4. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION AND ALTERNATIVES

This section describes potential environmental impacts of the proposed action and alternatives. If the proposed action is implemented, activities would be limited to existing facilities. A WERF modification would be required to allow for injection of an atomized aqueous waste stream into the incinerator lower chamber. The installation would be performed within the WERF incinerator/stabilization building and may use an existing incinerator access port. Installation work would be similar to many routine maintenance and modification actions at WERF.

A detailed analysis of potential impacts from processing INEL-generated LLW at commercial facilities is not presented in this EA because specific commercial facilities and processes have not been selected. Processing the INEL LLW waste at commercial facilities would result in emissions and impacts at rates that already occur at these facilities from their normal operations. Based on review of potentially qualified vendors, DOE does not expect that the INEL material would constitute a significant change in the overall level of operations of any likely vendor. Commercial LLW incinerators and processing facilities must operate within federal and state regulatory limits. EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61 Subpart H) require that radiological exposure from ambient air emissions from a DOE facility be less than 10 mrem/yr EDE to a member of the public. WAC, process controls, and monitoring would ensure that air emissions from the commercial facility would be within acceptable standards and license restrictions. The facility must observe applicable requirements of 40 CFR 61 Subpart I, such as monitoring the radiological effluents or proving compliance with the standard by using an approved modeling code. In addition, NRC requires an approved radioactive materials license for the operational phase of the facility prior to startup. The license or permit would embody the standards in 10 CFR 20, which cover worker safety, restricted and unrestricted area (onsite or offsite) radiation levels, and effluent limits. The WAC would be based on standards for workers and limits for unrestricted areas.

4.1 Operational Impacts of Proposed Action

All aspects of the proposed action include provisions to protect WERF and other INEL personnel and members of the public. WERF modifications and normal operational activities would proceed according to Occupational Safety and Health Act (OSHA) regulations (29 CFR 1910 and 1926). The work environment is monitored and personnel and area exposure monitoring data are obtained to verify that workplace air contaminant levels are below those prescribed by the American Conference of Governmental Industrial Hygienists (ACGIH), OSHA, and applicable DOE standards. Worker exposure to radioactivity would be as low as reasonably achievable and below the DOE radiation protection standards for occupationally related external and internal exposures. WERF operating personnel would be qualified hazardous material and radiation workers.

Primary impacts from WERF operations would be from airborne emissions of radionuclides (from incinerating, stabilizing, compacting, and sizing), hazardous materials, and criteria pollutants. There are two emission points for these activities: the WERF east stack exhausts ventilation air from

the compaction and sizing building, and the north stack discharges incinerator offgas and ash stabilization room ventilation air from the incineration/stabilization building. Offgas and ventilation air at both buildings are processed through a baghouse, prefilter, and HEPA filter before being discharged to the atmosphere. A preventive maintenance program ensures that all HEPA filters are routinely tested for efficiency to avoid failure. Differential pressure measurements, flow measurements, and continuous, stack sampling monitor any degradation of the filtration system. Additionally, an isokinetic stack sampling system monitors actual stack emissions of radioactive material.

Ventilation air from the incinerator room is HEPA filtered before being exhausted to the WERF south stack (shown in Figure 3). The south stack formerly exhausted the compactor room in the incinerator building; however, as part of WERF upgrades, the compactor was moved to the sizing/compaction building. The potential for radiological emissions from the south stack has been analyzed and this stack is exempt from 40 CFR 61 Subpart H monitoring requirements; however, for process control purposes, a non-isokinetic sampling system is used to monitor radioactive particulates.

4.1.1 Impacts from Waste Incineration

This EA is intended to provide a reasonable upper bound to potential impacts; therefore, the source term for the WERF incinerator is based on conservative assumptions. For radionuclides, a maximum annual release for each constituent was developed. For hazardous waste constituents, feed rates were determined based on the maximum possible incinerator capacity. Ambient concentrations resulting from releases were calculated and compared to occupational exposure and other appropriate limits. Incineration rates of chlorinated hydrocarbons are governed by the release limit for HCl (40 CFR 264), which is formed during incineration of chlorinated compounds. The incinerator is assumed to operate 240 days per year. Approximately 40 days would be used for MLLW incineration based on current generation rates; the remainder would be for LLW. If MLLW generation rates increase, additional treatment time would be required. The impact analysis in this section conservatively assumes that all incinerated waste is MLLW.

Combustion offgases from the incinerator are cooled using an air-to-air heat exchanger supplemented by dilution. These gases then pass through a baghouse filter system, prefilters, and HEPA filters prior to being discharged from the WERF north stack. The HEPA filter system is tested and certified to provide a minimum particulate removal efficiency of 99.97% for particulates 0.3 μm (0.3 millionths of a meter). During incineration of MLLW, in accordance with RCRA permits, carbon monoxide levels would be continuously monitored to ensure proper combustion efficiency of the incinerator.

Administrative and mechanical controls would ensure that incinerator releases are within the bounds presented in this EA. A burn plan would be developed prior to incinerating waste, taking into consideration detailed waste information provided by waste generators, and release limits described in the following sections. Monitoring systems for both radiological and nonradiological emissions would verify that the incinerator and support systems are operating properly.

4.1.1.1 Radiological Impacts. INEL is subject to 40 CFR 61 Subpart H, which limits radiological releases from DOE facilities to an EDE of 10 mrem/yr at the nearest site boundary. EPA determined that this level of exposure (10 mrem/yr) would result in a lifetime risk of contracting fatal cancer for an individual exposed for 70 years of less than 1E-04, or one in ten thousand. Additionally, if a single stack or vent within a facility has the potential to exceed 0.1 mrem/yr without taking into account pollution control equipment, continuous monitoring is required. The WERF east and north stacks are required to comply with the monitoring requirements in 40 CFR 61 Subpart H. The monitoring systems have been installed and are operational.

Radionuclide distributions expected in wastes were derived, for many of the nuclides, from analysis of fly ash from previous incinerator campaigns (Atwood, 1992). Other nuclides were added to the source term based on knowledge of INEL waste-generating processes. Release rate limits for these nuclides (Table 2) were established such that the total dose rate from all nuclides would not exceed a dose of 0.1 mrem/yr, as modeled by the CAP-88 computer code (EPA, 1989a), to the maximally exposed individual (MEI) at the INEL boundary (12.1 km) (Staley, 1992a). The release limits in Table 2 apply to both LLW and MLLW.

Waste feed stocks may contain limited quantities of gaseous/volatile radionuclides. Carbon-14, iodine-129, and tritium are gaseous nuclides that would not be captured by the offgas treatment system; hence, release rates are assumed to be equal to processing rates for these nuclides. Cesium would volatilize (i.e., become a gas) at incinerator temperatures (boiling point of cesium = 669°C), but would condense in the offgas treatment system as the offgas is cooled to less than 260°C prior to HEPA filtration.

The CAP-88 computer code (EPA, 1989a) was used to model dispersion and doses from all exposure pathways as a result of the releases listed in Table 2. Doses are presented in Table 3 for three receptor groups: a) a worker 100 m from the stack[a], b) a hypothetical MEI living at the INEL boundary location where maximum airborne concentrations of incinerator releases would occur (12.1 km south-southwest of WERF), and c) the population living within 80 km of WERF (based on 1990 census data). The calculated EDE to the 100-m worker is 1.1 mrem/yr, far below the DOE radiation worker limit of 5,000 mrem/yr, and the 500-mrem/yr limit for nonradiation workers. The EDE to the MEI would be 9.6E-02 mrem/yr, 100 times lower than the EPA NESHAP annual limit for the public of 10 mrem/yr. The collective dose to the population within an 80-km radius of WERF (160,120 persons) would be 3.7E-01 person-rem/yr EDE, far below doses received from background radiation in southeast Idaho (Section 3.5). Based on a cancer risk factor of 5E-04 deaths/person-rem (NRC, 1991), the increase in cancer incidence in the population from incinerator releases would be 1.9E-04 deaths/yr. This represents a 0.0007% increase over expected cancer deaths in the 80-km population from all other sources.

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a. The minimum distance of 100 m is frequently used in environmental impact analyses because Gaussian dispersion equations used in most dispersion codes are not intended for nearby dispersion calculations. One hundred meters is considered the minimum distance for which reasonable dispersion estimates can be obtained.

Table 2. Radionuclide release rate limits from the WERF north stack.

Release rate nuclide	Ci/yr	Release rate nuclide	Ci/yr
Ag-110M	1.22E-01	Pa-233	1.26E-05
Am-241	1.52E-04	Pa-233	1.92E-06
Ba-137M[a]	2.95E-01	Pa-234M	1.09E-03
Ba-140	1.26E-02	Pb-210	1.26E-04
Bi-212	1.26E-04	Pb-212	1.26E-04
C-14	1.26E-02	Po-210	1.26E-04
Ce-141	1.26E-03	Pr-144	3.57E-03
Ce-144	3.57E-03	Pu-238	1.03E-03
Cm-244	9.34E-05	Pu-239	3.06E-04
Co-57	1.26E-03	Ra-224	1.26E-04
Co-58	1.26E-03	Rh-106	1.53E-02
Co-60[a]	7.32E-02	Ru-103	1.26E-03
Cr-51	1.26E-02	Ru-106	1.53E-02
Cs-134	1.52E-02	Sb-124	1.26E-03
Cs-137[a]	2.95E-01	Sb-125	2.65E-02
Eu-152	2.61E-04	Sr-90	1.16E-02
Eu-154	3.30E-04	Tc-99	1.26E-03
Eu-155	1.10E-04	Th-228	1.26E-04
Fe-55	1.26E-02	Th-231	9.72E-05
Fe-59	1.26E-02	Th-232	8.95E-06
H-3	1.26E+00	Th-234	1.09E-03
Hf-181	1.26E-02	Tl-208	1.26E-04
Hg-203	1.26E-03	U-234	1.35E-03
I-129	1.26E-03	U-235	9.72E-05
Ir-192	1.26E-03	U-238	1.09E-03
K-40	1.26E-02	Y-90	1.16E-02
La-140	1.26E-02	Zn-65	4.03E-02
Mn-54	1.70E-03	ZR-95	1.26E-02
Nb-95	1.26E-02	Total	2.35E+00
Ni-63	1.26E-02		
Np-237	1.26E-05		

a. Nuclides that contribute greater than 10% of the total dose.

It should be noted that the release rates in Table 2 and doses in Table 3 represent the maximum limit for WERF and are far greater than those expected from foreseeable incinerator operations. Assuming a nominal efficiency of the WERF offgas treatment system of 99.9%, to reach Table 2

Table 3. Estimated maximum dose consequences to three receptor groups from LLW and proposed MLLW incineration and LLW compaction and sizing at WERF.

	Incineration	Compaction/ sizing	Annual total	Project total[a]
Worker				
Dose (mrem)	1.1E+00	1.0E+00	2.1E+00	4.2E+01
Cancer risk[b]	4.4E-07	4.0E-07	8.4E-07	1.7E-05
MEI				
Dose (mrem)	9.6E-02	6.8E-02	1.6E-01	3.2E+00
Cancer risk[b]	4.8E-08	3.4E-08	8.2E-08	1.6E-06
Population				
Dose (person-rem)	3.7E-01	2.0E-01	5.7E-01	1.1E+01
Cancer risk[b,c]	1.9E-04	1.0E-04	2.9E-04	5.8E-03

a. Assumes 20-year project life.

b. Based on 4E-04 and 5E-04 cancers/person-rem for workers and the public, respectively (NRC, 1991).

c. Estimated additional number of fatal cancers per year in the affected population of 160,120 persons (1990 census data). The risk to an individual (increased cancer risk per person) is the stated risk (total cancers) divided by the population size. For example, the "annual total" risk (from compaction and sizing releases) of an individual developing fatal cancer equals 1.8E-09 (2.9E-04 ÷ 160,120), or about 1 in 552,000,000.

release rates, wastes containing over 1,076 Ci (excluding carbon-14, iodine-129, and tritium, which are assumed to volatize and pass through the filtration system unabated) distributed among Table 2 nuclides would have to be incinerated per year. For perspective, from 1984 to 1991, the WERF incinerator processed wastes containing a *total* of 17.9 Ci in 9,200 m^3 of waste. At a conservative throughput of 4 m^3/hr for 5,760 hr/yr, 23,000 m^3 could be incinerated. At radiation levels of past waste, this would equate to only 45 Ci of activity processed per year. Future wastes are expected to be similar to past wastes in composition because wastes will be from the same or similar waste-generating processes; no new facilities or processes are planned at the INEL that would change the radioactive characteristics of waste received for processing at WERF. Planned environmental restoration and decommissioning and decontaminating activities will generate incinerable waste similar to past processed wastes.

4.1.1.2 Nonradiological Impacts. Nonradiological releases from waste incineration would consist of small fractions of waste constituents and products of combustion, including criteria pollutants.

The WERF incinerator is designed and will be operated to achieve a 99.99% minimum destruction removal efficiency (DRE) for principal organic hazardous constituents as required under RCRA. The trial burn and emission monitoring programs required by regulations would be conducted to show that WERF emissions would be within RCRA permit requirements. During the trial burn, emissions would be analyzed for HCl, total particulates, oxygen, carbon monoxide, and principal organic hazardous constituents. Carbon monoxide measurements would verify that the incinerator is operating with adequate combustion efficiency.

The WERF incinerator may burn dioxin precursors such as benzene. EPA (1990) has found that dioxins typically form at temperatures above 260°C, and that dioxin formation is minimized if offgas temperatures are reduced to below 260°C before entering air pollution control devices. Dioxin emissions from WERF are not expected to be significant. This is because, when burning dioxin precursors, the incinerator offgas would be cooled to less than 260°C before entering the air pollution control equipment.

Releases of criteria pollutants (carbon monoxide, sulfur dioxide (SO_2), nitrogen oxides (NO_x), and particulates) were evaluated for combined WERF operations (Sterling, 1992). The emission points of criteria pollutants are the north stack, the east stack, and the standby diesel generator exhaust. Table 4 compares estimated annual releases of criteria pollutants with State of Idaho Significant Emission Rates [State of Idaho Division of Environmental Quality (IDEQ), Idaho Administrative Procedures Act (IDAPA) 16.01.01003,86.A]. For proposed, new or modified facilities, emissions exceeding the Idaho Significant Emission Rates require a Prevention of Significant Deterioration Review. Estimated emissions during proposed normal operations of WERF facilities would be well below these emission rates. Calculation of ambient air concentrations and comparison to National Ambient Air Quality Standards were considered for these releases. These standards apply to the *total* background plus increases in ambient concentrations. Background data are unavailable for criteria pollutants at appropriate public receptor locations. The potential receptor locations are within areas of air quality attainment. The conservatively estimated emissions from WERF would be sufficiently low (i.e., well below the Idaho Significant Emissions Rate) so that WERF emissions would not be expected to lead to nonattainment of National Ambient Air Quality Standards for criteria pollutants.

The lists of hazardous MLLW constituents to be incinerated at WERF were compiled from several sources including analyses of stored wastes, manifest records, and assigned waste codes. Hazardous waste constituents were categorized by chlorinated organic compounds, nonchlorinated organic compounds, and metals. Table 5 presents the most common compounds that are expected to be incinerated at WERF. The RCRA Part A Permit for WERF contains a complete list of compounds that may be treated.

Table 4. Maximum release rates of criteria pollutants from routine WERF operations.

Pollutant[a]	WERF release rate (ton/yr)	Idaho significant emissions rate (ton/yr)
CO[b]	1.76E+01	1.0E+02
NO_x[c]	1.25E+01	4.0E+01
SO_2[d]	9.73E+00	4.0E+01
PM[e] (total)		2.5E+01
PM-10[f]	8.09E+00	1.5E+01

a. Metals included in Table 6.

b. Carbon monoxide.

c. Nitrogen oxides.

d. Sulfur dioxide.

e. PM = Particulate matter.

f. PM less than 10 micrometers.

The incineration feed rate for chlorinated organic compounds would be governed by the release rate limit for HCl of 1.8 kg/hr (40 CFR 264.343). For simplicity, the maximum feed rate for chlorinated organics is assumed equal to the release limit or 1.8 kg/hr. Assuming the liquid feed capacity of the incinerator is 50 kg/hr, it is possible that this limit could be exceeded if sufficiently high concentrations of liquid chlorinated organics were present in the wastes (most of the chlorinated organics are liquids). HCl emissions would be controlled by blending down concentrations of chlorinated hydrocarbons in liquid waste and/or controlling the feed rate to stay below the 1.8 kg/hr HCl release rate limit. Releases of 1.8 kg/hr HCl would result in a worst-case (under fumigation conditions) airborne concentration at the 100-m worker location of 0.30 mg/m^3, well below the threshold limit value (TLV) short-term exposure limit for HCl of 7 mg/m^3 (ACGIH, 1991).

Maximum release rates for the nonchlorinated organics listed in Table 5 were used to calculate air concentrations at 100 m from the stack and at the MEI location to compare to TLVs (ACGIH, 1991). In addition, the IDEQ has established or proposed acceptable ambient concentrations (AACs) for noncarcinogens and acceptable ambient concentrations for carcinogens (AACCs). Note that these

Table 5. AACs[a] and TLVs (in mg/m^3) for representative nonchlorinated and chlorinated organic compounds potentially released during routine mixed waste incineration.

Compound non-chlorinated organics	AAC	TLV[b]	
2-Butanone (Methyl Ethyl Ketone)	5.9	590	
Toluene	3.75	147	
Acetone	17.8	1780	
Hexane	1.8	176	
Hexone	2.05	205	
Xylene (M,P,O)	4.384	434	
Tributyl Phosphate	0.025	2.2	
Methanol	2.62	262	
Oxalic Acid	0.01	1	
2-Butoxy Ethanol	1.21	121	Skin
Benzene	1.2E-04[c]	32	Suspected carcinogen
Ethylbenzene	4.384	434	
Bis (2-ethylhexyl)-phthalate	4.2E-03[c]	10	
Phenol	0.19	19	Skin
Benzo (A) Anthracene	1.1E-06[c]	0.2	Suspected carcinogen
Benzo (A) Pyrene	3.0E-07[c]	0.2	PEL[d] suspected carcinogen
Benzo (B) Fluoranthene		0.2	Suspected carcinogen
Benzo (G,H,I) Perylene		0.2	Suspected carcinogen
Diethyl Phthalate	0.05	5	
Fluoranthene		0.2	Suspected carcinogen
Fluorine	0.02	1.6	
Napthalene	0.5	52	
Chlorinated Organics			
Methylene Chloride (Dichloromethane)	2.4E-04[c]	174	Suspected carcinogens
Tetrachloroethylene	2.1E-03[c]	339	Suspected carcinogens
1,1,1 Trichloroethane	19.1	1,910	Suspected carcinogens
Trichloroethylene	7.7E-03[c]	269	Suspected carcinogens
1,1,2 Trichloro -1,2,2 Trifluoroethane (Freon)	76.7	7670	
1,1 Dichoroethylene	2.0E-05[c]	20	
1,2 Dichoroethylene	7.9	793	
1,1 Dichloroethane	3.8E-05[c]	810	(405 NIC[e] TWA[f] value)
Chloroform	4.3E-05[c]	49	Suspected carcinogen

Compound non-chlorinated organics	AAC	TLV[b]	
Chlorobenzene	3.5	46	
1,2 & 1,3 & 1,4	3.0		
Dichlorobenzene	4.5	150	
		451	(60 NIC[d] TWA[e] value)
Dichlorodifluoromethane	49.5	4,950	
1,2,4 Trichlorobenzene	0.4	37	Ceiling value

a. Limits are acceptable ambient concentrations (AACs).

b. Short-term exposure limit; otherwise Time-weighted average (ACGIH, 1991), except as noted.

c. Limit is proposed AACC-Acceptable Ambient Concentration for a Carcinogen.

d. PEL = Permissible exposure limit (40 CFR 1910.1000).

e. NIC = Notice of Intended change in ACGIH values.

f. TWA = Time-weighted average.

IDEQ levels apply to *ambient* air (i.e., air at locations where the public has access). Therefore, they apply at the MEI location, but not at the 100-m location where the public is not routinely allowed.

The maximum feed rate for each nonchlorinated compound is based on assuming that a full drum of liquid MLLW containing a single organic compound would be fed to the incinerator at a rate of 50 kg/hr. It was assumed that the incinerator would operate at the required DRE of 99.99% for organic compounds. The RSAC-4 computer code[b] was used to generate short-term atmospheric dispersion factors for both receptors (Staley, 1992b). In accordance with National Oceanic and Atmospheric Administration guidance (Start, 1993), a wind speed of 0.5 m/s was used in the code for the 100-m location, and a wind speed of 2.0 m/s was used for the MEI location. The code was run using fumigation (worst case) conditions at 100 m, and Stability Class F (stable atmospheric conditions) for the MEI location. Atmospheric dispersion factors were calculated using Markee sigma values, appropriate for 1-hour or longer releases. Atmospheric dispersion factors used for calculating short-term exposures are 6.0E-04 and 8.4E-06 s/m^3 (seconds per cubic meter) for the 100-m and MEI locations, respectively.

For calculating average annual exposures to the MEI, the CAP-88 computer code was used to generate a dispersion factor, 9.8E-08 s/m^3. This code uses 5-year average, site-specific meteorological data. Further, the emission rate for all contaminants was adjusted to an average annual emission rate; that is, total emissions over the 240 days of WERF operations were averaged over 365 days. Average annual exposures are appropriate for comparison to IDEQ AACs and AACCs and for calculating cancer risks.

b. RSAC-4 is a Gaussian plume dispersion code that has been verified and validated in accordance with the guidelines in ANSI/ANS Standard 10.4-1987 (Wenzel, 1990).

Because the assumed feed rate, DRE, and applied dispersion factors are identical for all compounds, concentrations would also be identical. The concentration at the 100-m location was calculated to be 8.3E-04 mg/m^3, and can be compared to TLV short-term exposure limits (STEL), or TLV time-weighted averages (TWA) (Table 5): The calculated concentration is 200 times below the lowest TLV. The maximum hourly average concentration at the MEI location would be 1.2E-05 mg/m^3, about 16,000 times below the lowest TLV in Table 5. The *average annual* concentration at the MEI location would be 9.0E-08 mg/m^3, 100,000 times lower than the lowest IDEQ proposed AAC, and below all proposed AACCs. There would be no health effects to either receptor from such low concentrations.

For metals, feed rate limits (Table 6) were calculated based on RCRA "adjusted Tier I" methodology 0(EPA, 1989d). This is a risk-based approach developed by EPA to limit metals emissions from hazardous waste incinerators to ensure that ambient levels at a public receptor location do not exceed Reference Air Concentrations, which are intended to be protective of human health. For noncarcinogen metals, however, this methodology resulted in very high feed rates (Table 6). For those metals, a more restrictive administrative feed limit of 200 g/hr was used.

The incinerator was assumed to process metals at the WERF administrative feed rates presented in Table 6. The baghouse and HEPA filter were each credited with a removal efficiency of 95% for barium, beryllium, silver, and chromium; 50% for mercury; and 90% for the remaining metals. The calculated maximum hourly average concentrations at the 100-m and MEI locations are below all TLVs. Annual average concentrations of metals at the MEI location would be at least 15 times lower than IDEQ proposed AACCs, and at least 100 times lower than proposed AACs.

The NESHAP include limits for beryllium and mercury; however, the limit for beryllium applies to incinerating wastes generated by a "foundry, extraction plant, ceramic plant, or propellant plant." Wastes to be incinerated at WERF do not originate at such facilities; therefore, WERF does not fit the definition of a beryllium waste incinerator. DOE has verified this determination with EPA, Region X (Rothman, 1992). In the case of mercury, NESHAP Subpart E applies to sludge incineration plants and not to hazardous waste incinerators.

Some of the organic compounds and metals to be incinerated at WERF are known or suspected carcinogens. Carcinogenic risks to the MEI (Table 7) were calculated from airborne concentrations of 9.0E-08 mg/m^3 for nonchlorinated compounds, and Table 6 annual average values for metals at the MEI location. For *chlorinated* suspected carcinogens, the airborne concentration was determined by applying the appropriate atmospheric dispersion factor (9.0E-08 s/m^3) to a release rate calculated from the feed rate limit of 1.8 kg/hr, and a 99.99% DRE. The annual average concentration of suspected chlorinated carcinogens at the MEI location was estimated to be 3.2E-09 mg/m^3. Carcinogenic risks estimate the incremental (above background) probability of an individual developing cancer over a lifetime as a result of exposure to potential carcinogens and are calculated by summing carcinogenic risks due to individual waste constituents (EPA, 1989c). Individual constituent risks are the product of the chronic daily intake of a constituent and the slope factor (EPA, 1989c; 1992). Chronic daily intakes are a function of air concentrations previously presented. Slope factors represent an upper 95th percentile confidence limit of the probability of carcinogenic response based on experimental data used in a linear multistage model (EPA, 1989c).

Table 6. Calculated concentrations of WERF metals, based on maximum allowable feed rates, compared to TLVs and AACs.

	Feed rates		Concentration (mg/m3)				
			Annual average		Hourly average		
Metal	RCRA limit[a] (g/hr)	WERF limit (g/hr)	MEI	IDEQ toxics rules	100 m	MEI	TLV
Carcinogens				**AACC**			
Arsenic	8.4E+01	8.4E+01	1.5E-08	2.3E-07	1.4E-04	2.0E-06	0.2, TWA for inorg. cmpds.; 0.01 OSHA PEL[b]
Beryllium	1.5E+02	1.5E+02	6.7E-09	4.2E-06	6.2E-05	8.7E-07	0.002 TWA
Cadmium	2.0E+02	2.0E+02	3.6E-08	5.6E-07	3.3E-04	4.7E-06	0.05 TWA for respir. Cd; 0.002 NIC[c]
Chromium	3.0E+01	3.0E+01	1.3E-09	8.3E-08	1.3E-05	1.8E-07	0.5 TWA; 0.05 TWA for Cr(VI) H_2O cmpds
Noncarcinogens				**AAC**			
Antimony	1.1E+04	2.0E+02[d]	3.6E-08	5.0E-03	3.3E-04	4.7E-06	0.5 TWA
Barium	1.8E+06	2.0E+02[d]	9.0E-09	5.0E-03	8.3E-05	1.2E-06	0.5 TWA
Lead	3.2E+03	2.0E+02[d]	3.6E-08	--	3.3E-04	4.7E-06	0.15 TWA for Pb, inorganic dusts/fumes; 0.05 OSHA PEL[b]; 0.01 OSHA PEL[b] for lead arsenate; 0.05 TWA for lead chromate
Mercury	1.1E+04	2.0E+02[d]	9.0E-07	1.0E-04	8.4E-03	1.2E-04	0.05 TWA
Silver	1.1E+05	2.0E+02[d]	9.0E-09	1.0E-04	8.3E-05	1.2E-06	0.1 TWA; 0.01 OSHA PEL[b]; 0.01 TWA for Ag soluble compounds
Thallium	1.1E+04	2.0E+02[d]	3.6E-08	1.0E-03	3.3E-04	4.7E-06	0.1 TWA

a. Based on RCRA adjusted Tier I methodology.

b. PEL = Permissible exposure limit.

c. NIC = Notice of intended change.

d. WERF administrative limit (see text section 4.1.1.2).

Table 7. Carcinogenic risk to the MEI from maximum releases of nonradiological carcinogens from the WERF incinerator.

Carcinogen	Carcinogenic risk
Organics	
Benzene	7E-10
Benzo(a)pyrene	2E-07
Carbon Tetrachloride	5E-11
Chloroform	7E-11
1,1 Dichloroethylene	1E-09
Metals	
Arsenic	2E-07
Beryllium	2E-08
Cadmium	6E-08
Chromium	2E-08
Annual cancer risk	5E-07

The annual carcinogenic risk (5E-07) to the MEI from nonradiological releases resulting from proposed MLLW incineration was added to the risk from radiological releases (8.2E-08 from Table 3). This combined annual risk (total Table 3 and Table 7) would be 5E-07, or 5 in 10,000,000. Assuming WERF operates for 20 years, the lifetime increased cancer risk from WERF would be 1E-05 or 1 in 100,000. For perspective, EPA (1989b) has stated that an increased lifetime cancer risk of 1E-04 (1 in 10,000) is an acceptable level of risk, and it has based standards for exposures to radiation and nonradiological carcinogens on this risk level. By definition, the MEI is subject to a much higher risk than any actual member of the public. Therefore, the cancer risk to the population surrounding WERF would also be below the level determined by EPA to be acceptable.

4.1.2 Impacts from Compaction and Sizing

Compaction and sizing operations are performed on LLW only. The sizing room and compactor ventilation air are filtered by two baghouses in series and a HEPA filter which has a combined particulate removal efficiency of 99.99% using EPA prescribed filtration efficiencies for NESHAP.

An approach similar to that used for determining incinerator emission impacts was used for compaction and sizing impacts: release limits for known and possible radionuclides were established that would not exceed a dose of 0.1 mrem/yr, as modeled by the CAP-88 computer code (EPA, 1989a), to the MEI at the INEL boundary. These release rates are summarized in Table 8. Doses to the MEI, as well as to the 100-m worker and population within 80 km of WERF resulting from

Table 8. Estimated radionuclide release rate limits from the WERF east stack.

Nuclide	Release rate (Ci/y)	Nuclide	Release rate (Ci/y)
Ag-110M[a]	1.09E-01	Pa-234	1.91E-06
Am-241	1.51E-04	Pa-234M	1.08E-03
Ba-137M	3.97E-02	Pa-233	2.83E-05
Ba-140	2.83E-03	Pb-210	2.83E-04
Bi-212	2.83E-04	Pb-212	2.83E-04
C-14	2.83E-03	Po-210	2.83E-04
Ce-141	2.83E-03	Pr-144	3.58E-03
Ce-144	3.58E-03	Pu-238[a]	1.02E-03
Cm-244	9.28E-05	Pu-239	3.04E-04
Co-57	2.83E-03	Ra-224	2.83E-04
Co-58	2.83E-03	Rh-106	1.54E-02
Co-60[a]	7.04E-02	Ru-103	2.83E-03
Cr-51	2.83E-03	Ru-106	1.54E-02
Cs-134	1.01E-02	Sb-124	2.83E-03
Cs-137	3.97E-02	Sb-125	2.66E-02
Eu-152	2.62E-04	Sr-90	2.04E-03
Eu-154	3.31E-04	Tc-99	2.83E-03
Eu-155	1.10E-04	Th-228	2.83E-04
Fe-55	2.83E-03	Th-231	9.66E-05
Fe-59	2.83E-03	Th-232	8.90E-06
H-3	2.83E+00	Th-234	1.08E-03
Hf-181	2.83E-03	Tl-208	2.83E-04
Hg-203	2.83E-03	U-234	1.34E-03
I-129	2.83E-03	U-235	9.66E-05
Ir-192	2.83E-03	U-238	1.08E-03
K-40	2.83E-03	Y-90	2.04E-03
La-140	2.83E-03	Zn-65	1.62E-02
Mn-54	1.71E-03	Zr-95	2.83E-03
Nb-95	2.83E-03		
Ni-63	2.83E-03	TOTAL	3.25E+00
Np-237	2.83E-05		

a. Nuclides that contribute to greater than 10% of the total dose.

Table 8 releases, are summarized in Table 3. All doses would be well below DOE and EPA guidelines for worker and public exposures.

Using the assumed radioactive particulate resuspension rate of 1% (Elder et al., 1986) and the rated removal efficiency of 99.99%, wastes containing over 100,000 Ci of nuclides would have to be processed annually through compaction and sizing operations to reach Table 8 release rates. Future wastes are expected to be similar to past wastes, and there are no foreseeable circumstances that could result in processing wastes with this high level of radionuclides. To illustrate, all past compactor operations have processed approximately 3,500 m^3 of uncompacted LLW, containing only 25.7 Ci of radioactivity. The predicted future compaction rate is approximately 1,200 m^3/yr but could range up to 2,000 m^3/yr, equivalent to approximately 15 Ci of radioactivity per year (at past activity levels). Past sizing operations have processed approximately 4,700 m^3 of metal, with a total activity of 1.4 Ci. Future sizing rates are predicted to be approximately 420 m^3/yr, but past experience has shown this rate could range up to 880 m^3/yr, equivalent to 0.26 Ci (at past activity levels).

4.1.3 Cumulative Impacts

In considering cumulative impacts, DOE reviewed all known and reasonably foreseeable emission sources at INEL. The cumulative radiation dose equivalent from all atmospheric releases from the entire INEL is reported annually in environmental reports (e.g., DOE, 1991b,c). In addition to those reported doses, various major planned activities on the INEL would add to the cumulative dose. Planned activities are shown in Table 9. The listed doses are considered to be small. Other sources (e.g., Test Reactor Area and Naval Reactor Facility) are included in the "present INEL" dose. Activities at Test Area North (TAN) in the northern part of INEL are not considered in this analysis (except as part of the INEL total for existing activities). Doses from TAN are not additive because of the distance from WERF (approximately 35 km) and the different MEI location for TAN releases.

Operation of WERF at the maximum release rates in Tables 2 and 8 could result in maximum added EDE to the MEI of 0.16 mrem/yr. However, as explained in Sections 4.1.1.1 and 4.1.2, releases and resulting doses are expected to be far below those presented here. Also, it should be noted that the MEI locations are different for each INEL facility, so doses are not additive. Doses presented in Table 9 from cumulative INEL emissions are considered to be low.

Normal operations (incineration, solidification, sizing, and compaction) at WERF are estimated to result in 2.9E-04 additional latent cancer fatalities per year from radiological emissions to the affected population of 160,120 persons (1990 census data). This is equal to 1.8E-09 fatal cancers per person. The increased risk of an individual developing fatal cancer as a result of WERF emissions would be approximately 1 in 552,000,000. In this same population, an average 18.6 cancer deaths occur each year, based on 1983 EPA/National Cancer Institute (NCI) data from eastern Idaho (EPA and NCI, 1983). Therefore, activities at WERF would cause a 0.0016% statistical increase in cancer deaths and would not be a significant contributor to, nor discernable in, the normal cancer fatality rate in the surrounding population.

Table 9. Estimated cumulative radiological doses from existing INEL activities, proposed RWMC remedial activities, and WERF operations.

Activity/facility	EDE	
	MEI (mrem/yr)	Population (person-rem/yr)
Present INEL[a]	4.1E-03	—[b]
RWMC retrieval and remediation[c,d]	1.3E-01	2.7E-01
Test reactor area evaporation basin[d]	1.6E-04	—[b]
ICPP HLW[e] tank farm replacement[d]	1.1E-03	5.2E-03
WERF[d] incineration	<9.6E-02	<3.7E-01
Compaction, sizing	<6.8E-02	<2.0E-01
Total	<3.0E-01	8.5E-01

a. Calculated values based on measured emissions (DOE, 1992a).
b. Not calculated in DOE, 1992a.
c. Estimates may change if additional project proposals are developed or plans for listed projects are modified.
d. Calculated values based on maximum release scenarios.
e. ICPP HLW-Idaho Chemical Processing plant high level waste.

WERF would add an insignificant increment to INEL NO_x and SO_2 emissions. In 1990, INEL operations emitted approximately 173 tons of NO_x and 134 tons of SO_2 (DOE, 1991b); the maximum estimated WERF contribution to these emissions was 12.5 and 9.7 tons, respectively.

LLW transportation activities associated with WERF operations are estimated to result in a 0.000034% to 0.000091% statistical increase in cancer deaths. This would not be a significant contributor to, nor discernable in, the normal cancer fatality rate.

4.2 Impacts of Transportation of LLW to and from INEL

Preparation and transportation of LLW for offsite processing would be performed in accordance with applicable sections of 10 CFR and 49 CFR 170-179. Radiation levels on the outer trailer surface would not exceed 200 mrem/hr on contact or 10 mrem/hr at 2 m; levels "at any normally occupied position" in the vehicle would not exceed 2 mrem/hr. These maximum allowable levels are assumed for this analysis. Known treatment facilities capable of processing INEL LLW are all within 3,200 km

of INEL. However, 3,750 km was conservatively assumed for calculating impacts of LLW transportation to bound the onsite transportation and possible routing alternatives.

The number of trips to and from the commercial facility was estimated based on the volume, density, and volume reduction factors of LLW. The number of trips was expressed as a range (Table 10) because of the dependence on the volume and mass (weight) capacity of the transportation trailer. Estimates are provided for "Year 1", when shipment of INEL's current LLW inventory would occur, and "Years 2 through 20," when routine annual shipments would occur. The estimated rate of INEL LLW shipments is small compared to the annual average of 2 million non-DOE radioactive shipments per year. Many of these non-DOE shipments, however, are small quantities such as United Parcel Service parcels (Wolfe, 1984).

Transportation of LLW from INEL to a commercial processor may result in radiological exposures to truck drivers and the public along the route (radiological-nonoccupational) (Table 10). In addition to the incident-free or normal occurrences, a mishap or accident could occur in route. The health effects from normal and accidental occurrences have been assessed based on effect per km transported (Rao et al., 1981; Wolfe, 1984). Radiological effects are expressed in person-rem per km and nonradiological effects as consequences per km. A consequence is a deleterious health effect, which results in death after a period of time. The last column of Table 10 and footnote g summarize all effects in terms of deaths per year and deaths over the projected 20-year campaign.

Table 10 shows that the potential impacts of the proposed LLW shipments to and from a commercial processing facility would be extremely small. The maximum cumulative radiological health risk to transportation workers from incident-free waste shipping over the 20-year campaign is estimated to be 0.09 deaths. The maximum radiological and nonradiological health risk to the public from incident-free waste shipping over 20 years is estimated to be 0.82 deaths. Up to 0.77 deaths may also occur from transportation accidents. It should be noted, however, that the analysis presented here is considered conservative; actual effects would likely be less. For perspective, in the same population about 3,000 deaths from cancer from all other sources would be expected over the 20-year shipping campaign. Other studies that have reported the impacts from transportation of radioactive materials have also concluded that the health effects are minimal (NRC, 1977; DOE, 1980).

Only limited quantities (<5 m^3/yr) of non-INEL MLLW would be shipped to INEL. It is conceivable that these wastes could be shipped in as small an increment as 1 drum per shipment. One drum is equal to approximately 0.2 m^3; therefore, up to 25 shipments may occur to reach the 5 m^3/yr limited quantity. Because these shipments would involve very small quantities of MLLW, it is assumed that per km impacts from shipping MLLW would be bounded by per km impacts from transporting trailers filled with LLW; for conservatism, this analysis assumes equal per km impacts. It is also assumed the maximum trip distance is 3,750 km, for MLLW. From these assumptions, the annual number of radiological, nonoccupational, incident-free cancer deaths expected from 25 shipments of MLLW would be 25 x 3,750 km x 2E-04 person-rem/km x 5E-04 cancers/person rem = 9.4E-03, representing a 0.0000017% increase over cancer deaths normally expected in the affected populations.

Table 10. Summary of health effects from transportation of LLW.[a,b,c]

Type of effect		Unit dose or consequence[d]	Effect per trip[d]	Cancer deaths per trip[e]	Type of LLW[f]	Effect per year	Deaths/year
Year 1							
Radiological-occupational	Incident-free	3E-5 person-rem per km	1.1E-1 person-rem	4.5E-05	Incinerable (87-96)	9.6-10.6 person-rem	0.00392-0.00432
					Compactable (41-46)	4.5-5.1 person-rem	0.00185-0.00207
					Sizable (51-57)	5.6-6.3 person-rem	0.00230-0.00257
Radiological-non-occupational[f]	Incident-free	2E-4 person-rem per km	7.5E-01 person-rem	3.8E-4	Incinerable (87-96)	65.3-72.0 person-rem	0.0331-0.0365
					Compactable (41-46)	30.8-34.5 person-rem	0.0156-0.0175
					Sizable (51-57)	38.3-42.8 person-rem	0.0194-0.0217
	Accident	7E-6 person-rem per km	2.6E-02 person-rem	1.3E-5	Incinerable (87-96)	2.3-2.5 person-rem	0.00113-0.00125
					Compactable (41-46)	1.1-1.2 person-rem	0.000533-0.000598
					Sizable (51-57)	1.3-1.5 person-rem	0.000663-0.000741
Non-radiological	Incident-free	5E-9 consequence per km	1.9E-5 consequence		Incinerable (172-190)	0.00327-0.00361 consequence	0.00327-0.00361
					Compactable (68-76)	0.00129-0.00144 consequence	0.00129-0.00144
					Sizable (84-94)	0.00160-0.00180 consequence	0.00160-0.00180
	Accident	3E-8 deaths per km	1.1E-4 deaths		Incinerable (172-190)	0.0189-0.0209 deaths	0.0189-0.0209
					Compactable (68-76)	0.00748-0.00836 deaths	0.00748-0.00836
					Sizable (84-94)	0.00924-0.0103 deaths	0.00924-0.0103
Years 2–20							
Radiological-occupational	Incident-free	3E-5 person-rem per km	1.1E-1 person-rem	4.5E-5	Incinerable (35-39)	3.9-4.3 person-rem	0.00158-0.00176
					Compactable (28-32)	3.1-3.5 person-rem	0.00126-0.00144
					Sizable (22-24)	2.4-2.6 person-rem	0.000990-0.00108
Radiological-non-occupational[f]	Incident-free	2E-4 person-rem per km	7.5E-1 person-rem	3.8E-4	Incinerable (35-39)	26.3-29.3 person-rem	0.0133-0.0148
					Compactable (28-32)	21.0-24.0 person-rem	0.0106-0.0122
					Sizable (22-24)	16.5-18.0 person-rem	0.00836-0.00912
	Accidental	7E-6 person-rem per km	2.6E-2 person-rem	1.3E-5	Incinerable (35-39)	0.9-1.0 person-rem	0.000455-0.000507
					Compactable (28-32)	0.7-0.8 person-rem	0.000364-0.000416
					Sizable (22-24)	0.6-0.7 person-rem	0.000286-0.000312
Non-radiological	Incident-free	5E-9 consequences per km	1.9E-5 consequence		Incinerable (58-64)	0.00110-0.00122 consequence	0.00110-0.00122
					Compactable (46-52)	0.000874-0.000988 consequence	0.000874-0.000988
					Sizable (36-40)	0.000684-0.000760 consequence	0.000684-0.000760

Table 10. (continued).

Type of effect	Unit dose or consequence[d]	Effect per trip[d]	Cancer deaths per trip[e]	Type of LLW[f]	Effect per year	Deaths/year
Accidents	3E-8 deaths per km	1.1E-4 deaths		Incinerable (58-64)	0.00638-0.00704 deaths	0.00638-0.00704
				Compactable (46-52)	0.00506-0.00572 deaths	0.00506-0.00572
				Sizable (36-40)	0.00396-0.00440 deaths	0.00396-0.00440

a. Travel distance is assumed to be 3,750 km.

b. Travel demographics are assumed to be 90% rural (6 person/km^2), 5% urban (719 person/km^2), and 5% suburban (3861 person/km^2).

c. The maximum cumulative radiological health risk to transportation workers from incident-free waste shipping over the 20-year campaign is estimated to be 0.09 deaths. The maximum radiological and nonradiological health risk to the public from incident-free waste shipping over 20 years is estimated to be 0.82 deaths. Up to 0.77 deaths may also occur from transportation accidents.

d. 'Consequences' are health effects that result in death after some latency period.

e. Assumes 4E-04 and 5E-4 cancer deaths per person-rem, for workers and public, respectively.

f. Number of shipments per designated year.

g. The population is assumed to be within 1 km from the highway.

Transportation impacts from the hazardous (nonradioactive) component of MLLW would result only if an accident involving a spill were to occur. National statistics for accidents involving spills of hazardous materials show a rate of 0.28 accidents per million vehicle miles traveled (US Bureau of Land Management, 1990). This statistic includes tanker trucks, which are extremely vulnerable to spilling in an accident. At the above conservative distances, number of shipments, and accident rate, about 0.02 accidents per year, or one accident in 50 years, would be expected involving MLLW shipments to INEL. This low frequency, considered along with the very low quantities assumed (one drum per shipment) and U.S. Department of Transportation packaging requirements for hazardous wastes, makes the likelihood of injuries from hazardous materials releases in an accident very low.

The potential impacts of transporting LLW and MLLW across the Fort Hall Indian Reservation, south of INEL, were considered. For conservatism, it is assumed that all LLW is shipped from INEL through Pocatello, and south across 17 km of the reservation, and that 24 of the 25 annual shipments of MLLW are shipped from the west, through Pocatello to INEL, across 35 km of the reservation (the remaining MLLW shipment is assumed to originate in Idaho Falls, and would not cross reservation land). If the same per km effects presented in Table 10 are assumed, the consequences to the Fort Hall population are calculated by multiplying effects in Table 10 by the ratio of the distances: 17km/3,750 km for LLW and 35 km/3,750 km for MLLW. For example, the annual number of radiological, nonoccupational, incident-free cancer deaths expected in the Fort Hall population from 199 shipments of LLW across the reservation would be 3E-04. This represents about a 5E-10, or 1 in 2 billion increased risk over all other sources of cancer. Nonoccupational deaths from accidents from the 199 shipments would be 1.0E-04, or about 1 death in 10,000 years.

4.3 Potential Impacts from Accidents

Four accidents were evaluated involving different areas of WERF and different waste forms. These accidents were an earthquake, a baghouse/HEPA filter fire, an ash spill, and a compactor fire. The accidents were selected from numerous scenarios considering natural phenomena, external events, operational systems, safety features, and support systems. The accident analyses are based on conservative assumptions, which tend to overestimate the actual environmental impacts. Examples of such assumptions include: maximum inventories/throughput rates, conservative meteorological conditions, and that receptors would remain in the worst exposure locations through the duration of accidental releases. The assumptions provide assurance that an upper bound has been identified for the magnitude of potential environmental impact. The accidents and consequences are briefly summarized below; greater detail is provided in Schofield (1992a, b, c, and d).

For accidents with releases to the outside air, the RSAC-4 computer code was used to calculate doses to the 100-m, worker and MEI, and to generate atmospheric dispersion factors for calculating airborne concentrations at those locations from nonradiological, hazardous releases.

4.3.1 Earthquake

The bounding, credible accident is one in which an earthquake occurs toward the end of a 10-day (240-hr) incineration campaign, causing the incinerator room roof to slip off its supports and fall. The probability of occurrence is estimated to be 8.5E-05. As the roof collapsed, it would sever the offgas lines connected to the incinerator, allowing the offgas and resuspended bottom ash containing radionuclides and hazardous metals to escape unabated to the environment. The release would continue over a period of 8 hours.

For the earthquake scenario, radionuclides and heavy metals would be released at ground level to the surrounding environment, exposing workers in the immediate vicinity of the incinerator building (who would evacuate the area within 10 minutes), as well as downwind receptors. No impact from organics releases would be expected from this accident because volatile organic compounds would have been destroyed in the incinerator prior to release.

At the maximum processing rate, there could be up to 38 Ci of radioactivity distributed among Table 2 nuclides in the accumulated ash (except for carbon-14, hydrogen-3, and iodine-129, which volatilize and are not present in ash). A total of 0.38 Ci could be released from this accident. As calculated by the RSAC-4 code, this release would result in an 8-hour dose to a nearby worker/visitor of 1.3 rem and to the 100-m worker of 990 mrem. A maximum of 12 operations and support workers would be located within the operating areas where these exposures might occur. These doses overestimate what might realistically occur because workers would don protective equipment, be evacuated from the area, and would be exposed for only a fraction of the 8-hour duration of the release. The dose to the MEI, who is assumed to be exposed for 8 hours, would be 2.7 mrem. No health effects would be anticipated from these doses.

For metals, WERF administrative maximum feed rates, as specified in Table 6, are assumed. Other assumptions are the same as for radionuclides. Table 11 presents calculated concentrations at the nearest worker, 100-m, and MEI locations. Concentrations of all metals would be less than IDLH limits at both worker locations. Acute metal exposure to nearby workers exceeding TLV values may produce symptoms such as irritation of the respiratory tract, redness and swelling of the mouth and gums, sweating, thirst, metallic taste, headache, digestive disorders and muscle pain. Exposures below IDLH values would not incapacitate workers such that they would be unable to evacuate or don protective equipment. Concentrations at the MEI location would be less than TLVs.

4.3.2 Baghouse/HEPA Filter Fire

In this accident scenario, a fire starts in the baghouse of the north stack filtration system during maintenance while the incinerator is shut down. The probability of occurrence is estimated to be 2.7E-04/yr. The halon fire suppression system is assumed to fail and the fire spreads to the HEPA filters. The high temperatures cause the housing seals to fail on both the baghouse and HEPA filters, releasing radioactive and hazardous metal particulates into the highbay of the incinerator building and out an open door. The fire/release continues for 1 hour.

Table 11. Estimated metal concentrations resulting from the earthquake accident.

Metal	Worker (mg/m^3)	100-m concentration (mg/m^3)	IDLH[a] (mg/m^3)	12.1 km NSB[b] Concentration (mg/m^3)	TLV/PEL (mg/m^3)
Arsenic	3.6E+00	5.0E-02	1.00E+02	4.9E-05	1.0E-02[d]
Beryllium	6.4E+00	9.0E-02	1.00E+01	8.7E-05	2.0E-03[e]
Cadmium	8.5E+00	1.2E-01	5.00E+01	1.2E-04	1.0E-02[e]
Chromium	1.3E+00	1.8E-02	—[c]	1.7E-05	5.0E-02[e]
Antimony	8.5E+00	1.2E-01	8.00E+01	1.2E-04	5.0E-01[e]
Barium	8.5E+00	1.2E-01	1.10E+03	1.2E-04	5.0E-01[e]
Lead	8.5E+00	1.2E-01	7.00E+02	1.2E-04	5.0E-02[d]
Mercury	8.5E+00	1.2E-01	2.80E+01	1.2E-04	3.0E-02[f]
Silver	8.5E+00	1.2E-01	—[c]	1.2E-04	1.0E-02[e]
Thallium	8.5E+00	1.2E-01	2.00E+01	1.2E-04	1.0E-01[e]

a. NIOSH, 1990.

b. NSB - nearest site boundary.

c. No IDLH value exists for this metal.

d. OSHA PEL (29 CFR 1910.1000).

e. TWA (ACGIH, 1991).

f. STEL (ACGIH, 1991).

Estimated radiological releases from this event are based on the maximum processing rate distributed among Table 2 nuclides. Fifteen percent of the ash is fly ash; 90% of the fly ash is retained in the baghouse, and the remaining 10% is trapped on the HEPA filters with 99.97% efficiency. The calculated release from this accident is 2.7E-02 Ci of radioactivity distributed among Table 2 nuclides in the accumulated ash (except for carbon-14, hydrogen-3, and iodine-129, which volatilize and are not present in ash). The worker inside the incinerator building is assumed to be exposed for 10 minutes before evacuating the area; the dose to this worker was calculated to be 2.7E-01 rem, or 270 mrem EDE. A worker 100 m downwind from the release is assumed to be exposed for the entire hour of the release; the dose to this individual would be 7.0E-02 rem, or 70 mrem. The MEI is assumed to be exposed for 1 hour, resulting in a dose of 2.0E-04 rem, or 0.20 mrem. No health effects would be anticipated from these doses.

Hazardous metals releases were calculated similar to radionuclide releases, with Table 6 (WERF administrative) maximum feed rates assumed. Resulting concentrations at the nearest worker, 100-m worker, and MEI locations are presented in Table 12. Metal concentrations at the nearby worker and 100-m locations may exceed TLV's but would be below IDLHs. Acute worker exposures exceeding TLV values may produce symptoms such as irritation of the respiratory tract, redness and swelling of the mouth and gums, sweating, thirst, metallic taste, headache, digestive disorders and muscle pain. Exposures below IDLH values would not incapacitate workers such that they would be unable to evacuate or don protective equipment. Concentrations at the MEI location would be about 1/1000 of those at the 100-m location, and below all TLVs. The accident would trigger system and radiation monitor alarms so that employees would immediately evacuate the facility or don protective equipment and provide emergency response.

4.3.3 Ash Handling Spill

Two spill scenarios were evaluated for a single 269-l drum of ash: 1) a spill in the ash handling room, which is a worst-case scenario for a worker; and 2) a spill outside while loading a drum onto a truck, which exposes downwind receptors. The estimated probability of occurrence for each ash spill scenario is 4.0E-05/yr. The spills release radioactive and hazardous metal particulates. The ash drum is assumed to contain 0.26 Ci, distributed among Table 2 nuclides (except for carbon-14,

Table 12. Estimated metal concentrations resulting from the baghouse/HEPA fire accident.

Metal	Worker (mg/m^3)	100-m concentration (mg/m^3)	IDLH[a] (mg/m^3)	12.1 km NSB[b] concentration (mg/m^3)	TLV/PEL (mg/m^3)
Arsenic	6.9E-01	2.8E-02	1.00E+02	2.7E-05	1.0E-02[d]
Beryllium	1.1E+00	4.2E-02	1.00E+01	4.1E-05	2.0E-03[e]
Cadmium	1.6E+00	6.4E-02	5.00E+01	6.1E-05	1.0E-02[e]
Chromium	2.1E-01	8.5E-03	—[c]	8.2E-06	5.0E-02[e]
Antimony	1.6E+00	6.4E-02.	8.00E+01	6.1E-05	5.0E-01[e]
Barium	1.4E+00	5.9E-02	1.10E+03	5.7E-05	5.0E-01[e]
Mercury	1.9E+00	6.4E-02	2.80E+01	6.1E-05	3.0E-02[f]
Lead	1.6E+00	7.8E-02	7.00E+02	7.5E-05	5.0E-02[d]
Silver	1.4E+00	5.9E-02	—[c]	5.7E-05	1.0E-02[e]
Thallium	1.6E+00	6.4E-02	2.00E+01	6.1E-05	1.0E-01[e]

a. NIOSH, 1990.

b. NSB-nearest site boundary.

c. No IDLH value exists for this metal.

d. OSHA PEL (29 CFR 1910.1000).

e. TWA (ACGIH, 1991).

f. STEL (ACGIH, 1991).

hydrogen-3, and iodine-129, which volatilize and are not present in ash), which would give a 500-mrem/hr dose rate on contact. This dose rate is the maximum allowed for disposal at RWMC.

4.3.3.1 Spill in Ash Handling Room. The spill in the ash handling room is assumed to occur when an operator accidentally tips over a full ash drum during an ash transfer operation. Personnel do not wear respiratory protection devices in this area and it is conservatively assumed that it takes the workers approximately 10 minutes to exit the room. The workers are exposed to respirable particulates containing radionuclides and heavy metals. The calculated release from this accident is 2.6E-04 Ci of radioactivity distributed among Table 2 nuclides (except for carbon-14, tritium, and iodine-129, which volatilize and are not present in ash). This would result in a dose to the worker of 1.1 rem. No health effects would be anticipated from this dose.

The calculated concentrations of resuspended metals in the ash handling room from this accident are presented in Table 13. If this accident scenario occurred, workers might be exposed to beryllium, cadmium, antimony, mercury, and thallium concentrations that exceed IDLH limits. Worker exposures would be minimized by immediate evacuation from the ash handling room. Such evacuation normally requires only a few seconds. Depending on actual metal concentrations in the ash and the duration of inhalation exposures, effects on workers could result in symptoms ranging

Table 13. Estimated metals concentrations at receptor locations resulting from ash spill releases.

Metal	Worker (mg/m^3)	100-m concentration (mg/m^3)	IDLH[a] (mg/m^3)	12.1 km NSB[b] concentration (mg/m^3)	TLV/PEL (mg/m^3)
Arsenic	7.2E+01	4.1E-02	1.00E+02	3.9E-05	1.0E-02[d]
Beryllium	1.3E+02	7.2E-02	1.00E+01	7.0E-05	2.0E-03[e]
Cadmium	1.7E+02	9.6E-02	5.00E+01	9.3E-05	1.0E-02[e]
Chromium	2.6E+01	1.4E-02	—[c]	1.4E-05	5.0E-02[e]
Antimony	1.7E+02	9.6E-02	8.00E+01	9.3E-05	5.0E-01[e]
Barium	1.7E+02	9.6E-02	1.10E+03	9.3E-05	5.0E-01[e]
Lead	1.7E+02	9.6E-02	7.00E+02	9.3E-05	5.0E-02[d]
Mercury	1.7E+02	9.6E-02	2.80E+01	9.3E-05	3.0E-02[f]
Silver	1.7E+02	9.6E-02	—[c]	9.3E-05	1.0E-02[e]
Thallium	1.7E+02	9.6E-02	2.00E+01	9.3E-05	1.0E-01[e]

a. NIOSH, 1990.

b. NSB-nearest site boundary.

c. No IDLH value exists for this metal.

d. OSHA PEL (29 CFR 1910.1000).

e. TWA (ACGIH, 1991).

f. STEL (ACGIH, 1991).

from irritation of the eyes, nose, throat, and skin; breathing difficulty and coughing to blood changes, organ and nerve damage, coma, or death.

4.3.3.2 Spill Outside. For the ash spill outside the building, it is assumed that 0.1% of the ash is resuspended over a 1-hour period and dispersed downwind. Receptors are conservatively assumed to be exposed for the entire 1 hour. The radiation dose to the 100-m worker would be 7.0E-04 rem (0.70 mrem), and to the MEI would be 2.0E-06 rem (2.0E-03 mrem). No health effects would be anticipated from these doses.

The calculated concentrations of resuspended metals at the 100-m and MEI locations from this accident are also presented in Table 13. All metal concentrations at the 100-m and MEI locations would be below TLV and IDLH values.

4.3.4 Compactor Fire

In this scenario, a fire erupts in the compactor just after a bin has been filled. The probability of occurrence is estimated to be 9.0E-05/yr. The fire is assumed to spread through the ventilation system and involve the contents of both baghouses and the HEPA filters. The high temperatures generated by the fire are conservatively assumed to cause the baghouse seals to fail and release activity into the sizing/compaction building. The fractional inventory at risk in the burning bin [0.1% (Walker, 1986)] and the entrained activity in the baghouses are released to the building and then to the environment through an open door. Because the HEPA filters are located outside the exterior structure of the facility, their activity does not contribute to the activity released within the building. The release continues for 8 hours. A worker in the compactor room is exposed to the release for 10 minutes; a worker at 100 m and an MEI at the INEL boundary are assumed to be exposed for the entire 8 hours of the accident. Because no MLLW is processed in the compactor, this accident releases only radioactive contamination.

Given the maximum allowed radiation reading for a bin of 500 mrem/hr at 0.9 m, the maximum curie content of the bin, as calculated by the Microshield code (Grove Engineering, 1988), would be 2.8 Ci distributed among Table 8 nuclides. The release from the bin and baghouses/HEPA filters would be 1.0E-02 Ci over the 8-hour duration of the incident. From this release, the workers in the compactor room and at 100 m would receive doses of 6.6E-02 rem (66 mrem) each. The dose to the MEI would be 1.1E-04 rem. No health effects would be anticipated from these doses.

4.4 Impacts of Alternatives to the Proposed Action

This section discusses potential impacts of the five alternatives introduced in Section 2.4. A comparative summary of the impacts associated with the alternatives is presented in Table 14.

4.4.1 The No Action Alternative

The no action alternative would require DOE to continue storing INEL MLLW in INEL storage facilities and to continue using WERF for LLW volume reduction. Continued MLLW storage would be required due to the RCRA Section 3004 (40 CFR 268.50) prohibition on land

Table 14. Comparative impacts of proposed action and alternatives.

Impact	Proposed action	Alternative 1 No Action (continue to store INEL-generated MLLW and use WERF to incinerate, compact, and size LLW)	Alternative 2 Treat MLLW by methods other than incineration and use WERF to incinerate, compact, and resize LLW	Alternative 3 Dispose of LLW without volume reduction and continue to store MLLW	Alternative 4 Construct and operate a new MLLW incinerator and continue to incinerate, compact, and size LLW at WERF	Alternative 5 Treat MLLW at another DOE incinerator and continue to incinerate, compact, and size LLW at WERF
Environmental compliance	Would bring LDR MLLW into compliance with RCRA	Existing and future generated INEL MLLW would require continued storage.	Treatments other than incineration may not meet RCRA standards for MLLW. During the EPA approval process. INEL generated MLLW would require continued storage.	Existing and future generated INEL MLLW would require continued storage.	A new incinerator would require a RCRA Part B and State Air Permits. RCRA compliant MLLW treatment would be delayed 5-10 years. Existing and future generated INEL MLLW would require continued storage.	Compliance would be similar to PA if other DOE incinerators were licensed to treat INEL MLLW
Socioeconomic	Small work force needed to operate WERF	Similar to PA[a]	Similar to PA	Reduction in work force	New MLLW incinerator would operate intermittently (1-3 months/yr). Small additional work force may be needed during campaigns if WERF operates concurrently	Similar to PA
Land use	No Change	Possible increase for storage of MLLW and LLW awaiting treatment	Possible increase for storage of MLLW and LLW awaiting treatment	More land area needed for storage of MLLW and disposal of LLW	Additional land would be required for new incinerator and ingress/egress	Similar to PA
Health effects	Minor near term risks, lower long term risks	Near term risks would be less than PA, long term risks would be higher than PA	Near term risks would be less than PA. Due to the possibility of reclaiming waste, long term risks would be higher than PA	Increased near term risk to workers and long-term risk to public/environment	Near term effects would be less than PA. LLW transportation effects would be avoided. When new MLLW incinerator becomes operational, effects form incinerating MLLW and LLW would be similar to PA.	Processing risks would be similar to PA. MLLW transportation risks would increase, LLW transportation risks would be avoided
Terrestrial ecology	None	Possible loss of habitat due to expanded MLLW storage	Possible loss of habitat due to expanded MLLW storage	Increased habitat loss for expanded LLW disposal facility	Increased habitat loss for construction of new incinerator	None

Table 14. (continued).

Impact	Proposed action	Alternative 1 No Action (continue to store INEL-generated MLLW and use WERF to incinerate, compact, and size LLW)	Alternative 2 Treat MLLW by methods other than incineration and use WERF to incinerate, compact, and resize LLW	Alternative 3 Dispose of LLW without volume reduction and continue to store MLLW	Alternative 4 Construct and operate a new MLLW incinerator and continue to incinerate, compact, and size LLW at WERF	Alternative 5 Treat MLLW at another DOE incinerator and continue to incinerate, compact, and size LLW at WERF
Archeological and historical sites	None	Possible impacts due to expanded MLLW storage	Possible impacts due to expanded MLLW storage	Possible impacts due to expanded LLW disposal facility and expanded MLLW storage.	Possible impacts/mitigation requirements depending on new incinerator site	None
Accidents and occupational risks	Increased near term risks due to handling MLLW and from LLW transportation lower long term risks due to more stable storage/disposal form	LLW transportation risks less than PA; MLLW near term risk is less than PA, long term risk is greater due to extended storage	LLW transportation risks less than PA. MLLW near term risk is less than PA, long term risk is greater due to extended storage	Increased risk from handling more containers and from extended storage of MLLW	Increased risks from continued MLLW storage/monitoring until treatment capacity is available. Processing risks would be similar to PA for LLW and MLLW (when new MLLW incinerator becomes operational). LLW transportation risks would be avoided.	Processing risks would be similar to PA. MLLW transportation risks would increase, LLW transportation risks would be avoided

a. PA = Proposed Action

disposal of untreated hazardous wastes. To minimize health and environmental threats, EPA promulgated treatment standards for these wastes.

RCRA requires prompt treatment of restricted hazardous waste to avoid the risks of future releases from extended storage. Hazardous wastes, subject to LDR requirements found in 40 CFR 268, must be treated to EPA requirements prior to disposal. Storage of MLLW waste is prohibited unless stored solely for the purpose of recovery, treatment, or disposal.

Expected annual doses to workers from proposed treatment would be 10 to 20 mrem/person for each MLLW treatment campaign. However, if the MLLW continues to accumulate in storage facilities the dose to workers would increase based on weekly inspections of approximately one hour each giving a weekly dose of approximately 1 mrem (an annual dose of approximately 52 mrem). Indefinite storage of MLLW could result in a higher annual worker dose than from proposed MLLW processing.

The no action alternative would not entail the risk associated with shipping the LLW to a commercial facility. However, continued treatment of the LLW at WERF would require storing, handling, and monitoring the LLW at INEL until the inventory is processed. Worker exposure to radioactivity during processing would be as low as reasonably achievable for these activities and well below DOE standards for occupationally related exposures.

4.4.2 Treat MLLW By Methods Other Than Incineration and Continue Use of WERF to Incinerate, Compact, and Size LLW

Stabilization and biological and chemical treatment have been considered as alternatives to MLLW incineration (DOE, 1992b). Stabilization would immobilize but not reduce the toxicity or the volume of the waste. Consequently, the potential for environmental contamination may still exist at the disposal site and the waste may have to be reclaimed at a later date. Because of the specificity of chemical and/or biological treatments, multiple processes would be required to process various waste forms and chemical compositions. Multiple processes would increase the likelihood for exposure to radioactive and hazardous wastes. Currently, incineration is the only EPA-approved, technology-based treatment standard for many hazardous wastes. Obtaining approval from the EPA for treatment methods other than incineration is possible; however, the demonstration and the approval process would delay MLLW treatment.

Continued storage and treatment of LLW at WERF would result in actions and environmental impacts corresponding to the no action alternative as discussed in Section 4.4.1.

4.4.3 Dispose of LLW Without Volume Reduction and Continue to Store MLLW

Continued storage of MLLW without treatment would have impacts as described in the no action alternative in Section 4.4.1. Storage of hazardous waste is not allowed under RCRA except to accumulate sufficient quantities to facilitate proper treatment, recovery, or disposal.

Prior to 1982, LLW was disposed of directly by shallow-land burial at RWMC. This practice was determined to be inefficient because many waste forms had high bulk densities or contained void spaces. Volume reduction of LLW would decrease the number of containers to be disposed of in

the RWMC, but the radiation fields of the drums would be higher as a result of consolidation. Sending unprocessed LLW to RWMC would require more containers to be buried. Risks from spills, leaks, and exposures to workers resulting from handling accidents increase in proportion to the number of containers handled. Direct disposal would not use disposal space in RWMC efficiently, and the disposal capacity of RWMC would be reduced from the projected 21 years to approximately 7 years. Assuming continued generation of LLW, additional disposal sites would have to be developed sooner than under the proposed action. Additional disposal sites would require changes in both land use and environmental conditions at those sites.

In addition to risks to workers, NRC has examined the issue of relative risks to potential intruders and future populations from stabilized and unstabilized LLW. Stabilized waste was found to provide a reduction in risk over unstabilized waste ranging from a factor of 22 to 1,500, depending on the scenario (NRC, 1982).

4.4.4 Construct and Operate a New MLLW Incinerator and Continue to Incinerate, Compact, and Size LLW at WERF

Under this alternative, no immediate treatment capacity would be available; a new incinerator would be constructed at INEL to treat MLLW and WERF would continue to process LLW. Two separate incinerators would result in substantial duplication of facilities at a much greater cost than the proposed action. Similarly, maintenance costs would be higher for two incinerators. This alternative would result in a higher potential for emissions to the environment during concurrent operations.

Separate incinerators would not significantly improve the existing WERF combustion efficiency or emissions. Consequently, separate incinerators would not provide an environmental protection advantage compared to WERF.

The construction of a new incinerator would also require a new RCRA permit and trial burn. In addition, an analysis would be required to determine if NESHAP approval would be necessary, a Prevention of Significant Deterioration analysis would be required and an application for an Idaho permit to construct would be prepared. DOE would be required to continue storing existing MLLW until the new facility became operational.

4.4.5 Treat MLLW at Another DOE Incinerator and Continue to Incinerate, Compact, and Size LLW at WERF

Existing or planned radioactive or mixed waste incinerators that may have the capability to process INEL MLLW are located at RFP, LANL, ORR, and SRS. The RFP and existing SRS incinerators are not currently operational. The ORR incinerator is not suitable for beta/gamma-contaminated wastes and is scheduled to process onsite-generated wastes at or near capacity. The existing LANL pilot incinerator is permitted to treat only LANL-generated mixed transuranic waste. A consolidated incineration facility is being constructed at SRS to process hazardous and MLLW. The planned SRS facility is permitted only for SRS waste. Modifications to these permits, if granted, would require 3 to 5 years. Therefore, it is not anticipated that the SRP incinerator would be available to process INEL waste during the next 3 to 5 years.

5. WERF PERMITS AND AGENCIES/PERSONS CONSULTED

Projects and facilities at the INEL must comply with applicable environmental protection requirements of the EPA, DOE, other federal agencies, and the State of Idaho. This section provides a list of existing and planned environmental documents and permits, and regulatory agency staff who have been consulted during the preparation and approval processes.

Document/Permit	Lead Agency	Contact
NESHAP Approval to Construct	EPA (Region X)	J. Leitch R. Poeton
RCRA Parts A & B Permits	State of Idaho (Permits and Enforcement Division)	R. Steger B. Monson
Idaho Air Permit	IDEQ	M. Bauer D. Pitman