.

Under the Transuranic Separations Option, the remote-handled transuranic waste that would be produced would average less than 2 curies per liter. The total radioactivity of this transuranic waste would be about 330,000 curies. Based on this information, the waste would be expected to meet the current Waste Isolation Pilot Plant requirements and limits for remote-handled transuranic waste.

Under the Early Vitrification Option, the remote-handled transuranic waste produced would average less than 2 curies per liter and total about 510,000 curies of activity. The radioactivity would be well below existing limits and the total would consume about one tenth of the 5,100,000 curie limit. The current identified DOE inventory for remote handled transuranic waste does not consume the curie limit for the Waste Isolation Pilot Plant. An estimated 1.3 million curies remains, some of which may be used under this option.

Under the Steam Reforming Option, DOE would treat the post-2005 newly generated liquid waste with the mixed transuranic waste/SBW until the steam reformer's mission is completed in 2013, producing a total of 1,300 cubic meters of remote-handled transuranic waste. The steam-reformed waste would average less than 1 curie per liter and total about 410,000 curies of activity. After 2013, DOE would grout the newly generated liquid waste, producing approximately 1,300 cubic meters of remote-handled transuranic waste. The grouted waste would average less than 1 curie per liter and total about 150,000 curies of activity. Although grouting of newly generated liquid waste is only analyzed under the Steam Reforming Option, DOE could employ this

method for newly generated liquid waste treatment under any of the options analyzed in this EIS. Subsequent studies could determine that the grouted newly generated liquid waste could be classified as low-level waste.

Product High-Level Waste - The final disposition point for the INEEL's HLW is expected to be a geologic repository, and the only site currently being considered for this repository is at Yucca Mountain in Nevada. Planning for this facility includes a base case inventory of spent nuclear fuel and HLW ***as described in Section 2.2.4***. At this time there has been no determination of which waste would be shipped to the repository, or the order of shipments.

The planning for a repository at Yucca Mountain also includes analyses of modules for "reasonably foreseeable future actions" that include accepting additional quantities of spent nuclear fuel and HLW. One of the modules being considered includes accepting all of the current inventory of HLW. As shown in Table 5.2-3***6***, the volume of HLW that would be generated by the INEEL from the various options ranges from 0 to 13,000 cubic meters.

Current planning for the repository is based on the premise that HLW will be in a vitrified form. This could represent another issue with regard to the repository's receipt of INEEL HLW because options being considered include the generation of HLW in non-vitrified forms. This issue is addressed further in Section 6.3.

Industrial Waste - Each of the alternatives would involve generation of industrial (non-hazardous and non-radiological) waste, and in each case this waste would be disposed of at the INEEL. The INEEL's industrial/commercial disposal facility complex annually receives between 46,000 and 85,000 cubic meters of solid waste for disposal or recycling (LMITCO 1998). Under the waste processing alternatives, production of industrial waste could be as high as about 8,500 cubic meters per year during construction (Table 5.2-3***2***) and about 3,000 cubic meters per year during operations (Table 5.2-3***4***). The large quantities generated during construction would be for a relatively short period, and some of these waste materials may be disposed of as clean construction rubble rather than take up room in the disposal facility. The operations phase represents by far the longer duration activity. The peak annual production of industrial waste during this phase is small in comparison to the volumes currently disposed of at the INEEL disposal facility. DOE expects that the quantities of solid industrial waste that would be produced under any of the alternatives would not cause problems for the existing INEEL disposal facility operations (EG&G 1993).

Hazardous Waste - Hazardous waste has been generated, or is projected to be generated, at most DOE sites. Much of this waste, particularly hazardous wastewater, is stored and treated onsite. However, based on fiscal year 1992 data, about 3,440 cubic meters of hazardous waste were sent to commercial facilities from DOE sites (DOE 1997a). In the Waste Management Programmatic EIS (DOE 1997a), DOE assumes that this quantity of hazardous waste (3,440 cubic meters or an equivalent 3,440 metric tons per the EIS's one-to-one conversion factor) is representative of DOE's current hazardous waste treatment requirements. This document identifies another 6,600 cubic meters of Toxic Substances Control Act, State-regulated hazardous waste, and environmental restoration generated hazardous waste that was shipped to commercial treatment in fiscal year 1992. As shown in Table 5.2-3***4***, the peak annual quantities of hazardous waste that would be produced at the INEEL from the waste processing alternatives vary from 0 to 80 cubic meters depending on the alternative and option. These quantities are minor in comparison to those produced throughout the DOE complex and sent to commercial facilities for treatment and disposal. It is unlikely these additional wastes would adversely impact the ability of commercial facilities to manage hazardous waste. The Waste Management Programmatic EIS also makes the assumption that if additional capacity is needed, new DOE facilities or offsite commercial facilities will be available (DOE 1997a).

Mixed Low-Level Waste - Mixed low-level waste is either generated, projected to be generated, or stored at 37 DOE sites. DOE estimates that approximately 137,000 cubic meters of mixed low-level waste will be generated over the next 20 years (DOE 1997a). Analysis in the Waste Management Programmatic EIS assumes use of existing and planned facilities in the management of this waste until their capacities are met.

Then if additional capacity is needed, DOE assumes new facilities would be constructed. Total quantities of mixed low-level waste produced during construction and operations under the proposed action would be about 10,000 cubic meters or less. These estimated quantities are small enough in comparison to DOE's 20-year projection of mixed low-level waste generation that they should not adversely impact DOE's plans for the management of this type waste. This is more evident when it is realized that personal protective equipment would make up most of the mixed low-level waste in Tables 5.2-3***2*** and 5.2-3***3***. This material could easily be subjected to significant reductions in volume through compaction and is normally amenable to treatment through incineration for even greater reduction in volume.

Low-Level Waste - Low-level waste is routinely generated at the INEEL and will continue to be generated in the future. As identified in Section 4.14 (Table 4-***30***), annual production of low-level waste at the INEEL is currently about ***2,900*** cubic meters. Although the peak annual quantity of low-level waste generated under the proposed action could be as high as 1,400 cubic meters, the highest annual average would be only about 400 cubic meters. These quantities should not overload the site's capacity and capability to accumulate, manage, and transport this type waste.

On a DOE complex-wide basis, low-level waste is generated, projected to be generated, or stored at 27 DOE sites. According to DOE estimates, approximately 1.5 million cubic meters of low-level waste will be generated over the next 20 years (DOE 1997a). Estimates of low-level waste generation from the proposed action vary from about ***190*** to $\boldsymbol{1.0 \times 10^4}$ cubic meters over the ***operating*** life of the project, depending on the alternative (see Table 5.2-3***3***). These quantities are minor in comparison to the amount that would be produced from other DOE activities and should have no more than a minor impact on the ability of the DOE complex facilities to manage low-level waste. The Waste Management Programmatic EIS (DOE 1997a) assumes that new facilities will be constructed if additional capacity is needed.

5.2.14 FACILITY ACCIDENTS

This section presents a summary of the accident analysis conducted to identify impacts associated with the waste processing alternatives described in Chapter 3. Appendix C.4, Facility Accidents, contains additional details and discussion. This section does not include the following accident analyses, which are found under other subject headings in this EIS or other documents as noted below:

- Industrial accidents and occupational risks due to waste processing operations. These health and safety impacts are evaluated separately in Section 5.2.10.

- Accidents associated with transportation of radioactive or hazardous material, other than transportation within a site as part of facility operations. The impacts of transportation are presented in Section 5.2.9.

- Bounding accidents associated with facility disposition activities. The impacts of facility disposition activities are included in Section 5.3.12

- Facility accidents at Hanford due to the processing of INEEL waste under the Minimum INEEL Processing Alternative, are addressed in the Tank Waste Remediation EIS prepared for processing the liquid HLW stored at that site. If DOE decides to treat INEEL HLW at Hanford, a determination will be made as to whether additional National Environmental Policy Act analysis is necessary.

- Accidents at offsite disposal facilities such as the Waste Isolation Pilot Plant (transuranic waste), the proposed Yucca Mountain geologic repository (HLW), and the Hanford Site or Nevada Test Site (low-level waste and mixed low-level waste), which are evaluated in other National Environmental Policy Act documents.

- Accidents at other INEEL facilities.

Facility accidents are unplanned, unexpected, and undesired events (such as earthquakes, operational errors, or process equipment failures) that can occur during or as a result of implementing a waste processing alternative and that have the potential to impact human health and the environment. Facility accidents with the potential to harm the public include structural failures, fires, and explosions that could result in the release of radioactive and chemical contaminants. Such releases may result in immediate health impacts, for example a lethal chemical exposure. However, they are more likely to have a delayed health impact that occurs over time, such as exposure to ionizing radiation that could eventually result in a cancer fatality.

Implementation of the various projects associated with each of the waste processing alternatives temporarily adds risk to humans and the environment. This implementation risk is illustrated qualitatively in Appendix C.4, Figure C.4-1.

Compliance with DOE Orders and Standards provides the assurance that facility accident risk from implementation of waste processing alternatives is minimized through the incorporation of safety features in the design, construction, and operation of new facilities. Many of the actions under the waste processing alternatives are continuations or modifications of past or present activities at INTEC. As such DOE would continue to control the hazards associated with any of the waste processing alternatives consistent with the operating history at the INEEL. DOE has an ongoing commitment to high levels of safety to assure that the risk of facility accidents is minimized under any of the waste processing alternatives. A thorough review of historical accident experience at the INEEL has been completed.

An analysis has been performed to identify the potential for immediate and long-term environmental impacts, particularly human health impacts, that could occur as a result of implementing the waste processing alternatives and options. The postulated accidents that were analyzed would not necessarily occur but are considered reasonably foreseeable.

5.2.14.1 Methodology for Analysis of Accident Risk to Noninvolved Workers and the Public.

The technical approach and methods used in this accident analysis are intended to be fully compliant with DOE technical guidelines for accident analysis (DOE 1993). These technical guidelines define a bounding facility accident for alternatives as the reasonably foreseeable accident that has the highest potential for environmental impacts, particularly human health and safety impacts, among all identified reasonably foreseeable accidents. An accident scenario that does not require extraordinary initiating events or unrealistic assumptions about the progression of events or the resulting releases is said to be "reasonably foreseeable." For the purposes of this EIS accident analysis, reasonably foreseeable refers to facility accidents for which the frequency is estimated to be greater than once in ten million years. The guidelines also recommend identification of a bounding accident in each of three broad frequency ranges: abnormal, design basis, and beyond design basis. Abnormal events have estimated frequencies of occurrence equal to or greater than once in a thousand years; design basis accidents have frequencies equal to or greater than once in a million years but less than once in a thousand years; and beyond design basis events have frequencies that are less than once in a million years. Within each frequency range, selection of the bounding accident assures that any other reasonably foreseeable accident (in that range) would be expected to have smaller consequences. DOE frequency ranges are compared in Table 5.2-38.

Several general assumptions were used to identify bounding facility accidents in this EIS.

- Facilities are assumed to be designed, constructed, and operated in compliance with DOE Orders, directives, and standards and within regulatory requirements. However, accidents are defined using bounding reasonably foreseeable assumptions regarding initiator severity and facility design response.
- Potential source terms of radioactive or chemically hazardous releases during accidents are evaluated assuming the design features of the facility perform as expected, but no further mitigating actions, including evacuation, are included.
- Potential receptors of postulated air releases are assumed to be directly downwind of the release; as close as the site boundary for a member of the public; and 640 meters for the noninvolved worker.
- Releases to groundwater are assumed to occur immediately, without any holdup as a result of the leak path. Potential receptors are assumed to be directly over the location of the spill, consuming only contaminated groundwater from the aquifer over a 30-year period of exposure, in most cases.

Although this approach overstates the risk of accidents, it provides a level of certainty that the estimated risks reported in this EIS are not likely to be exceeded and it provides a reasonable basis for comparing one waste processing alternative to another.

DOE performed accident analyses of waste processing facilities that are currently operating using safety assurance information from facility safety analysis reports, along with facility operating experience, and probabilistic data from similar facilities and operations. Accident analysis of facilities that have not yet been designed (including most facilities proposed in this EIS to implement waste processing alternatives) uses information primarily from technical feasibility studies performed to ascertain process feasibility and identify process implementation costs. Such information includes preliminary inventories of material at risk, process design data, and some overall design features.

Methods used to assess the potential for facility accidents are based primarily on DOE guidance, experience with similar systems, and understanding of the INTEC site layout. The EIS accident analyses of waste processing facilities incorporates the following three levels of screening analyses.

1. DOE performed a screening evaluation of major facilities and identified various operations needed to implement waste

Table 5.2-38. DOE facility accident frequency categories.

	Accident Frequency Categories	Accident Frequency Category Descriptions	Percent chance of an accident occurring in any given year.	Number of years during which a particular accident could occur. (Accident / Years)
	Accident frequency is a tool used to determine risk to a receptor population. It is not a prediction of when an accident will occur. For example a Design Basis Event with a chance of occurring once in ten thousand years could occur within the first 100 years.		The less probable an accident, the less likely it is to occur in any given year.	The more probable an accident, the shorter the time period in which it could occur.
Reasonably Foreseeable Accidents	Abnormal Event	Accidents that could occur once in a thousand years.	100 %	1/1
			10 %	1/10
			1%	1/100
			0.1%	1/1000
	Design Basis Event	Accidents that could occur once in a million years but not more frequently than once in a thousand years.	0.01%	1/10,000
			0.001%	1/100,000
			0.0001%	1/1,000,000
	Beyond Design Basis Event	Accidents that could occur once in ten million years but not more frequently than once in a million years.	0.00001%	1/10,000,000
Not Reasonably Foreseeable Accidents	Not analyzed in the EIS because of the extreme unlikelihood of these events.	Accidents that could occur less frequently than once in ten million years.	< 0.00001%	< 1/10,000,000

processing alternatives (referred to as process elements) to assess the potential for significant facility accidents. Process elements attributes that infer the existence of significant process hazards include inventories of hazardous or radioactive materials, dispersible physical forms, and the potential for energetic releases during operation.

2. An accident initiating event consists of an occurrence (i.e., natural phenomena, human error, or equipment failure) that can challenge and sometime degrade the safety functions of a facility. An "accident scenario" consists of a set of causal events starting with an initiating event that can lead to a release of radioactive or hazardous materials with the potential to cause injury or death. Therefore, along with the initiator, accident scenarios include events such as the failure of facility safety functions or failure of facility defense in depth features. DOE performed detailed accident analyses beginning with the description of activities, inventories, and conditions pertinent to the accident analysis. DOE compared a standardized set of "accident initiating events" against the described set of activities, inventories, and operating conditions to identify and describe accident scenarios.

3. Finally, DOE grouped accident scenarios into the three major frequency categories. The accident scenario in each frequency range category with the highest potential risk of health and safety impacts to offsite persons or noninvolved onsite workers (the potentially bounding accident scenario) was selected for consequence evaluation. DOE performed detailed consequence (health impact) evaluations for each of these potentially bounding accidents, selecting the reasonably foreseeable accident with the largest impact on human health in each frequency category for each waste processing alternative as bounding.

For purposes of the facility accident analysis, DOE considered six classes of initiating events:

- Fires during facility operations
- Explosions during facility operations
- Spills (of radiological or hazardous material) during facility operations
- Criticality (uncontrolled nuclear chain reaction) during facility operations
- Natural phenomena (for example: flood, lightning, seismic event, high wind) during facility operations
- External events (human-caused events that are external to a facility and may impact the safe operation and integrity of the facility) during facility operations

As noted above, the accident analysis assessed the potential for criticality accidents for each waste processing activity. There have been three criticalities at INTEC (October 16, 1959; January 25, 1961; and October 17, 1978). All three events were a result of a high uranium concentration aqueous solution being placed in a geometrically unsafe storage condition. The sets of conditions leading to the historically recorded criticality events (i.e., sufficient inventory of fissile material in an aqueous environment) are considered reasonably foreseeable only for the Transuranic Separations Option and the Minimum INEEL Processing Alternative. Implementing these alternatives could involve circumstances where a potentially high concentration of transuranic species exists in a stored or handled waste that is not immobilized.

In the aftermath of the tragic events of September 11, DOE is continuing to assess measures that it can take to minimize the risk of potential consequences of radiological sabotage or terrorists attacks against the INEEL site. For this reason, sabotage and terrorist activities are not addressed in the facility accident analysis. The threat of significant health impacts due to sabotage and terrorist activities requires the coexistence of significant radioactive inventories and energy sources capable of causing a substantial release. The defense in depth approach used to design nuclear facilities with significant radiological inventories at the INEEL, combined with limited sources of release energy, precludes a major impact from terrorist action.

The screening process identified a subset of process elements requiring detailed accident analysis to assess the potential for bounding accidents to occur. In some cases, the bounding accident for several alternatives could be identified using a single accident evaluation. The resulting set of required accident analyses used to identify potentially bounding accident scenarios for the waste processing alternatives is shown in Table 5.2-39. From Table 5.2-39, there are 22 separate accident analyses used to identify potentially bounding accident scenarios. Each accident analysis identifies potentially bounding accident scenarios in the three frequency classes, abnormal events, design basis events, and beyond design basis events.

Source Term Identification

Radiological Releases - Most of the accidents analyzed in this EIS result in releases to the atmosphere. This is because air release accidents generally show the highest potential to result in health impacts. For non-criticality radiological releases, the source term is defined as the amount of respirable material released to the atmosphere from a specific location. The radiological source term for non-criticality events is dependent upon several factors including the material at risk, material form, initiator, operating conditions, and material composition. The technical approach described in DOE-STD-3010 (DOE 1994) is modified in the Safety Analysis and Risk Assessment Handbook (Peterson 1997) and was used to estimate source term for radioactive releases. This approach applies a set of release factors to the material at risk constituents to produce an estimated release inventory. The release inventory was combined with the conditions under which the release occurs and other environmental factors to produce the total material released for consequence estimation. Factors applied in the DOE-STD-3010 (DOE 1994) source term method and additional details with respect to source term estimation are contained in Appendix C.4.

Table 5.2-39. Accident evaluations required.

Waste Processing Alternatives Processing Elements	No Action	Continued Current Operations	Full Separations	Planning Basis	Transuranic Separations	Hot Isostatic Pressed Waste	Direct Cement Waste	Early Vitrification	Steam Reforming	Min. INEEL Processing	Vitrification without Calcine Separations	Vitrification with Calcine Separations
SBW/Newly Generated Liquid Waste Processing[a]		X		X		X	X		X			
New Waste Calcining Facility High Temperature and MACT Modifications		X		X		X	X					
Calcine Retrieval and Onsite Transport[b]	c	c	X	X	X	X	X	X	X	X	X	X
Full Separations[d]			X	X								X
Transuranic Separations					X							
Cesium Separations		X[e]								X		X
Class C Grout					X					X		
Borosilicate Vitrification (cesium, transuranic, strontium)[f]			X	X								X
Borosilicate Vitrification (Calcine and SBW)[g]								X			X	
HLW/SBW Immobilization for Transport (Calcine & Cs IX)										X		
HLW/SBW Immobilization for Transport (HIP)						X						
HLW/SBW Immobilization for Transport (Direct Cement)							X					
HLW/SBW Immobilization for Transport (Calcine & SBW)[h]												
Liquid Waste Stream Evaporation[i,j]		X	X	X	X	X	X		X			X
Additional Offgas Treatment[k]			X	X	X	X	X	X	X	X	X	X
Class C Grout Disposal					X							
HLW Interim Storage for Transport									X	X		
HLW/HAW Stabilization and Preparation for Transport (Calcine and Cs Resin Feedstocks)										X		
HLW/HAW Stabilization and Preparation for Transport (Calcine and SBW Feedstocks)[h]												
Storage of Calcine in Bin Sets[l,m]	X[n]	X[n]	X	X	X	X	X	X	X	X	X	X
Transuranic Waste Stabilization and Preparation for Transport					X					X		

Table 5.2-39. Accident evaluations required (continued).

Processing Elements	Waste Processing Alternatives: No Action	Continued Current Operations	Full Separations	Planning Basis	Transuranic Separations	Hot Isostatic Pressed Waste	Direct Cement Waste	Early Vitrification	Steam Reforming	Min. INEEL Processing	Vitrification without Calcine Separations	Vitrification with Calcine Separations
Storage of SBW[o]	X	X	X	X	X	X	X	X	X	X	X	X
SBW Stabilization and Preparation for Transport[p]								X	X		X	X
SBW Retrieval and Transport[q]		X	X	X	X	X	X	X	X	X	X	X

HAW = high-activity waste; SBW = mixed transuranic waste/SBW

a. Title reflects completion of liquid HLW calcining mission. DOE has placed calciner in standby.

b. Process elements associated with calcine retrieval are assumed to be identical to the calcine retrieval process for other waste processing alternatives.

c. Prior engineering assessment indicated bin set 1 to be potentially structurally unstable under static load thus possibly unable to meet requirements of DOE Order 420.1. This condition resulted in an Unresolvd Safety Question, and an assumption that retrieval of calcine from bin set 1 was required to implement any of the waste processing alternatives. Additional structural evaluation since that time resolved this Unresolved Safety Question and calcine retrieval from bin set 1 for the No Action and Continued Current Operations Alternatives is not anticipated.

d. Assumed to be identical to full separations process for Full Separations Option.

e. Requirement for Cs separations for Continued Current Operations Alternative was based on concern that treatment of mixed transuranic waste/SBW, newly generated liquid waste, and tank heels may require additional or alternate processing other than calcination. Currently, DOE has no planned Cs separations facility although Vitrification With Calcine Separations may utilize a partial separations process.

f. Smaller borosilicate vitrification process is analyzed for immobilization of HAW fractions after separation.

g. For Vitrification Without Calcine Separations, process element is assumed to be identical to Borosilicate Vitrification process for Early Vitrification Option.

h. Defined and analyzed based on preliminary descriptions of treatment alternatives and implementing processes. Later information indicated that modeled processes were identical to others or similar to and bounded by other processes (in terms of potential for health impacts) so this accident is not required for analysis.

i. Analyzed liquid waste stream evaporation as post-treatment for separations process. Application to mixed transuranic waste/SBW pretreatment, requires elimination of accidents with no physical basis.

j. Smaller borosilicate vitrification process requires mixed transuranic waste/SBW volume reduction beyond what is currently planned for near term management of mixed transuranic waste/SBW inventories, prior to vitrification.

k. In this EIS, all borosilicate vitrification and separation processes are assumed to require offgas treatment. Continued Current Operations Alternative would rely on current evaporators, which are also analyzed.

l. Identical to equivalent process element for other waste processing alternatives that address calcine waste and includes accidents covering short-term storage of calcine over a 35-year period of vulnerability.

m. Accident analysis process element assumes vulnerability to short term storage accidents over a 35-year period of vulnerability except for the No Action and Continued Current Operations Alternatives, where storage of calcine in the bin sets is permanent.

n. Includes long-term storage accidents that could occur over a 10,000 year period of vulnerability.

o. Evaluation of this process element addresses accidents involving long-term storage and degradation of mixed transuranic waste/SBW storage facilities (10,000 year exposure). However, potentially bounding design basis and beyond design basis accident scenarios could occur at any time. Therefore, the analysis has been expanded to evaluate design basis and beyond period of vulnerability.

p. Process element is assumed to be identical to mixed transuranic waste/SBW stabilization and preparation process for Early Vitrification Option. The radiological source term in a container of vitrified mixed transuranic waste/SBW is about twice the source term in a container of vitrified calcine. Therefore, accident for mixed transuranic waste/SBW provides a bounding analysis.

q. Process element is assumed to be identical to mixed transuranic waste/SBW retrieval process for waste processing alternatives.

The potential for a criticality was assessed in each accident analysis evaluation. Only one reasonably foreseeable criticality accident scenario was identified in the accident analysis evaluations. An inadvertent criticality during transuranic waste shipping container-loading operations results from a vulnerability to loss of control over storage geometry. This scenario is identified under both the Transuranic Separations Option and the Minimum INEEL Processing Alternative. The frequency for this accident is estimated to be between once in a thousand years and once in a million years of facility operations. This event could result in a large dose to a nearby, unshielded maximally exposed worked that is estimated to be 218 rem, representing a 1 in 5 chance of a latent cancer fatality. However, this same analysis estimates a dose to the maximally exposed offsite individual at the site boundary (15,900 meters down wind at the nearest public access) to be only 3 millirem, representing a 2 per million increase in cancer risk to the receptor.

Chemical Releases - Facility accidents may include sets of conditions leading to the release of hazardous chemicals that directly or indirectly threaten involved workers and the public. This EIS facility accident review includes an evaluation of the potential for chemical release accidents. Currently, there is insufficient information on chemical inventories of proposed future waste processing facilities to support a comprehensive and systematic review of chemical release accidents. However, DOE assumed that future requirements for hazardous chemicals during waste processing would be similar to present requirements.

Chemicals that pose the greatest hazard to workers and the public are gases at ambient temperatures and pressures. An example of this type of gas is ammonia, which is stored under pressure as a liquid but quickly flashes to a vapor as it is released. Chemicals such as nitric acid that are liquids at ambient conditions also could pose a toxic hazard to involved workers. However, the potential for these types of chemicals to become airborne and travel to nearby or offsite facilities is low. The facility accident analysis focused on those chemicals that are gases at ambient conditions. Appendix C.4 of this EIS provides additional information on chemical releases.

Receptor Identification

Radiological Releases - For radiological releases, DOE calculated the health impact of the bounding accidents by estimating the dose to human receptors. Human receptors are people who could potentially be exposed to or affected by radioactive releases resulting from accidents associated with the waste processing alternatives.

Four categories of human receptors are considered in this EIS:

- **Involved Worker:** A worker who is associated with a treatment activity or operation of the HLW treatment facility itself;
- **Maximally Exposed Individual:** A hypothetical individual located at the nearest site boundary from the facility location where the release occurs and in the path of an air release.
- **Noninvolved Worker:** An onsite employee not directly involved in the site's HLW management operations.
- **Offsite Population:** The population of persons within a 50-mile radius the INTEC and in the path of an air release.

Doses to individual receptors from a radiological release are estimated in rem. Doses to receptor populations are estimated in person-rem. A person-rem is the product of the number of persons exposed to radiation from a single release and the average dose in rem.

Most bounding accidents evaluated in this EIS impact the receptor population by releasing radioactive particles into the environment, which are then inhaled or settle on individuals or surfaces such that humans are exposed. Such exposures usually result in chronic health impacts that manifest over the long-term and are calculated as latent cancer fatalities. Consequences to receptors impacted by a radiological release are expressed as an increase in the probability of developing a fatal cancer (for an individual) or as an increase in the number of latent cancer fatalities (for a population).

Chemical Releases - To determine the potential health effects to workers and the public that could result from accidents involving releases of chemicals and hazardous materials, the airborne concentrations of such materials released during an accident at varying distances from the point of release were compared to Emergency Response Planning Guideline (ERPG) values. The American Industrial Hygiene Association established ERPG values, which are specific to hazardous chemical substances, to ensure that necessary emergency actions are taken in the event of a release. ERPG severity levels are as follows:

- **ERPG-3.** Exposure to airborne concentrations greater than ERPG-3 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop life-threatening health effects.
- **ERPG-2.** Exposures to airborne concentrations greater than ERPG-2 but less than ERPG-3 values for a period greater than 1 hour results in an unacceptable likelihood that a person would experience or develop irreversible or other serious health effects or symptoms that could impact a person's ability to take protective action.
- **ERPG-1.** Exposure to airborne concentrations greater than ERPG-1 but less than ERPG-2 values for a period of greater than 1 hour results in an unacceptable likelihood that a person would experience mild transient adverse health effects or perception of a clearly defined objectionable odor.

The facility accident analysis assumes that accident scenarios with the potential for ERPG-2 or ERPG-3 health impacts are bounding scenarios for the waste processing alternatives.

Consequence Assessment

DOE used the "Radiological Safety Analysis Computer Program (RSAC-5)" to estimate human health consequences for radioactive releases. Radiological source terms were used as input to the computer program to determine radiation doses at receptor locations for each potentially bounding facility accident scenario. Meteorological data used in the program are consistent with previous INEEL EIS analyses (i.e., SNF & INEL EIS; DOE 1995) for 95 percent meteorological conditions (i.e. conditions whose severity, from the standpoint of induced consequences to an offsite population, is not exceeded more than 5 percent of the time).

DOE converted radiation doses to various receptors into potential health effects using dose-to-risk conversion factors recommended by the National Council on Radiation Protection and Measurements (NCRP). For conservatism, the NCRP guidelines assume that any additional exposure to radiation carries some incremental additional risk of inducing cancer. In the evaluation of facility accident consequences, DOE adopted the NCRP dose-to-risk conversion factor of 5×10^{-4} latent cancer fatalities for each person-rem of radiation dose to the general public. DOE calculated the expected increase in the number of latent cancer fatalities above those expected for the potentially exposed population. For individual receptors, a dose-to-risk conversion factor of 5×10^{-4} represents the increase in the probability of cancer for an individual member of the general public per rem of additional exposure. For larger doses, where the total exposure during an accident could exceed 20 rem, the increased likelihood of latent cancer fatality is doubled, assuming the body's diminished capability to repair radiation damage.

The consequences from accidental chemical releases were calculated using the computer program "Areal Locations of Hazardous Atmospheres (ALOHA)." Because chemical consequences are based on concentration rather than dose, the computer program calculated air concentrations at receptor locations. Meteorological assumptions used for chemical releases were the same as used for radiological releases.

For each accident evaluation, conservative assumptions were applied to obtain bounding results. For the most part, the assumptions in this EIS are consistent with those applied in other EIS documents prepared at the INEEL, such as the SNF & INEL EIS. However, there were some assumptions that differed.

In this EIS, DOE performed a comprehensive evaluation of accidents that could result in an air release of radioactive or chemically hazardous materials to the environment. The reason for this simplification was that the short time between the occurrence of an air release and the time it would impact human health through respiration would not allow for mitigation measures other than execution of the site emergency plan. Accidents that resulted in a release only to groundwater were not generally evaluated since the time between their occurrence and their impact on the public was assumed to be long enough to take comprehensive mitigation measures. The one exception is that DOE did analyze bounding groundwater release accidents for which effective mitigation might not be feasible.

In this EIS, DOE focused on the human health and safety impacts associated with air release accidents. Other environmental impacts would also result from such events, such as loss of farm production, land usage, and ecological harm. However, these consequences were not evaluated directly in this EIS. Preliminary sensitivity calculations indicate that accidents which bounded the potential for human health impacts also bounded the potential for land contamination and other environmental impacts.

DOE decided not to evaluate impacts from some initiators (i.e., volcanoes) because they determined that such evaluations would not provide new opportunities to identify bounding accidents. Based on evaluations in the accident analysis, volcanic activity impacting INTEC was considered a beyond design basis event. This would place the event with initiators such as external events and beyond design basis earthquakes. This is because the lava flow from the eruption (basaltic volcanism) would likely cover some affected structures, limiting the amount of hazardous and radioactive waste that is released from process vessels and piping. Therefore, the impacts due to a lava flow event are assumed to be bounded by other external events, where the entire inventory would be impacted and available for release. Appendix C.4 contains additional information on volcanism.

5.2.14.2 Methodology for Integrated Analysis of Risk to Involved Workers

Health and safety risk to involved workers (workers associated with the construction, operation, or decontamination and decommissioning of facilities that implement a waste processing alternative) is a potentially significant "cost" of implementing waste processing alternatives, and has been systematically characterized and reported in this EIS. Together with health and safety risk to the public, evaluation of involved worker risk provides a comprehensive basis for comparing waste processing alternatives on the basis of contribution to the implementation risk due to accidents. Unlike health and safety risk to noninvolved workers and the public that results mainly from facility accidents and accidents occurring during transportation, health and safety risk to involved workers results from three sources, industrial accidents, exposure to radioactive materials during normal operations, and facility accidents.

- Industrial accident risk to involved workers results from industrial activities needed to complete major projects that implement an alternative.

- Occupational risk to involved workers results from routine exposure to radioactive materials during industrial activities that implement an alternative.

- Facility accident risk to involved workers results from accidents that release radioactive or chemically hazardous materials, accidents (e.g., criticality) that could result in direct exposure to radiation, or energetic accidents (e.g,. explosions) that can directly harm workers.

Risk to involved workers from facility accidents is evaluated in a manner analogous to evaluation of risk to noninvolved workers and the public. Consequences for involved workers are estimated using information on bounding accidents in three frequency categories with the highest potential consequences to noninvolved workers and the public. Due to limitations on the accuracy of consequence prediction codes at locations near the origin of a release, doses to involved workers are estimated proportionally based on doses to noninvolved workers at 640 meters. On the average, the dose at 100 meters was 9 times greater than the dose at 640 meters. The method used is intended to provide consistency with the definition of facility worker utilized in the SNF & INEL EIS (DOE 1995).

Risk to involved workers from occupational exposures and industrial accidents is appraised in the Health and Safety section of this EIS (5.2.10). In the accident analysis methodology, information used to generate worker risk due to industrial accidents and occupational exposures is integrated with results of the facility accidents evaluation to produce a comprehensive perspective on involved worker risk.

5.2.14.3 Bounding Radiological Impacts to Noninvolved Workers and the Public of Implementing the Alternatives

This EIS analyzes the impacts or consequences of implementing the waste processing alternatives and their options. It describes (1) the major processes of each alternative, (2) the bounding accident scenarios applicable to the major processes, and (3) the resulting impact to INEEL workers and the general public. The systematic accident analysis process employed by DOE identified potentially bounding accidents for each alternative/option. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the risk accruing processes associated with each waste processing alternative.

In general, the process used in selecting the bounding accident scenario was to select the scenario with the highest consequence within each frequency bin. In some cases, one scenario had the highest consequence for the maximally-exposed individual and noninvolved worker, but another scenario had higher consequences for the offsite population and latent cancer fatalities. In these cases, the scenario with the higher consequences for the offsite population/latent cancer fatalities was selected as bounding.

The results for radiological impacts due to releases of radioactive material are expressed in terms of risk. Risk is quantified in terms of the estimated probability of fatality for the maximally exposed individual, involved worker, and noninvolved worker, and the estimated increase in latent cancer fatalities for the INEEL offsite population. A dose-to-risk conversion factor of 5×10^{-4} per person-rem represents the increase in the probability of a fatal cancer for an individual member of the public. For conservatism, this same conversion to dose was used to analyze risk to the noninvolved worker.

Bounding accidents are identified in this EIS based on analysis of those activities, projects, and facility operations that are required to implement the waste processing alternative, and that potentially pose a risk of health impacts to various receptor populations. These bounding accidents are presented in Appendix C.4.

5.2.14.4 Anticipated Radiological Risks of Bounding Facility Accidents

The systematic accident analysis process employed by DOE identified potentially bounding facility accident scenarios for the waste processing alternatives. The potentially bounding accident scenarios were identified for each of the functional activities that implement the various alternatives. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each alternative. Table 5.2-40 summarizes the bounding facility accidents for each of the alternatives, along with their forecast consequences. Table 5.2-40 contains the following information:

Radiation Dose to Receptors - For each potentially bounding facility accident scenario, this section estimates doses to each receptor given that an accidental release of radioactivity has

Table 5.2-40. Anticipated risk for bounding radiological events for the various waste processing alternatives.[a]

Frequency of occurrence	Abnormal Event (AB) Could occur more than once in a thousand years of facility operation		Design Basis Event (DBE) Could occur more than once in a million years but less than once in a thousand years of facility operation	Beyond Design Basis Event (BDB) Could occur less than once in a million years of facility operation	
Process title	Long Term Storage of Calcine in Bin Sets	Calcine Retrieval Onsite Transport	Short Term Storage of Calcine in Bin Sets	Short Term Storage of Calcine in Bin Sets	Borosilicate Vitrification
Window of exposure (years)	9.5×10^{3}	35	35	35	20
Accident scenario (Event description)	Seismic induced failure of degraded bin set results in failure of the outer containment and a portion of the internal containment in a bin set and the possibility of opening a bin set to the environment. Likelihood of this event increases after 2095 when monitoring and maintenance requirements would no longer be met.	Equipment failure results in release of calcine during retrieval and transport operations.	A short-term flood induced failure of a bin set structure and equipment such that a release occurs with a direct pathway to the environment (No interdiction for 30 days).	An external event results in a bin set release (calcine) during short term storage.	An external event results in release of high activity waste from the borosilicate vitrification facility containment.
Risk to Receptors					
Maximally exposed individual					
Dose (millirem)	8.3×10^{4}	40	880	1.4×10^{4}	1.7×10^{4}
Latent cancer fatality probability	0.042	2.0×10^{-5}	4.4×10^{-4}	7.0×10^{-3}	8.5×10^{-3}
Noninvolved worker					
Dose (millirem)	5.7×10^{6}	2.7×10^{3}	5.9×10^{4}	9.3×10^{5}	1.2×10^{6}
Latent cancer fatality probability	1.0	1.4×10^{-3}	0.059	0.94	1.0
Offsite population					
Dose (person-rem)	5.3×10^{5}	470	5.7×10^{4}	1.2×10^{5}	1.5×10^{5}
Latent cancer fatalities	270	0.23	29	61	76

Table 5.2-40. Anticipated risk for bounding radiological events for the various waste processing alternatives[a] (continued).

Frequency of occurrence	Abnormal Event (AB) Could occur more than once in a thousand years of facility operation		Design Basis Event (DBE) Could occur more than once in a million years but less than once in a thousand years of facility operation	Beyond Design Basis Event (BDB) Could occur less than once in a million years of facility operation	
Process title	Long Term Storage of Calcine in Bin Sets	Calcine Retrieval Onsite Transport	Short Term Storage of Calcine in Bin Sets	Short Term Storage of Calcine in Bin Sets	Borosilicate Vitrification
Accident Analysis included in Alternatives/Options					
No Action Alternative	✔[b]		✔	✔	
Continued Current Operations Alternative	✔		✔	✔	
Separations Alternative					
Full Separations Option		✔	✔		✔
Planning Basis Option		✔	✔		✔
Transuranic Separations Option		✔	✔	✔	
Non-Separations Alternative					
Hot Isostatic Pressed Waste Option		✔	✔	✔	
Direct Cement Waste Option		✔	✔	✔	
Early Vitrification Option		✔	✔	✔	
Steam Reforming Option		✔	✔	✔	
Minimum INEEL Processing Alternative		✔	✔	✔	
Direct Vitrification Alternative					
Vitrification without Calcine Separations Option		✔	✔	✔	
Vitrification with Calcine Separations Option		✔	✔		✔

a. See Table C.4-2 for additional information.
b. Check mark indicates this analyzed accident applies to these EIS alternatives/options

occurred. Source terms are evaluated in the accident analysis. Doses are estimated for unit radioactive source terms (i.e. assuming one curie of each radioactive substance is released) using RSAC-5. Dose estimates for accident scenario source terms are then estimated using an Excel spreadsheet to correct for radioactivity content of the released material.

Health Impacts - Conditional risk estimates the probability of health impacts assuming that an accidental release has occurred. For individual receptors, conditional risk is the probability of a fatality given exposure to the release. For the INEEL offsite public, conditional risk is the number of latent cancer fatalities. Consistent with assumptions discussed above regarding dose-to-risk conversion (i.e., a dose-to-risk conversion factor of 5×10^{-4} latent cancer fatalities for each person-rem of radiation received in the accident) the conditional risk of health impacts (fatalities only) is estimated for offsite receptors and is for noninvolved workers.

5.2.14.5 Impacts of Chemical Release Accidents on Noninvolved Workers and the Public of Implementing the Alternatives

DOE has analyzed the consequences of chemical releases from accidents that occur as a result of implementing the waste processing alternatives and their options. This section describes (1) the major processes that contribute chemicals to the atmosphere during an accident and (2) the impacts to INEEL workers and the general public in terms of ERPG values. Potentially bounding chemical release accidents from the accident analysis include mercury and ammonia. Mercury could be released during calcining operations from the carbon bed filter during an exothermic reaction that results from inadequate nitrous oxide reduction. Ammonia could be released during failure of the ammonia storage tanks. Current feasibility studies for several waste processing alternatives identify a need for additional offgas treatment to meet EPA environmental requirements during separation, vitrification, and other functions associated with alternative implementation. These same feasibility studies have identified an ammonia-based treatment process as being most likely to meet the technical requirements of the waste processing alternatives. Thus, ammonia has been identified as a chemical substance posing a potential significant hazard to workers and the public during waste processing alternative implementation.

The major processes or functions that could produce chemical releases from accidents during implementation of waste processing alternatives are the New Waste Calcining Facility High Temperature and Maximum Achievable Control Technology Modifications, and the Additional Offgas Treatment. The analysis of these accidents shows that failures involving ammonia handling and storage equipment represent the bounding abnormal, design basis, and beyond design basis chemical release accidents for all alternatives requiring additional offgas treatment. The beyond design basis accident, which involves an external event and subsequent fire could result in a release from another waste processing facility due to operator incapacitation or evacuation. The impacts due to these bounding accidents are shown in Table 5.2-41.

5.2.14.6 Groundwater Impacts to the Public of Implementing the Alternatives

The bounding accident scenarios described in Appendix C.4 produce human health consequences mainly as a result of inhalation of airborne released contaminants. In this EIS accident analysis, DOE assumed that the inhalation pathway is the predominant source of human health consequences since an air release does not provide an opportunity for intervention and mitigation.

Several potentially bounding accident scenarios identified in the accident analysis produced mainly groundwater releases. In theory, groundwater releases can be mitigated, with little ultimate impact on the public. However, since significant groundwater releases would produce a substantive risk to the environment and the opportunity to mitigate may be limited by time and resource constraints, the impact of accident scenarios resulting in groundwater releases is considered in the facility accidents evaluation.

Environmental risk is presented in the Remedial Investigation/Feasibility Study process in terms of expected exposure to contamination as a func-

Table 5.2-41. Summary of bounding chemical events for the various waste processing alternatives.[a]

Events	Process title	Event description	Contaminant	Peak atmospheric concentration (ERPG)
Abnormal	Additional Offgas Treatment	Failure of ammonia tank connections results in a spill of 150 pounds per minute of liquid ammonia. A fraction of the ammonia would flash to vapor as it escapes the tank. The remainder would settle and form a boiling pool.	Ammonia	Less than ERPG-2 at 3,600 meters
Design Basis	Additional Offgas Treatment	Failure of ammonia tank connections results in a spill of 1,500 pounds per minute of liquid ammonia. A fraction of the ammonia would flash to vapor as it escapes the tank. The remainder would settle and form a boiling pool.	Ammonia	Greater than ERPG-2 at 3,600 meters
Beyond Design Basis	Additional Offgas Treatment	Failure of ammonia tank connections results in a spill of 15,000 pounds per minute of liquid ammonia. A fraction of the ammonia would flash to vapor as it escapes the tank. The remainder would settle and form a boiling pool.	Ammonia	Greater than ERPG-2 at 3,600 meters

a. Results based on modeling assumptions used for CERCLA analyses as reported in Rodriguez et al. (1997).

tion of time. Therefore, the measures of environmental risk such as the EPA drinking water standards or maximum contaminant levels can be used to estimate the potential for future adverse human health impacts. Specifically, expected contamination due to a postulated release can be compared with maximum contaminant level values to assess the severity of environmental risk associated with a release. In this way, accident scenarios resulting in a release to groundwater can be appraised for their potential contribution to environmental risk and the overall potential economic impact of the accident.

Appendix C.4 presents analyses of three major processes or functions that could produce groundwater releases from accidents. These are New Waste Calcining Facility Operations, Long-term Storage of Calcine in Bin Sets, and Storage of Mixed Transuranic Waste/SBW. The predicted impacts to groundwater from accident scenarios resulting in major groundwater releases are described below and the impacts are summarized in Table 5.2-42.

New Waste Calcining Facility Operations

Operation of the New Waste Calcining Facility requires the combustion of kerosene for fluidized bed operation. An accident could leak 15,000 gallons of kerosene (which contains benzene) from storage facilities associated with the New Waste Calcining Facility. This is considered to be an abnormal event with an occurrence equal to or greater than once in 1,000 years. A similar but less probable occurrence, beyond design basis event, would be an external event involving both kerosene storage tanks causing a release of 30,000 gallons of kerosene and a fire. The estimated chance of occurrence for this event is less than one in one million.

For the abnormal and beyond design basis kerosene spill accidents, DOE analyzed the risk to a resident drinking 2 liters per day of the benzene contaminated groundwater from beneath the INTEC Tank Farm. The additional risk of developing cancer over a 30-year lifetime due to these accidents is 1.9×10^{-4} for the abnormal

Table 5.2-42. Groundwater impacts due to accidents.

Process Title	Event	Accident Frequency	Constituent	Peak groundwater concentration (µg/L or pCi/L)	Maximum contaminant level (µg/L or pCi/L)
New Waste Calcining Facility Operations	A leak through failed process connections leaks 15,000 gallons of kerosene.	Abnormal Event	Benzene in kerosene	120	5
New Waste Calcining Facility Operations	An external event results in the failure of both kerosene storage tanks and a subsequent fire.	Beyond Design Basis Event	Benzene in kerosene	180	5
Long-Term Storage of SBW-Single Tank Failure	A seismic event causes the failure of a single full SBW tank and a release of SBW directly to the soil column in the year 2001.	Design Basis Event	I-129 Tc-99 Np-237 Total Pu	0.13[a] 100[a] 0.030[a] 1.1[a]	1 900 15 15
Long-Term Storage of SBW-5 Tank Failure	Degradation and simultaneous failure of 5 full SBW tanks in 2500.	Abnormal Event	I-129 Tc-99 Np-237 Total Pu	0.47[a] 380[a] 0.34[a] 8.6[a]	1 900 15 15

a. Results based on modeling assumptions used for CERCLA analyses as reported in the *Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL, Part A, RI/BRA Report* (Rodriguez et al. 1997).

MACT = maximum achievable control technology; SBW = mixed transuranic waste/SBW; µg/L = micrograms per liter; pCi/L = picocuries per liter.

event and 2.9×10^{-4} for the beyond design basis event (Jenkins 2001a). Cancer fatalities were not estimated for either event.

Long-Term Storage of Calcine in Bin Sets

This accident assumes that a bin set full of mixed HLW calcine degrades and fails during a seismic event after 500 years. The bin set is assumed to breach releasing the entire inventory of calcine directly to the soil column. Once released, the calcine would partially dissolve under the influence of local precipitation and would release contaminants to the groundwater. Because this event is assumed to occur after 500 years, it is treated as an abnormal event although the seismic initiator is considered a design basis event.

As discussed in Appendix C.4, the radionuclides released from this accident would be a fraction of the radionuclides released from the assumed failure of five full mixed transuranic waste/SBW tanks at 500 years. The 5-tank failure is discussed below. For the bin set failure at 500 years, the percent of the radionuclide inventory released the first year compared to the inventory released from the 5-tank failure is: iodine-129 (1 percent); technetium-99 (11 percent); neptunium-237 (7 percent), and total plutonium (less than 1 percent).

The additional risk for developing cancer for a potential groundwater user after bin set failure at 500 years was not analyzed since groundwater impacts would be easily bounded by the 5-tank failure at 500 years as shown below.

The nonradiological impact of this accident was analyzed by comparing the percentage of the nonradionuclides inventory released during the first year of bin set failure, to the nonradionuclide inventory released for the 5-tank failure in 2500. The analysis (Jenkins 2001b) shows that the most impacting contaminants are beryllium

(8 percent of the 5-tank failure inventory) and molybdenum (4 percent of the 5-tank failure inventory). All other nonradionuclides would be less than 1 percent of the inventory released from the 5-tank failure. Therefore, the impacts from nonradionuclide contaminants released from the failure of a bin set would be bounded by the 5-tank failure at 500 years and the concentrations would be much less than drinking water standards.

Storage of Mixed Transuranic Waste/SBW

Two accidents associated with storage of mixed transuranic waste/SBW in the INTEC Tank Farm were analyzed for this EIS. These are:

- Failure of a full mixed transuranic waste/SBW tank vault with subsequent tank rupture and release of mixed transuranic waste/SBW directly to the soil column due to a seismic event. This event was analyzed to occur in the year 2001 and is considered a design basis event.
- Degradation and eventual simultaneous failure of 5 full mixed transuranic waste/SBW tanks and their vaults after 500 years with a release of mixed transuranic waste/SBW directly to the soil column. This is treated as an abnormal event since it is assumed that the event occurs at 500 years.

Failure of a Full Mixed Transuranic Waste/SBW Tank in the Year 2001 - The rupture of a full mixed transuranic waste/SBW tank in the year 2001 due to a seismic event is assumed to release liquid waste directly to the soil column, where it infiltrates and disperses through the vadose zone and migrates in the groundwater. The impacts for this accident were analyzed using similar modeling assumptions to those considered for CERCLA analyses in the *Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL, Part A, RI/BRA Report* (Rodriguez et al. 1997). Under these assumptions, the predicted peak groundwater concentration for iodine-129 is 0.13 pCi/L, which is 13 percent of the maximum contaminant level of 1.0 pCi/L. The peak iodine-129 concentration would occur in the year 2075. The predicted groundwater concentration for total plutonium (plutonium-239, plutonium-240, and plutonium-242) is 1.1 pCi/L, which does not exceed the maximum contaminant level of 15 pCi/L for alpha-particle emitters such as plutonium. The peak plutonium concentration would occur in the year 6000. The predicted groundwater concentrations for technetium-99 and neptunium-237 are 110 pCi/L and 0.7 pCi/L, respectively; well below their maximum contaminant levels of 900 pCi/L and 15 pCi/L. The peak concentration for these radionuclides would occur in the years 2095 and 2075, respectively (Bowman 2001a).

The potential nonradionuclide contaminants of concern included those constituents that could reasonably be expected to reach the aquifer in sufficient concentrations to impact the groundwater and pose a threat to the environment. Following screening, the contaminants of concern analyzed were: arsenic, barium, beryllium, cadmium, chromium, fluoride, mercury, molybdenum, nitrates, nickel, lead and uranium. For the single tank failure, the peak concentrations for the 12 species analyzed were all well below the drinking water standards. The peak concentrations for cadmium and nitrate were the closest, but were still more than a factor of 10 below their maximum contaminant levels based on the CERCLA model.

Degradation and Simultaneous Failure of 5 Full Mixed Transuranic Waste/SBW Tanks After 500 Years - For the No Action Alternative, mixed transuranic waste/SBW would be stored in the underground tanks indefinitely. The impact of the tank failures has been analyzed under the assumptions that (a) all five tanks fail simultaneously and (b) prior to failure all other tank contents and tank heels have been pumped into the five tanks. Although five times more mixed transuranic waste/SBW would be released to the soil column (relative to the single tank failure described above), many of the radionuclides would have decayed to very low activities over the 500 years. The impacts for this accident were analyzed using similar modeling assumptions to those considered for the CERCLA analyses in Rodriguez et al. (1997). Under these assumptions, the analysis shows that the impact from the tank failures would result in peak concentrations of iodine-129 at 0.47 pCi/L in the year 2575, technetium-99 at 390 pCi/L in the year 2595, neptunium-237 at 8.1 pCi/L in the year 2575, and total plutonium about 9 pCi/L in the year 6500. Thus, the peak concentrations for these key radionuclides would be less than current drinking water standards (Bowman 2001b).

The risk to an assumed long-term resident drinking the groundwater from beneath the INTEC Tank Farm was analyzed for this accident. Using the concentration-to-dose conversion factor from DOE (1988), and assuming 72 years of water ingestion at 2 liters per day, DOE estimated a lifetime whole-body dose equivalent to 420 millirem due to total plutonium for this accident. This equates to a 210 per million increase in the probability of a fatal cancer. This accident would release at least 5 times more source term to the soil column than considered for the single tank failure. Nevertheless, the concentrations of nonradionuclide contaminants in the aquifer would be less than the drinking water standards.

For nonradionuclide contaminants, the analysis for the 5-tank failure shows the greatest impact would be due to cadmium which would be about 41 percent of its maximum contaminent level. The next most impacting contaminant, uranium, would be about 0.5 percent of its maximum contaminant level based on the CERCLA model.

For purposes of this EIS, DOE calculated the groundwater impacts beneath the mixed transuranic waste/SBW tanks at INTEC. As for the single tank failure, these results could be non-conservative depending on the assumed mass release time for the 5-tank failure. Since doses are directly related to concentrations, a faster release time would be expected to increase concentration and doses accordingly. These impacts are provided for comparison purposes between alternatives under accident conditions and are not meant to fulfill the needs of or replace a performance assessment or INEEL-wide composite analysis as required by DOE Order 435.1. Facilities disposition and closure activities would eventually require such assessments but it is premature to attempt performance assessments until the waste processing technology is selected and the facilities to implement the selected technology are chosen.

5.2.14.7 Consideration of Other Accident Initiators

Each of the process elements associated with the waste processing alternatives were evaluated using a consistent set of accident initiators. During the review of the accident analysis, additional initiators were identified that could potentially result in releases of radioactive or hazardous materials. However, the bounding accidents that describe the potential risk associated with the waste processing alternatives and the accident analyses were not modified as a result of identifying these additional initiators for the following reasons:

Initiator Frequency is Less Than Beyond Design Basis - Very low likelihood events (e.g., meteor strikes) have the potential to cause significant releases. However, accidents that have a frequency of occurrence much less than 1.0×10^{-7} pose a limited risk of occurrence and do not impact the choice of bounding accidents.

Initiator is Encompassed by Another Initiator - The consequences and initiating frequencies of some newly identified initiators are bounded by accidents already identified in the accident analysis. For instance, a release could originate from an aircraft crash (included in analysis) or volcanic activity (identified in review process). The magnitude of the release and the initiating event frequencies for both initiators are similar and for all intents and purposes, the risk is the same. In this case, the volcanic activity initiator is not added into the accident analysis.

Initiator is in Planning/Hypothetical Stage - Some newly identified initiators are associated with potential future activities in and around the INEEL site. However, for activities such as these, their impact on waste processing alternatives would be evaluated as plans for initiation of the project are defined.

5.2.14.8 Sensitivity Analysis

The accident analysis consequence modeling was generally performed using very conservative assumptions to assure bounding results. For the most part, the assumptions in this EIS were consistent with those applied in other EIS documents prepared at the INEEL, such as the SNF & INEL EIS. However, there were some assumptions that differed. Of the assumptions incorporated in consequence modeling for this EIS, exposure pathways, exposure time, breathing rate, meteorology, location (for the population dose), and mass release times for tank failures were some that had significant impact on the results. The approach taken in this EIS ensures a "consequence envelope" is provided. As discussed above, this approach differs in part from the approach taken in other EISs, such as the SNF & INEL EIS. Therefore, the impacts presented in this EIS are generally larger than the impacts that would have been obtained by applying the SNF & INEL EIS assumptions. This EIS provides a likely upper bound to the potential consequences for the accidents associated with the candidate alternatives. In addition, these conservative assumptions were incorporated in a consistent manner. Although adjustments to these assumptions will modify the absolute magnitudes of the predicted consequences, they will not modify the relative ranking of the modeled scenarios. So the set of bounding scenarios are anticipated to remain the same.

5.2.14.9 Risk to Involved Worker

This EIS provides comprehensive and integrated evaluation of involved worker risk (in fatalities over life of the activity) as a result of industrial accidents, occupational exposures, and facility accidents. This EIS developed baseline estimates of involved worker risk using point estimates of risk contributors. Results of the point estimates are presented in Table 5.2-43. The involved worker risks do not include the risks posed by transportation or facility disposition. Appendix C.4, Facility Accidents, provides more information.

From Table 5.2-43 several conclusions can be drawn:

- Involved worker risk for all alternatives are sensitive to parameters such as the number of worker years of exposure, the rate of industrial accident fatalities, and the frequency of radiological release accidents. Consistent with the state of knowledge regarding projects and activities associated with implementation of alternatives, the point estimates provide a means for comparison of alternatives.

- Estimates of involved worker risk due to industrial accidents do not favor options that require the largest amount of manpower during implementation. Thus, waste processing options which rely on separations technology pose the highest risk to involved workers. The separations options encompass the largest requirements for facility construction as well as the longest facility operation campaigns.

- Industrial accidents are the largest contributors to involved worker risk. Therefore, estimates of integrated involved worker risk (including all sources) favor the options that involve less site activity over time.

Table 5.2-43. Point estimates of integrated involved worker risk for the waste processing alternatives.

	Involved worker risk (fatalities)[a]			
	Industrial accidents[b]	Occupational radiation dose[b]	Facility accidents[b]	Integrated worker risk[b]
No Action Alternative	0.44	0.15	21	21
Continued Current Operations Alternative	0.54	0.20	21	21
Separations Alternative				
Full Separations Option	1.8	0.38	2.3×10^{-3}	2.2
Planning Basis Option	1.9	0.47	2.3×10^{-3}	2.4
Transuranic Separations Option	1.2	0.36	2.3×10^{-3}	1.6
Non-Separations Alternative				
Hot Isostatic Pressed Waste Option	1.2	0.44	2.3×10^{-3}	1.6
Direct Cement Waste Option	1.4	0.51	2.3×10^{-3}	1.9
Early Vitrification Option	1.1	0.37	2.3×10^{-3}	1.5
Steam Reforming Option	0.82	0.31	2.3×10^{-3}	1.1
Minimum INEEL Processing Alternative[c]	0.92	0.32	2.3×10^{-3}	1.2
Direct Vitrification Alternative				
Vitrification without Calcine Separations Option	0.90	0.29	2.3×10^{-3}	1.2
Vitrification with Calcine Separations Option	1.6	0.31	2.3×10^{-3}	1.9

a. Does not include risk associated with decontamination and decommissioning (addressed in Section 5.3.12) or transportation (addressed in Section 5.2.9) activities.

b. Fatalities over life of activities.

c. Does not include activities at the Hanford Site.