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# APPENDIX E

GLOSSARY

Terms in this glossary are defined based on the context in which they are used in t

100-year flood A flood event of such magnitude it occurs, on average, every 100 ye a 1 percent probability of occurring in any given year).

500-year flood A flood event of such magnitude it occurs, on average, every 500 ye a 0.2 percent probability of occurring in any given year).

absorbed dose The energy imparted by ionizing radiation per unit mass of irradiate The unit of absorbed dose is the rad.

accelerator produced radioactive material Radioactive material that was produced i particle accelerator.

acceptable ambient concentration for a carcinogen (AACC) Ambient air quality stanc based on the probability of developing excess cancers over a 70-year lifetime expos microgram per cubic meter (1ug/m^3) of a given carcinogen and expressed in terms of emission level or an acceptable ambient concentration for a carcinogenic toxic air

acceptable ambient concentration for a noncarcinogen (AAC) Ambient air quality sta based on occupational exposure limits for airborne toxic chemicals expressed in ter emission level or an acceptable ambient concentration for a noncarcinogenic toxic a

accident An unplanned sequence of events that results in undesirable consequences.

actinide Any of a series of chemically similar, mostly synthetic, radioactive elem numbers ranging from actinium-89 through lawrencium-103.

acute exposure The absorption of a relatively large amount of hazardous material ( hazardous material) over a short period of time.

adsorption The attraction and adhesion of ions or molecules in a gaseous or aqueou solid surface.

air pollutant Any substance including, but not limited to, dust, fumes, gas, mist, vapor, pollen, soot, carbon, or particulate matter that is regulated.

air quality The specific measurement in the ambient air of a particular air pollut time.

air quality criteria The varying amounts of pollution and lengths of exposure at w adverse effects to health and welfare take place.

air quality standard The prescribed level of a pollutant in the outside air that c during a specified time in a specified geographical area. Established by both Feder governments.

alluvium Sedimentary material deposited by flowing water, as in a river bed or del

alpha-emitter A radioactive substance that decays by releasing an alpha particle.

alpha low-level waste Waste that was previously classified as transuranic waste bu transuranic concentration lower than the currently established limit for transurani level waste requires additional controls and special handling. This waste stream ca for onsite disposal under the current waste acceptance criteria; therefore, it is s

alpha-particle A positively charged particle ejected spontaneously from the nuclei radioactive elements. It is identical to a helium nucleus that has a mass number of electrostatic charge of +2.

ambient air That portion of the atmosphere outside of buildings to which the genera access.

applicable or relevant and appropriate requirements (ARARs) Requirements, includin cleanup standards, standards of control, and other substantive environmental protec and criteria for hazardous substances as specified under Federal and State law and must be met when complying with the Comprehensive Environmental Response, Compensat Liability Act of 1980 (CERCLA).

aquifer A body of rock or sediment sufficiently permeable to conduct groundwater a significant quantities of water to wells and springs.

as low as reasonably achievable (ALARA) A process by which a graded approach is ap maintaining dose levels to workers and the public and releases of radioactive mater environment as low as reasonably achievable.

attainment area Any area which is designated, pursuant to 42 U.S.C. Section 7407(d Clean Air Act, as having ambient concentrations equal to or less than national prim ambient air quality standards for a particular air pollutant or air pollutants.

atomic number The number of positively charged protons in the nucleus of an atom an number of electrons on an electrically neutral atom.
background level The value assigned to the quantity of particulate or gaseous mate air which originates from natural sources uninfluenced by the activity of man.
background radiation Radiation from cosmic sources, naturally occurring radioactiv including radon (except as a decay product of source or special nuclear material), it exists in the environment from the testing of nuclear explosive devices.
basalt A general term for dark-colored, fine-grained igneous rock. Commonly extrus composed primarily of calcic plagioclase and pyroxene minerals.
baseline For purposes of this EIS, the conditions projected to exist in June 1995, date for the Record of Decision, against which the environmental consequences of th alternatives are evaluated.
below regulatory concern A definable amount of low-level waste that is sufficientl can be deregulated with minimal risk to the public.
best available control technology (BACT) An emission standard (including fuel clea treatment or innovative fuel combination techniques) for control of such contaminan be determined on a case-by-case basis, taking into account energy, environmental an impacts, and other costs, and shall be at least as stringent as any applicable Sect 60 and 40 CFR Part 61. If an emissions standard is infeasible, a design, equipment, operational standard, or combination thereof, may be prescribed as BACT.
beta-emitter A radioactive substance that decays by releasing a beta particle.
beta-particle A charged particle emitted from a nucleus during radioactive decay, equal to 1/1837 that of a proton. A negatively charged beta particle is identical t positively charged beta particle is called a positron.
beyond design basis accidents Accidents of the same type as a distinct design basi (fire, earthquake, and so forth) but defined by parameters that exceed in severity defined for the distinct design basis accident.
bound To estimate or describe an upper limit on a potential environmental conseque uncertainty exists.
bounding That which represents the maximum reasonably foreseeable event or impact. reasonably foreseeable events or impacts would have fewer and/or less severe envirc consequences.
breeder reactor A type of nuclear reactor that creates more fissionable fuel than i
buffer zone An area designed to separate. Specifically, the portion of a disposal controlled by the licensee and that lies under and between the disposal units and t site.
by-product material (a) Any radioactive material (except special nuclear material) made radioactive by, exposure to the radiation incident to the process of producing nuclear material, and (b)the tailings or wastes produced by the extraction or conce or thorium from any ore processed primarily for its source material content [Atomic 11(e)]. By-product material is exempt from regulation under the Resource Conservati Recovery Act.
calcination The process of converting high-level waste to unconsolidated granules called calcining).
calcine The materials produced by calcination.
canning The process of placing spent nuclear fuel in canisters to retard corrosion radioactive releases, or control geometry.
certification plan See waste certification plan.
certified waste Waste that has been confirmed to comply with the waste acceptance treatment, storage, or disposal facility for which it is intended under an approvec program.
certifying authority or official An organization or person outside the waste gener organization who is responsible for certifying that the waste being sent to a treat disposal facility meets the requirements of the receiving facility's waste acceptan
characterization The determination of waste composition and properties, whether by process knowledge, nondestructive examination or assay, or sampling and analysis, g the purpose of determining appropriate storage, treatment, handling, transportation requirements.
chronic exposure The absorption of hazardous material (or intake of hazardous mater long period of time (for example, over a lifetime).
cladding The outer jacket of fuel elements and targets usually made of aluminum, s or zirconium-aluminum alloy, used to prevent fuel corrosion and retain fission proc operation, or to prevent releases into the environment during storage.
Class I area Under the Clean Air Act, any Federal land that is classified or recla

The designation applies to pristine areas, such as national parks and wilderness ar
substantial growth is effectively precluded in order to avoid any degradation of th
clean waste Waste products that are neither radioactive nor hazardous but require
disposal in a solid waste landfill.
closure Deactivation, stabilization, and surveillance of a waste management unit,
facility. Closure often refers to the process under the Resource Conservation and R
involving the preparation and signing of a Closure Plan.
cold nuclear fuel Nuclear reactor fuel which has not been exposed to a neutron flu
reactor.
collective dose The sum of the individual doses received in a given period of time
population from exposure to a specified source of radiation. The units of collectiv
rem.
co-located workers Workers in a fixed population outside the day-to-day process sa
management controls of a given facility area. In practice, this fixed population is
workers at an independent facility area located some distance from the reference fa
commercial waste management facility A facility located off DOE-controlled property
not managed by DOE to which DOE sends waste for treatment, storage, and/or disposal
committed dose equivalent (H50) The dose equivalent to organs or tissues of refere
be received from an intake of radioactive material by an individual during the 50-y
following the intake. The International Commission on Radiological Protection defin
committed equivalent dose.
committed effective dose See committed effective dose equivalent.
committed effective dose equivalent (HE,50) The sum of the products of the weighti
applicable to each of the body organs or tissues that are irradiated and the commit
to these organs or tissues. The International Commission on Radiological Protection
the committed effective dose.
Comprehensive Environmental Response, Compensation, and Liability Act of 1980
(CERCLA) A Federal law (also known as "Superfund") that provides a comprehensive f
to deal with past or abandoned hazardous materials. The Comprehensive Environmental
Compensation, and Liability Act of 1980 (CERCLA) provides for liability, compensati
and emergency response for hazardous substances released into the environment that
public health, welfare, or the environment, as well as the cleanup of inactive haza
sites. CERCLA has jurisdiction over any release or threatened release of any "hazar
to the environment. Under CERCLA, the definition of "hazardous" is much broader tha
Resource Conservation and Recovery Act, and the hazardous substance need not be a w
meets the CERCLA requirements for designation, it is ranked along with other "Super
listed on the National Priorities List. This ranking and listing is the U.S. Envir
Agency's way of determining which sites have the highest priority for cleanup.
committed equivalent dose See committed dose equivalent.
confinement General control of contaminants through engineering design, such as he
ventilation systems that use high-efficiency particulate air (HEPA) filters to remc
before discharge to the atmosphere. Such systems may break down or experience a los
power that would "lose confinement" temporarily. This may require evacuation of the
would not lead to significant consequences to workers or a significant release.
Consent Order and Compliance Agreement (COCA) A legally binding agreement signed i
1987 between the U.S. Department of Energy Idaho Field Office (DOE-ID), U.S. Envirc
Protection Agency Region 10 (EPA Region 10), and the U.S. Geological Survey (USGS).
agreement addressed environmental restoration activities at the INEL. The COCA was
the Federal Facilities Agreement/Consent Order, among DOE-ID, EPA Region 10, and th
Idaho, signed in December 1991.
contact-handled waste Packaged waste whose external surface dose rate does not exce
millirem per hour.
containerization The process of placing radioactive or other hazardous material in
receptacle for storage or transport. For spent nuclear fuel, this is called canning
containment The provision of a gastight shell or other enclosure around a reactor t
fission products that otherwise might be released into the atmosphere in the event
contamination The deposition of unwanted radioactive material on the surfaces of st
areas, objects, or personnel.
contingency plan A document setting out an organized, planned, and coordinated cou
to be followed in case of unanticipated events such as fire, explosion, or other ev
toxic chemicals, hazardous wastes, or radioactive materials to threaten human healt
environment. The goal of the contingency plan is the containment or mitigation of t
resulting from the event.
continuity of operations Activities that include developing strategic and long-rang

management plans, surveillance and maintenance of facilities and equipment, waste c
proper training programs for personnel, and record/information administration.
control equipment Any method, process or equipment which removes, reduces, or renc
noxious, air pollutants discharged into the atmosphere.
coolant A gas or liquid circulated through a nuclear reactor to remove or transfer
core The central portion of a nuclear reactor containing the fuel elements, moderat
poisons, and support structures.
criteria air pollutant Under the Clean Air Act, and the State of Idaho air quality
air pollutant for which there is a State or national ambient air quality standard.
cumulative impact The impact on the environment which results from incremental impa
action when added to other past, present, and reasonably foreseeable future actions
agency (Federal or non-Federal) or person undertakes such other actions. Cumulative
result from individually minor but collectively significant actions taking place ov
curie (Ci) The basic unit used to describe the intensity of radioactivity in a sam
curie is equal to 37 billion disintegrations per second, which is approximately the
gram of radium. A curie is also a quantity of any radionuclide that decays at a rat
disintegrations per second.
decay, radioactive The decrease in the amount of any radioactive material with the
time, due to the spontaneous emission from the atomic nuclei of either alpha or bet
accompanied by gamma radiation. (See half-life; radioactive.)
decommissioning The process of removing a facility from operation, followed by
decontamination, entombment, dismantlement, or conversion to another use.
decontamination The actions taken to reduce or remove substances that pose a subst
or potential hazard to human health or the environment, such as radioactive contami
facilities, soil, or equipment by washing, chemical action, mechanical cleaning, or
defense waste Radioactive waste from any activity performed in whole or in part in
DOE atomic energy defense activities; excludes waste from DOE nondefense activities
the purview of the U. S. Nuclear Regulatory Commission or generated by the commerci
power industry.
delta E A parameter used to define color shift in visual impact modeling. It is th
for determining perceptibility of plume visual impact in screening analyses.
design basis accident (DBA) Accidents that are postulated for the purpose of estab
functional requirements for safety significant structures, systems, components, and
diffusion The process by which a pollutant plume is diluted by turbulent eddies.
discharge Under principles of hydrogeology, the amount of water passing through (c
given cross-sectional area in a given period of time. Under the Clean Water Act, di
pollutant, which includes any addition of any pollutant or combination of pollutant
United States from any point source. This definition includes additions of pollutan
the United States from: surfaced runoff which is collected or channeled by man; dis
pipes, sewers, or other conveyances owned by a State, municipality, or person which
treatment works; and discharges through pipes, sewers, or other conveyances, leadin
owned treatment works.
dispersion In air pollution, the process of transport and diffusion of airborne cc
atmosphere.
disposal Emplacement of waste in a manner that ensures protection of human health
environment within prescribed limits for the foreseeable future with no intent of r
requires deliberate action to regain access to the waste.
disposal facility A facility or part of a facility at which hazardous waste is int
into or on any land or water and at which waste will remain after closure.
dissolution The ability of water to take a substance into solution.
DOE orders Requirements internal to the U.S. Department of Energy (DOE) that estab
policy and procedures, including those for compliance with applicable laws.
DOE site boundary A geographic boundary within which public access is controlled a
are governed by the U.S. Department of Energy (DOE) and its contractors, not by loc
Based on the definition of exclusion zone, a public road traversing a DOE site is c
within the DOE site boundary if DOE or the site contractor has the capability to cc
any time necessary.
dose (or radiation dose) A generic tern that means absorbed dose, dose equivalent,
dose equivalent, committed dose equivalent, committed effective dose equivalent, or
dose equivalent, as defined elsewhere in this glossary.
dose conversion factor Any factor that is used to change an environmental measureme
in the units of concern. Frequently used as the factor that expresses the committed
equivalent to a person from the intake (inhalation or ingestion) of a unit activity
radionuclide.

dose equivalent The product of the absorbed dose in tissue, quality factor, and al modifying factors at the location of interest. The unit of dose equivalent is the r International Commission on Radiation Protection defines this as the equivalent dos
dose rate The radiation dose delivered per unit of time; measured, for example, in
dry storage Storage of spent nuclear fuel in environments where the fuel is not im for purposes of cooling and/or shielding.
earthquake magnitude A measure of earthquake size, determined by taking the common logarithm (base 10) of the largest ground motion recorded during the arrival of a s and applying a standard correction for distance to the epicenter. Three common type are Richter (or local) (ML), P body wave (mb), and surface wave (M8).
effective dose See effective dose equivalent.
effective dose equivalent (EDE) The sum of the products of the dose equivalent to tissue and the weighting factors applicable to each of the body organs or tissues t includes the dose from radiation sources internal and/or external to the body and i of rem. The International Commission on Radiation Protection defines this as the ef
effluent The wastewater, treated or untreated, that flows out of a facility. Genera discharged into surface waters.
emission Any controlled or uncontrolled release or discharge into the outdoor atmc air pollutants or combination thereof. Emission also includes any release or discha pollutant from a stack, vent, or other means into the outdoor atmosphere that origi emission unit.
emission standard A permit or regulatory requirement established by the Idaho Depa Health and Welfare, or a requirement contained in 40 CFR Part 60, 40 CFR Part 61, c State Implementation Plan (SIP), which limits the quantity, rate, or concentration continuous basis, including any requirements which limit opacity, prescribe equipme specifications, or prescribe operation or maintenance procedures to assure continuc control.
engineered barriers Manmade components of a waste management system or facility de prevent or impede the release of radionuclides or other waste material into the bic includes the waste form, radioactive waste containers, and other materials placed c such containers, and physical features of the system or facility.
enriched uranium Uranium that has greater amounts of the fissionable isotope urani occurs naturally. Naturally occurring uranium is 0.72 percent uranium-235.
environmental monitoring The process of sampling and analysis of environmental mec around a facility being monitored for the purpose of (a) confirming compliance with objectives and (b) early detection of any contamination entering the environment tc remedial action.
environmental restoration Cleanup and restoration of sites and decontamination and decommissioning of facilities contaminated with radioactive and/or hazardous substa production, accidental releases, or disposal activities.
environmental restoration program A DOE subprogram concerned with all aspects of assessment and cleanup of both contaminated facilities in use and of sites that are active operations. Remedial actions, most often concerned with contaminated soil an and decontamination and decommissioning are responsibilities of this program.
eolian Applied (a) to deposits arranged by the wind, (b)to the erosive action of t deposits which are due to the transporting action of the wind.
equivalent dose See dose equivalent.
existing facilities Facilities that are projected to exist as of the Record of Dec scheduled for June 1995.
exposure Being exposed to ionizing radiation or to hazardous material. Alternativel of the ionization produced in air by X or gamma radiation; the unit of exposure in
external accident Accidents initiated by manmade energy sources not associated wit a given facility. Examples include airplane crashes, induced fires, transportation a facility, and so forth.
external dose That portion of the dose equivalent received from radiation sources body.
facility (a) Any building, structure, installation, equipment, pipe or pipeline (i into a sewer or publicly owned treatment works), well, pit. pond, lagoon, impoundme landfill, storage container, motor vehicle, rolling stock, or aircraft; or (b) any hazardous substance has been deposited, stored, disposed of, placed, or otherwise c
facility area The area within the DOE site boundary immediately surrounding a faci facilities that functions under process safety management programs and a common eme response plan. This definition covers any building within such an area regardless c dedicated to production, waste handling, or administrative issues; for example, an

cafeteria, a production facility, a machine shop, and a waste handling facility all common boundary. If programs such as radiation protection, training, auditing, and integral part of safety management at each facility and emergency response plans cc responses of individuals at all buildings, then the collection of buildings constit All personnel in the area are facility workers, not co-located workers.

facility area boundary The geographic boundary of an area controlled on a daily bas safety management and a common emergency response plan.

facility security plan In the context of waste management, a security plan is one measures required by law, regulation, or good judgment for prevention of unknowing entry into a treatment, storage, or disposal facility; or operation of facility equ access to waste material or spent nuclear fuel.

facility worker Any worker whose day-to-say activities are controlled by process s management programs and a common emergency response plan associated with a facility area. This definition includes any individual within a facility/facility area or it area. This definition can also include those transient individuals or small populat exclusion zone but inside the radius defined by the maximally exposed co-located wc efforts to account for such people have been made in the facility or facility area facility accident analyses, the facility worker is defined as an individual locatec downwind of the facility location where an accidental release occurs.

feasibility study (FS) A step in the environmental restoration process specified b Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERC objectives are to identify the alternatives for remediation and describe a remedial applicable or relevant appropriate requirements (ARRs) for mitigating confirmed env contamination. The FS presents a series of specific engineering or construction alt dealing up a site; for each alternative presented, there will be a detailed analysi engineering feasibility, and environmental impacts. The FS is based on information remedial investigation (RI). Successful completion of an FS should result in a deci Decision) selecting a remedial action alternative and the subsequent development of for implementation of the selected remedial action.

Federal Facility Compliance Act (FFCA) Federal law signed in October 1992 amending Resource Conservation and Recovery Act. The objective of the FFCA is to bring all F facilities into compliance with applicable Federal and State hazardous waste laws, sovereign immunity under those laws, and to allow the imposition of fines and penal also requires the U.S. Department of Energy to submit an inventory of all its mixec develop a treatment plan for mixed wastes.

Federal Facility Agreement and Consent Order (FFA/CO) A binding agreement, negotiat pursuant to Section 120 of CERCLA, signed by DOE, the Environmental Protection Agen 10, and the State of Idaho, to coordinate cleanup activities at the INEL. The FFAIC Plan outline the remedial action process that will encompass all investigation of h release sites. The FFA/CO superseded the Consent Order and Compliance Agreement (CC

Federal land manager The Secretary of the Federal department with authority over an lands in the United States.

field offices An administrative division of the DOE that operates facilities that jurisdiction.

fiscal year (FY) The time frame specified by any public or private entity to separa financial (fiscal) activities from the next year's. The 1994 Federal Fiscal Year (F October 1, 1993, and ended on September 31, 1994.

fissile material Although sometimes used as a synonym for fissionable material, th acquired a more restricted meaning; namely, any material fissionable by thermal (sl The three primarily fissile materials are uranium-233, uranium-235, and plutonium-2

fission The splitting of a nucleus into at least two other nuclei and the release amount of energy. Two or three neutrons are usually released during this type of tr

fission products The nuclei (fission fragments) formed by the fission of heavy ele nuclides formed by the fission fragments' radioactive decay.

fissionable material Commonly used as a synonym for fissile material, the meaning c has been extended to include material that can be fissioned by fast neutrons, such

fluorides Gaseous or solid compounds containing fluorine emitted into the air fron industrial processes.

free liquid Liquid that is not absorbed into host material such that it could readi solid portion of a waste under ambient temperature and pressure and spill or drain

fugitive dust Dust that is stirred up and released into the atmosphere during const Fugitive emissions composed of particulate matter.

fugitive emissions Those emissions which could not reasonably pass through a stack vent, or other functionally equivalent opening.

gamma-emitter A radioactive substance that decays by releasing gamma radiation.
gamma ray (gamma radiation) High-energy, short wavelength electromagnetic radiatic packet of energy) emitted from the nucleus. Gamma radiation frequently accompanies emissions and always accompanies fission. Gamma rays are very penetrating and are t shielded against by dense materials, such as lead or uranium. Gamma rays are simila are usually more energetic.
generator (generation) Organizations of the DOE that produce waste.
geologic repository A system that is intended to be used for, or may be used for, radioactive waste or Spent nuclear fuel in excavated geologic media. A geologic rep (a) the geologic repository operations area, and (b)the portion of the geologic set isolation. A near-surface disposal area is not a geologic repository.
geothermal energy The energy available from natural sources of heat, such as hot s near-surface heat sources in volcanically active areas.
graded approach A process by which the level of analysis, documentation, and actic to comply with a requirement are commensurate with (a) the relative importance to s and security; (b) the magnitude of any hazard involved; (c) the lifecycle stage of programmatic mission of a facility; (e) the particular characteristics of a facilit relevant factor.
graphite fuel Fuel that consists of small pellets of highly enriched uranium (HEU) surrounded by protective layers of other carbide compounds. These pellets are dispe larger graphite structures for handling and neutron moderation.
greater-than-Class-C waste (GTCC) Low-level radioactive waste that is generated by commercial sector and that exceeds U. S. Nuclear Regulatory Commission concentratic Class-C low-level waste as specified in 10 CFR 61. DOE is responsible for the dispc than-Class-C wastes from DOE nondefense programs.
groundwater Generally, all water contained in the ground. Water held below the wat available to freely enter wells.
grouting Grouting is the process of immobilizing or fixing solid forms of waste sc more safely stored or disposed.
half-life The time in which half the atoms of a particular radioactive substance d another nuclear form. Measured half-lives vary from millionths of a second to billi Also called physical half-life.
hazard classification A safety classification based on potential onsite consequenc this classification are discussed in DOE Order 5480.23 (Nuclear Safety Analysis Rep
hazardous air pollutant Any air pollutant subject to a standard promulgated under Section 7412 or other requirements established under 42 U.S.C. Section 7412 of the including 42 U.S.C. Section 7412(g), (j), and (r) of the Clean Air Act.
hazardous substance Any substance that when released to the environment in an uncc unpermitted fashion becomes subject to the reporting and possible response provisic Water Act and the Comprehensive Environmental Response, Compensation, and Liability
hazardous waste Under the Resource Conservation and Recovery Act, a solid waste, c combination of solid wastes, which because of its quantity, concentration, or physi infectious characteristics may (a) cause, or significantly contribute to, an increa increase in serious irreversible, or incapacitating reversible, illness; or (b)pose or potential hazard to human health or the environment when improperly treated, stc or disposed of, or otherwise managed. Source, special nuclear material, and byprodu defined by the Atomic Energy Act, are specifically excluded from the definition of
hazardous waste landfill A disposal facility or part of a facility where hazardous in or on land and which is not a pile, a land treatment facility, a surface impounc underground injection well, a salt dome formation, a salt bed formation, an undergr cave.
heavy metals Metallic elements with high atomic weights (for example, mercury, chr cadmium, arsenic, and lead) that can damage living things at low concentrations anc accumulate in the food chain.
heterogeneous Pertaining to a substance having different characteristics in differ synonym is nonuniform.
high-efficiency particulate air (HEPA) filter A filter with an efficiency of at lea used to separate particles from air exhaust streams prior to releasing that air to
high-level waste The highly radioactive waste material that results from the reprc nuclear fuel, including liquid waste produced directly from reprocessing and any sc from the liquid that contains a combination of transuranic and fission product nucl that require permanent isolation. High-level waste may include other highly radioac the U. S. Nuclear Regulatory Commission, consistent with existing law, determines t permanent isolation.

Holocene In the geological scale of time, the more recent of the two epochs of the period (10,000 years ago to the present); that period of time since the last ice ag
hot cell/hot cell facility A heavily shielded enclosure for handling and processing means or automatically) or storing highly radioactive materials.
hydraulic conductivity Capacity of a porous media to transport water.
hydraulic gradient The slope of the water table per unit of distance, resulting in movement.
hydrogeochemistry The study of the chemical interactions between the earth's compo including rocks, minerals, and water.
hydrogeology The study of the geological factors relating to water.
hydrology The study of water, including groundwater, surface water, and rainfall.
infiltrate Water passing from the land surface through the vadose zone into the aq
intermittent surface water A stream, creek, or river which does not contain water d all of the year.
inadvertent intrusion The inadvertent disturbance of a disposal facility or its im environment by a potential future occupant that could result in loss of containment exposure of personnel. Inadvertent intrusion is a significant consideration that sh in the design requirements or waste acceptance criteria of a waste disposal facilit
incineration The efficient burning of combustible solid and liquid wastes to destr constituents and reduce the volume of the waste. Incinerators are designed to burn high efficiency. The greater the burning efficiency, the cleaner the air emission. radioactive materials does not destroy the radionuclides but does significantly red these wastes. High-efficiency particulate air (HEPA) filters are used to prevent ra heavy metals from going out of the stack and into the atmosphere.
industrial commercial waste Material that is not subject to Resource Conservation Act Subtitle C or Atomic Energy Act regulation. It is generated by manufacturing or processes. Industrial commercial waste is also known as solid waste and is regulate Conservation and Recovery Act, Subtitle D.
INEL industrial waste Industrial commercial waste generated at the INEL is categor industrial waste.
institutional control The control of waste management facilities by human institut
Interagency Agreement (IAG) See Federal Facility Agreement and Consent Order.
interim status facility See RCRA interim status facility.
Interim action (CERCLA) A remedial action undertaken to clean up or contain a pote to human health and the environment that can or should be addressed within a short study associated with an interim action may be completed within an "umbrella" remed investigation/feasibility study. Interim actions are completed on an accelerated sc deal with well-defined contamination problems that present a significant, although threat to human health and the environment.
interim action (NEPA) An action that may be undertaken while work on a required pr is in progress and the action is not covered by an existing program statement. An i not be undertaken unless such action: (a) is justified independently of the program accompanied by an adequate EIS or has undergone other NEPA review; and (c) will not ultimate decision on the program. Interim action prejudices the ultimate decision c when it tends to determine subsequent development or limit alternatives.
internal accidents Accidents that are initiated by man-made energy sources associa operation of a given facility. Examples include process explosions, fires, spills, forth.
inversion In the atmosphere, a condition in which air temperature warms with incre
isotope One of two or more atoms with the same number of protons, but different nu neutrons, in their nuclei. Thus, carbon-12, carbon-13, and carbon-14 are isotopes c carbon, the numbers denoting the approximate atomic weights. Isotopes have very nea chemical properties, but often different physical properties (for example, carbon-1 stable, carbon-14 is radioactive).
Kjeldahl nitrogen A method of nitrogen analysis designed to measure nitrogen prese organic compounds.
lacustrine Pertaining to, produced by, or formed in a lake or lakes; growing in or
Land Disposal Restrictions A Resource Conservation and Recovery Act (RCRA) program restricts land disposal of RCRA hazardous and RCRA mixed wastes and requires treatm promulgated treatment standards. Land Disposal Restrictions identify hazardous wast restricted from land disposal and define those limited circumstances under which an prohibited waste may continue to be land disposed.
land-use planning A decisionmaking process to determine the future or end use of a land, considering such factors as current land use, public expectations, cultural c

ecological factors, legal rights and obligations, technical capabilities, and costs
lapse In the atmosphere, a condition in which air temperature cools with increasin
less-than-go-day storage The onsite accumulation and/or storage of hazardous waste
of less than 90 days by a generator subject to the requirements of 40 CFR 262.34(a)
life cycle The entire time period from generation to permanent disposal or elimina
liquid metal fast breeder reactor A reactor that operates using a type of fission
fission where the neutrons that are used to split the atoms are not slowed down or
usually the case with normal fission. It creates more fissionable material than it
liquid metal as a coolant. Liquid sodium is a common metal used to cool this type c
listed waste Under the Resource Conservation and Recovery Act, waste listed in 40
Subpart D, as hazardous. Listed hazardous wastes include wastes from specific sourc
sources, and discarded commercial chemical products. These wastes have not been suk
toxicity characterization leaching procedure because the dangers they present are c
loess A homogeneous deposit consisting predominantly of silt, with subordinate amc
fine sand and/or clay.
long-term storage The storage of hazardous waste (a) Onsite (a generator site) for
days or greater, other than in a satellite accumulation area, or (b)off-site in a p
treatment, storage, or disposal facility for any period of time.
low-level waste Waste that contains radioactivity and is not classified as high-le
transuranic waste, or spent nuclear fuel. Test specimens of fissionable material ir
and development only, and not for the production of power or plutonium, may be clas
level waste, provided the concentration of transuranic elements is less than 100 na
of waste.
mafic Pertaining to or composed predominantly of the magnesian rock-forming silicat
some igneous rocks and their constituent minerals; synonymous with "dark minerals."
major radionuclides The radioisotopes that together comprise 95 percent of the tot
of a waste package by volume and have a half-life of at least 1 week. Radionuclides
important to a facility's radiological performance assessment and/or a safety analy
the facility's waste acceptance criteria are considered major radionuclides.
management (of spent nuclear fuel) Emplacing, operating, and administering facilit
transportation systems, and procedures to ensure safe and environmentally responsik
storage of spent nuclear fuel pending (and in anticipation of) a decision on ultima
maximally exposed co-located worker (MCW) A hypothetical individual defined to all
or dosage comparison with numerical criteria for co-located workers. This individu
whichever is the greater of 0.4 miles from the facility area boundary (that is, the
boundary) or 75 percent of the distance to the nearest independent facility area (t
population zone boundary). The MCW is irrelevant if the DOE site boundary is closer
MCW location.
maximally exposed individual (MEI) A hypothetical individual defined to allow dose
comparison with numerical criteria for the public. This individual is located at tk
site boundary nearest to the facility in question. Sometimes called maximally expos
individual (MOI).
maximally exposed offsite individual (MOI) A hypothetical individual defined to all
dosage comparison with numerical criteria for the public. This individual is locate
the DOE site boundary nearest to the facility in question. Sometimes called maximal
individual (MEI).
maximum concentration level These are the maximum concentrations of radionuclides
estimated to correspond to a lifetime cancer risk of 1/10,000, assuming a lifetime
of 2 liters of water. These concentrations assume radionuclides emit only one type
nonradioactive, noncarcinogenic compounds, maximum concentration levels are based c
observable effect levels.
maximum contaminant level (MCL) Under the Safe Drinking Water Act, the maximum
permissible concentrations of specific constituents in drinking water that are deli
public water system that serves 15 or more connections and 25 or more people. The s
maximum contaminant levels take into account the feasibility and cost of attaining
meteorological classifications Categories defining various states of atmospheric t
(dispersion and dilution) that are used to estimate diffusion of radioactive materi
accident scenarios. The criteria consider the relationship of wind speed, insolatic
incoming solar radiation), and cloudiness (see Brenk et al. 1983).

Average (50 percent) meteorology: Average meteorological dispersion condition
favorable and less favorable to dispersion conditions will each occur 50 perc
Conservative (95 percent) meteorology: Adverse meteorological dispersion conc
(unfavorable to dispersion) which will not occur more than 5 percent of the t
Neutral meteorology: Pasquill Stability Class D, conditions which neither enk

inhibit vertical diffusion in the atmosphere.
Stable meteorology: Pasquill Stability Class F, moderately stable conditions; atmospheric condition existing when the temperature of the air rises rather t altitude. It allows for little or no vertical air movement.

metric tons of heavy metal (MTHM) Quantities of unirradiated and spent nuclear fuel are traditionally expressed in terms of metric tons of heavy metal (typically urani inclusion of other materials, such as cladding, alloy materials, and structural mat is 1,000 kilograms, which is equal to about 2,200 pounds.

millirem One thousandth of a rem (see rem).

mitigation Those actions that avoid impacts altogether, minimize impacts, rectify or eliminate impacts, or compensate for the impact.

mixed waste Waste that contains both hazardous waste under the Resource Conservatic Recovery Act and source, special nuclear, or by-product material subject to the Atc 1954.

mixing depth The height to which pollutants can freely disperse, above which inver exist.

moment magnitude A measure of earthquake size. The rigidity of the rock times the a faulting times the amount of slip.

M(s) Surface wave magnitude; motion is restricted to near the ground surface. Such correspond to ripples of water that travel across a lake. Most of the wave motion i outside surface itself; and, as the depth below this surface increases, wave displa and less.

nanocurie One billionth of a curie (see curie).

National Environmental Policy Act of 1969 (NEPA) A law that requires Federal agenc include in their decisionmaking processes appropriate and careful consideration of environmental effects of proposed actions, analyses of their alteratives, and measu minimize adverse effects of a proposed action that have the potential for significa environment. These analyses are presented in either an environmental assessment (EA environmental impact statement (EIS).

National Oceanic and Atmospheric Administration (NOAA) A Federal agency that colle and analyzes information on the weather. NOAA has an office at INEL for collecting information. NOAA also is involved with the environmental monitoring programs at IN

National Priorities List (NPL) A formal listing of the nation's worst hazardous wa established by the Comprehensive Environmental Response, Compensation, and Liabilit (CERCLA), that have been identified for remediation.

natural phenomena accidents Accidents that are initiated by phenomena such as earth tornadoes, floods, and so forth.

near-surface disposal Disposal in the uppermost portion of the earth, approximatel Near-surface disposal includes disposal in engineered facilities that may be built above-grade provided that such facilities have protective earthen covers. A near-su facility is not considered a geologic repository.

nearest public access For facility accident analyses, the location of the nearest where members of the public could be present.

new facilities Any facility that is not an existing facility or an existing hazard management facility.

nitrogen oxides (N0x) Gases formed in great part from atmospheric nitrogen and oxyg combustion takes place under conditions of high temperature and high pressure; cons air pollutant. Two major nitrogen oxides, nitric oxide (NO) and nitrogen dioxide ( important airborne contaminants. In the presence of sunlight, nitric oxide combines oxygen to produce nitrogen dioxide, which in high enough concentrations can cause l

nonattainment area Any area which has been designated as not meeting (or contribut ambient air quality in a nearby area that does not meet) the national primary or se quality standard for the pollutant.

noncertifiable waste Waste that is not able to meet the waste acceptance criteria treatment, storage, or disposal facility; transportation requirements; or waste tha to characterize adequately to prove that it meets the applicable criteria.

nonreactor nuclear facility Those activities or operations that involve radioactive fissionable materials in such form and quantity that a nuclear hazard potentially e employees or to the general public. These activities or operations include producin storing radioactive liquid or solid waste, fissionable materials, or tritium; condu operations; conducting inspections of irradiated materials, fuel fabrication, decon recovery operations; conducting fuel enrichment operations; or performing environme or waste management activities involving radioactive materials.

nonhazardous Waste that does not pose risks to human health and the environment.

Industrial/commercial waste is an example (see hazardous waste).
normal conditions All activities associated with a facility mission, whether operat
maintenance, storage, and so forth, which are carried out within a defined envelope
can be design process conditions, performance in accordance with procedure, and so
normal operation All normal conditions and those abnormal conditions that frequenc
techniques indicate occur with a frequency greater than 0.1 events per year.
NO(x) A generic term used to describe the oxides of nitrogen (see nitrogen oxides)
nuclear criticality A self-sustaining chain reaction that releases neutrons and en
radioactive by-product material.
nuclear fuel Materials that are fissionable and can be used in nuclear reactors tc
nuclide A general term referring to all known isotopes, both stable (279) and unst
5,000), of the chemical elements.
off-link doses Doses to members of the public within 800 meters (2,625 feet) of a
railway.
offsite facility A facility located at a different site or location than the shipp
offsite population For facility accident analyses, the collective sum of individual
an 80-kilometer (50-mile) radius of the INEL facility and within the path of the pl
blowing in the most populous direction.
on-link doses Doses to members of the public sharing a road or railway.
onsite The same or geographically contiguous property that may be divided by public
right-of-way, provided the entrance and exit between the properties is at a cross-r
and access is by crossing as opposed to going along the right-of-way. Non-contiguou
owned by the same person but connected by a right-of-way that he/she controls and t
public does not have access is also considered onsite property.
onsite facilities Buildings and other structures, their functional systems and equ
fixed systems and equipment installed onsite.
operable unit A discrete portion of a Waste Area Group (WAG) consisting of one or
sites considered together for assessment and cleanup activities. The primary criter
release sites into an operable unit include geographic proximity, similarity of was
site types, and the possibilities for economy of scale.
operator The organization that operates a facility.
organic compounds Chemicals containing mainly carbon, hydrogen, and oxygen. Petrol
products, petroleum-based solvents, and pesticides are samples of organic compounds
some organic compounds can produce toxic effects on body tissues and processes.
orphan wastes Wastes in a classification that currently have no long-term disposal
anticipated. An example of an orphan waste is low-level mixed waste. Orphan waste i
radioactive enough to qualify for disposal at the Waste Isolation Pilot Plant and i
of onsite because it has hazardous components.
orthophosphate The phosphate ions including H(2)O(4), HPO(4)^2-, and PO(4)^3-.
overpack A secondary container placed around a primary container to provide additi
to or from the contents of a waste package or enclose a damaged primary container.
package The packaging plus its contents.
packaging A receptacle and any other components or materials necessary for the rec
perform its required containment function.
particulate matter Any material, except water in uncombined form, that exists as a
solid at standard conditions.
passivation The process of making metals inactive or less chemically reactive. For
passivate the surface of steel by chemical treatment.
perched water A discontinuous saturated water body above the water table with unsa
conditions existing both above and below.
perennial surface water A stream, creek, lake, pond, or river which contains water
performance assessment A systematic analysis of the potential risks posed by waste
management systems to the public and environment and a comparison of those risks tc
performance objectives.
performance assessment limited waste Special-case waste comparable to greater-than-
waste but generated by the government. This is a low-level waste but has unique cha
make it unsuitable for shallow land burial.
performance-assessment-limited alpha waste Any alpha-contaminated waste, not meeti
definition of transuranic waste, that cannot be disposed of by shallow land burial,
documented site-specific performance assessment approved by the DOE Operations Offi
Headquarters.
performance objectives Parameters within which a facility must perform to be consi
acceptable.
permeability The degree of ease with which water can pass through a rock or soil.

person-rem A unit of collective radiation dose applied to populations or groups of
collective dose).
playa The shallow central basin of a desert plain in which water gathers and then
Pleistocene The older of the two epochs of the Quaternary period (2 million to 10,0
plume The three-dimensional area containing measurable concentrations of a compoun
which has migrated from its source point.
PM-10 All particulate matter in the ambient air with an aerodynamic diameter less
a nominal ten (10) micrometers.
pollutant migration The movement of a contaminant away from its initial source.
pollution prevention The use of any process, practice, or product that reduces or
generation and release of pollutants, hazardous substances, contaminants, and waste
that protect natural resources through conservation or more efficient utilization.
polychlorinated biphenyls (PCBs) A class of chemical substances formerly manufactu
insulating fluid in electrical equipment that is highly toxic to aquatic life. In t
exhibit many of the characteristics of dichloro diphenyl trichloroethane (DDT); the
environment for a long time and accumulate in animals.
population dose The overall dose to the offsite population.
porosity (n) Porosity is an index of the relative pore volume. It is the total uni
or rock divided into the void volume.
preferential pathways Preferred pathways for fluid flow. They are dependent upon t
content of the porous media.
pressurized water reactor A nuclear power reactor that uses water under pressure as
The water boiled to generate steam is in a separate system.
primary ambient air quality standard That air quality that, allowing an adequate m
safety, is requisite to protect the public health.
probable maximum flood The largest flood for which there is any reasonable expecta
specific area. The probable maximum flood is normally several times larger than the
record.
process knowledge The set of information that is used by trained and qualified indi
are cognizant of the origin, use, and location of waste-generating materials and pr
detail so as to certify the identity of the waste.
processing (of spent nuclear fuel) Applying a chemical or physical process designed
characteristics of a spent nuclear fuel matrix.
public Anyone outside the DOE site boundary at the time of an accident or during n
operation. With respect to accidents analyzed in this EIS, anyone outside the DOE s
the time of an accident.
quality assurance All those planned and systematic actions necessary to provide ad
confidence that a facility, structure, system, or components will perform satisfact
service. Quality assurance includes quality control, which is all those actions nec
verify the features and characteristics of a material, process, product, or service
requirements.
quality factor (Q) The modifying factor that is used to derive dose equivalent frc
Quaternary The younger of the two geologic periods in the Cenozoic Era (2 million y
the present). Quaternary is subdivided into the Pleistocene and Holocene epochs.
rad The special unit of absorbed dose. One rad is equal to an absorbed dose of 100
radiation (ionizing radiation) Alpha particles, beta particles, gamma rays, x-rays
speed electrons, high-speed protons, and other particles capable of producing ions.
used in this EIS, does not include nonionizing radiation, such as radio- or microwa
infrared, or ultraviolet light.
radiation worker A worker who is occupationally exposed to ionizing radiation and
specialized training and radiation monitoring devices to work in such circumstances
radioactive waste Waste that is managed for its radioactive content.
radioactivity The property or characteristic of material to spontaneously "disinte
emission of energy in the form of radiation. The unit of radioactivity is the curie
radioisotope An unstable isotope, of an element, that decays or disintegrates spon
emitting radiation. Approximately 5,000 natural and artificial radioisotopes have b
radiological survey The evaluation of the radiation hazards accompanying the produ
existence of radioactive materials under a specific set of conditions. Such evaluat
includes a physical survey of the disposition of materials and equipment, measureme
of the levels of radiation that may be involved, and a sufficient knowledge of proc
materials to predict hazards resulting from unexpected or possible changes in mater
Radiological and Environmental Sciences Laboratory (RESL) A facility involved in
environmental monitoring of INEL onsite and offsite radiation and research on its e
radionuclide See radioisotope.

RCRA See Resource Conservation and Recovery Act.
RCRA accumulation point There are two types of accumulation areas allowed under the Resource Conservation and Recovery Act (RCRA):

Satellite Accumulation Areas (SAAs): Locations where hazardous waste generat allowed to accumulate waste at or near the point of generation. Generators m up to 55 gallons of hazardous waste or one quart of acutely hazardous waste point of generation. Upon reaching 55 gallons, the generator has 72 hours tc hazardous waste to either a temporary accumulation area or a permitted facil

Temporary Accumulation Areas (TAAs): Under RCRA, the location where hazardous waste may be stored by a generator without a RCRA permit, TAAs are limited by of time they can store a hazardous waste. Generators may store hazardous wast 90 days without a permit if the generator complies with other safety and stor including a personnel training plan, a contingency plan, and an emergency pre response plan.

RCRA interim status facility Hazardous waste management facilities (that is, treat or disposal facilities) subject to Resource Conservation and Recovery Act requireme existence on the effective date of regulations are considered to have been issued a interim basis as long as they have met notification and permit application submissi Such facilities are required to meet interim status standards until they have been or until their interim status is withdrawn.
RCRA storage A facility used to store Resource Conservation and Recovery Act (RCRA hazardous waste for greater than 90 days. To be in compliance with the regulatory r RCRA, the facility must meet both documentation requirements (for example, continge analysis plans) and physical requirements (for example, specific aisle widths and s incompatible wastes).
reclassified low-level waste See alpha low-level waste.
Record of Decision (ROD) A public document that records the final decision(s) conc proposed action. The Record of Decision is based in whole or in part on information analysis generated either during the Comprehensive Environmental Response, Compensa Liability Act (CERCLA) process or the National Environmental Policy Act (NEPA) proc which take into consideration public comments and community concerns.
recycling Recycling techniques are characterized as use, reuse, and reclamation te (resource recovery). Use or reuse involves the return of a potential waste material originating process as a substitute for an input material or to another process as Reclamation is the recovery of a usefill or valuable material from a waste stream. potential waste materials to be put to a beneficial use rather than going to treatm disposal.
regulated substances A general term used to refer to materials other than radionuc regulated by Federal, State, (or possibly local) requirements.
release site A location at which a hazardous, radioactive, or mixed waste release is suspected to have occurred. It is usually associated with an area where these wa contaminated with them, have been used, treated, stored, and/or disposed of.
rem The dosage of an ionizing radiation that will cause the same biological effect of X-ray or gamma-ray exposure.
remedial investigation (RI) The Comprehensive Environmental Response, Compensation Liability Act of 1980 (CERCLA) process of determining the extent of hazardous subst contamination and, as appropriate, conducting treatability investigations. The RI p site-specific information for the feasibility study (FS).
remediation Process of remedying a site where a hazardous substance release has oc
remote-handled waste Packaged waste whose external surface dose rate exceeds 200 m per hour.
remote handling The handling of wastes from a distance so as to protect human oper unnecessary exposure.
repository A permanent deep geologic disposal facility for high-level or transuran spent nuclear fuel.
representative sample A sample of a universe or whole (for example, waste pile, la water) that can be expected to exhibit the average properties of the universe or wh
reprocessing (of spent nuclear fuel) Processing of reactor irradiated nuclear mate spent nuclear fuel) to recover fissile and fertile material, in order to recycle su for defense programs. Historically, reprocessing has involved aqueous chemical sepa elements (typically uranium or plutonium) from undesired elements in the fuel.
research reactor A nuclear reactor used for research and development.
Resource Conservation and Recovery Act (RCRA) A Federal law addressing the managem of waste. Subtitle C of the law addresses hazardous waste under which a waste must

"listed" on one of the U. S. Environmental Protection Agency's (EPA's) hazardous wa meet one of EPA's four hazardous characteristics of ignitability, corrosivity, reac measured using the toxicity characterization leaching procedure (TCLP). Cradle-to-g management of wastes classified as RCRA hazardous wastes must meet stringent guidel environmental protection as required by the law. These guidelines include regulatic transportation, treatment, storage, and disposal of RCRA-defined hazardous waste. S law addresses the management of nonhazardous, nonradioactive, solid waste, such as wastes.

retrieval The process of recovering wastes that have been stored or disposed of on be appropriately characterized, treated, and disposed of.

rhyolite A very acid volcanic rock that is the lava form of granite.

risk Quantitative expression of possible loss that considers both the probability harm and the consequences of that event.

roentgen A unit of exposure to ionizing radiation. It is that amount of gamma or X to produce ions carrying one electrostatic unit of electrical charge in one cubic c under standard conditions.

safe and secure Storage with design and operational features that maintain the int cladding, prevent criticalities, preclude diversion, and so forth. Safe and secure generally meet the intent of DOE Orders, but waivers may be required and granted fc requirements on a case-by-case basis where warranted.

safety analysis report A report, prepared in accordance with DOE Orders 5481.1B an that summarizes the hazards associated with the operation of a particular facility safety requirements.

safety class structures, systems, and components Those systems, structures, or com whose functioning is necessary to keep maximally exposed offsite individual (MOI) e dose of 25 rem or an Emergency Response Planning Guideline-2 dosage for design basi and evaluation basis accidents.

sanitary landfill A facility for the disposal of solid waste where there is no rea of adverse effects on health or the environment from disposal of the solid waste at facility is not an open dump and is not for disposal of hazardous waste.

sanitary waste Liquid or solid wastes that are generated as a result of routine ope facility and are not considered hazardous, or radioactive.

satellite accumulation See RCRA accumulation point.

saturated zone That part of the earth's crust in which all naturally occurring voi water.

scaling factor A multiplier that allows the inference of one radionuclide concentr another that is more easily measured.

scientific notation A notation adopted by the scientific community to deal with ve very small numbers by moving the decimal point to the right or left so that only on zero is to the left of the decimal point. Scientific notation uses a number times t positive or negative exponent to show how many places to the left or right the deci moved. For example, in scientific notation, 120,000 would be written as 1.2 x 10^5, would be written as 1.2 x 10^-5. In a variation of scientific notation often used i the multiplication sign and number 10 are replaced by the letter E. The above numbe written as 1.2E5 and 1.2E-5, respectively.

scrubber A device that uses a liquid spray to remove aerosol and gaseous pollutant airstream. The gases are removed either by absorption or chemical reaction. Solid a particulates are removed through contact with the spray.

secondary ambient air quality standard That air quality which is requisite to prot welfare from any known or anticipated adverse effects associated with the presence the ambient air.

secondary emissions Emissions which would occur as a result of the construction, m or operation of a stationary source or facility but do not come from the stationary itself.

sedimentary interbeds Rock layers composed of materials, such as sand or gravel, w derived from the breakdown of various rocks that are layered between other rock typ

segregation The process of separating (or keeping separate) individual waste types order to facilitate their cost-effective treatment and storage or disposal.

seismicity The phenomenon of earth movements; seismic activity. Seismicity is rela location, size, and rate of occurrence of earthquakes.

site inspection The Comprehensive Environmental Response, Compensation, and Liabili 1980 (CERCLA) process to acquire the necessary data to confirm the existence of env contaminatiOn and to assess the associated potential risks to human health, welfare environment. The data collected must be sufficient to support the decision either f

a remedial investigation/feasibility study (RI/FS) or for removing the site from fu through a decision document.

site waste management organization The functional organization at a DOE site whose responsibility it is to manage waste generated by that site's operations.

sizing The process of reducing the size of various types of solid wastes by compac mechanical reduction.

small quantity generator A generator who generates less than 1,000 kilograms of haz waste in a calendar month.

sodium-bearing waste Liquid radioactive waste generated from decontamination of pr equipment and other miscellaneous activities at the Idaho Chemical Processing Plant

sole source aquifer A designation granted by the U. S. Environmental Protection Ag groundwater from a specific aquifer supplies more than 50 percent of the drinking w overlying the aquifer. Sole source aquifers have no alternative source or combinat which could physically, legally, and economically supply all those who obtain their from the aquifer. Sole source aquifers are protected from federally financially ass determined to be potentially unhealthy for the aquifer.

solid waste Any garbage, refuse, or sludge from a waste treatment plant, water sup plant, or air pollution control facility and other discarded material, including sc or contained gaseous material resulting from industrial, commercial, mining, and ag operations, and from community activities. It does not include solid or dissolved m sewage, or solid or dissolved materials in irrigation return flows or industrial di point sources subject to permits under Section 402 of the Federal Water Pollution C amended, or source, special nuclear, or by-product material as defined by the Atomi 1954, as amended [Public Law 94-580, 1004(27) (Resource Conservation and Recovery A

solid waste management units (SWMU) Any site, excluding Land Disposal Units, that or handled solid waste, whether or not hazardous constituents were involved.

solvents Liquid chemicals, usually organic compounds, that are capable of dissolvi substance. Exposure to some organic solvents can produce toxic effects on body tiss processes.

source material (a) Uranium, thorium, or any other material that is determined by Regulatory Commission pursuant to the provisions of the Atomic Energy Act of 1954, be source material; or (b)ores containing one or more of the foregoing materials, i concentration as the Nuclear Regulatory Commission may by regulation determine from [Atomic Energy Act 11 (z)]. Source material is exempt from regulation under the Res Conservation and Recovery Act.

source term The type and quantity of pollutants emitted to air from a specific sou sources.

SO(x) A generic term used to describe the oxides of sulfur. The combination of sul water vapor produces acid rain (see sulfur oxides).

special nuclear material (a) Plutonium or uranium enriched in the isotope 233, or 235, and any other material that the U. S. Nuclear Regulatory Commission, pursuant provisions of the Atomic Energy Act of 1954, Section 51, determines to be special n or (b) any material artificially enriched by any of the foregoing, but does not inc Special nuclear material is exempt from regulation under the Resource Conservation Act (RCRA).

special-case waste Radioactive waste owned or generated by DOE that does not fit i management plans developed for the major radioactive waste types.

spent nuclear fuel Fuel that has been withdrawn from a nuclear reactor following i constituent elements of which have not been separated. For the purposes of this EIS fuel also includes uranium/neptunium target materials, blanket subassemblies, piece debris.

stabilization (of spent nuclear fuel) Actions taken to further confine or reduce t associated with spent nuclear fuel, as necessary for safe management and environmen storage for extended periods of time. Activities that may be necessary to stabilize include canning, processing, and passivation.

stabilized waste (stability) Treatment or packaging of a waste stream that is inten that the waste does not structurally degrade and affect overall stability of the di slumping, collapse, or other types of failures that will lead to water infiltration Stabilization is also a factor in limiting exposure to an inadvertent intruder sinc recognizable and nondispersible waste.

stable Low potential for vertical mixing.

stakeholder Any person or organization with an interest in or affected by DOE acti Stakeholders may include representatives from Federal agencies, State agencies, Con American Tribes, unions, educational groups, industry, environmental groups, other

members of the general public.
stationary source Any building, structure, emissions unit, or installation which e any air pollutant.
storage The collection and containment of waste or spent nuclear fuel in such a ma constitute disposal of the waste or spent nuclear fuel for the purposes of awaiting disposal capacity (that is, not short-term accumulation).
storativity Storativity of a saturated aquifer is defined as the volume of water t the aquifer releases from storage under a unit decline in hydraulic head.
sulfur oxides Pungent, colorless gases formed primarily by the combustion of fossil considered major air pollutants, sulfur oxides may damage the respiratory tract as (see SOx).
subsurface The area below the land surface (including the vadose zone and aquifers
superfund The common name used for the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and its amendments.
superfund site Any site that has been listed on the National Priority List (NPL) b been identified by the EPA as having the potential to harm human health and the env and cleanup activities at these sites are regulated by the Comprehensive Environmen Compensation, and Liability Act (CERCLA). "Superfund" sites at Federal facilities m up by the operating agency (lead agency) under the oversight of the U. S. Environme Agency and other parties to a Federal Facility Agreement.
surface dose The radiological dose emanating from a container of material (waste), expressed as a measurement at contact and at one meter.
tank A stationary device designed to contain an accumulation of waste, which is cc primarily of non-earthen materials (for example, wood, concrete, steel, plastic) wh structural support.
target A tube, rod, or other form containing material that, on being irradiated in would produce a designed end product (that is, uranium-238 produces plutonium-239 a 237 produces plutonium-238).
technical safety requirement Those requirements that define the conditions, safe b the management or administrative controls necessary to ensure the safe operation of and reduce the potential risk to the public and co-located workers from uncontrolle radioactive materials, radiation exposure due to inadvertent criticality, or uncont nonradiological material or energy hazards.
tectonics Geological structural features as a whole, or a branch of geology concer structure of the crust of a planet and especially with the formation of folds and f
tephra Solid material ejected into the air during a volcanic eruption, including v and cinders.
Tertiary The older of the two geologic periods in the Cenozoic Era (63 to 2 million
thermal treatment The treatment of hazardous waste in a device which uses elevated as the primary means to change the chemical, physical, or biological character or c hazardous waste. Examples of thermal treatment processes are incineration, molten s calcination, wet air oxidation, and microwave discharge.
total effective dose equivalent The sum of the external dose equivalent (for exter and the committed effective dose equivalent (for internal exposures).
total suspended particulates All particulate matter in the ambient air as measured method described in Appendix B of 40 CFR Part 50.
toxic air pollutant Under the Idaho Air Quality Control Regulations, any air pollu determined by the Idaho Department of Health and Welfare to be, by its nature, toxi animal life or vegetation.
toxic air pollutant reasonably available control technology (T-RACT) An emission st based on the lowest emission of toxic air pollutants that a particular source is ca the application of control technology that is reasonably available, as determined b Department of Health and Welfare, considering technological and economic feasibilit
toxicological hazard Any material defined in 40 CFR 355 Appendix A as an extremely substance.
transient A change in the reactor coolant system temperature and/or pressure. Tran caused by adding or removing neutron poisons, by increasing or decreasing the elect turbine generator, or by accident conditions.
transmissivity The rate at which water of a prevailing density and viscosity is tr a unit width of an aquifer under a unit hydraulic gradient. It is a function of prc the porous media, and the thickness of the porous media.
transuranic waste Waste containing more than 100 nanocuries of alpha-emitting tran isotopes with half-lives greater than 20 years per gram of waste, except for (a) hi waste; (b)waste that the U. S. Department of Energy has determined, with the concur

Administrator of the U. S. Environmental Protection Agency, does not need the degre required by 40 CFR 191; or (c) waste that the U. S. Nuclear Regulatory Commission h for disposal on a case-by-case basis in accordance with 10 CFR 61.

transuranium radionuclide Any radionuclide having an atomic number greater than 92

treatment Any method, technique, or process designed to change the physical or che character of the waste to render it less hazardous, safer to transport, store or di volume.

treatment facility Land area, structures, and/or equipment used for the treatment nuclear fuel.

ultimate disposition The final step in which a material is either processed for sc disposed of.

United States Geological Survey (USGS) A Federal agency that collects and analyzes mation on geology and geological resources including ground and surface water.

vadose zone The zone between the land surface and the water table. Saturated bodie perched groundwater, may exist in the vadose zone. Also called the zone of aeration unsaturated zone.

vapor vacuum extraction (VVE) A technology that applies a vacuum to a well field t volatile organic contamination from soils and permeable rock layers in that well fi

vitrification The process of immobilizing waste material that results in a glass-l

volatile organic compound (VOC) Chemical containing mainly carbon, hydrogen, and c that readily evaporates at ambient temperature. Exposure to some organic compounds toxic effects on body tissue and processes.

Volcanic Rift Zones Linear belts of basaltic vents marked by open fissures, monocli normal faults. Volcanic rift zones were produced during the propagation of vertical dikes that fed surface eruptions.

vulnerabilities Conditions or weaknesses that may lead to radiation exposure to th unnecessary or increased exposure to the workers, or release of radioactive malrial environment. For example, some DOE facilities have had leakage from spent fuel stor excessive corrosion of fuel causing increased radiation levels in the pool, or degr systems. Vulnerabilities are also caused by loss of institutional controls, such a funding or reductions in facility maintenance and control.

waste Any waste defined as solid waste by 40 CFR 261.2. Solid waste excluded from by the Resource Conservation and Recovery Act (RCRA) is still considered a waste. T wastes of all types (solid, liquid, gaseous, hazardous, radioactive, sanitary, and

waste acceptance criteria (WAC) The requirements specifying the characteristics of waste packaging acceptable to a waste receiving facility; and, the documents and pr generator needs to certify that waste meets applicable requirements.

waste acceptance specifications The functions to be performed and the technical rec for a Waste Acceptance System for accepting spent nuclear fuel and high-level waste Radioactive Waste Management System according to the Waste Acceptance System Requir Document (DOE/RW-0352P, January 1993, Office of Civilian Radioactive Waste Manageme

waste analysis plan (WAP) A plan that specifies the parameters for which each wast analyzed. These include a testing and sampling method(s), timing, and the rationale or the facility operator responsible for treatment, storage, or disposal. It ensure type and composition determinations are made as required by law, regulation, or goc

waste area group (WAG) Ten groupings of release sites under the INEL Federal Facil Agreement and Consent Order (FFA/CO). Groupings are for efficiency in managing the and cleanup process. Nine of these WAGs are associated with specific facilities, an associated with the remaining miscellaneous facilities. Each WAG may be broken down individual operable units.

waste certification A process by which a waste generator certifies that a given wa stream meets the waste acceptance criteria of the facility to which the generator i waste for treatment, storage, or disposal. Certification is accomplished by a combi characterization, documentation, quality assurance, and periodic audits of the cert

waste certification plan A plan or collection of plans used by a generator to spec which waste is prepared and certified to meet applicable waste acceptance and safet hazardous and radiological waste handling, treatment, transportation, and packaging other local or site requirements. Certification plans result in developing the infc receiving facility needs to confirm the suitability of waste for acceptance.

waste certification program A systematic approach to ensure that waste characteriza conducted in a manner to provide reasonable assurance that the receiving facility's criteria are met. A waste certification program consists of all the functional elem and activities necessary to provide reasonable assurance that waste characterizatic sufficient accuracy to ensure proper handling. These functions can be performed by

organizations.
waste characterization See characterization.
waste container A receptacle for waste, including any liner or shielding material to accompany the waste in disposal.
waste generation Any waste (after being declared a waste, see "waste") produced du particular calendar year. This does not include waste produced in previous years th repacked, treated, or disposed of in the current calendar year. It does include any (for example, clothing, gloves, waste from maintenance operations, and so forth) ge treatment, storage, or disposal activities of previously generated wastes.
waste generator organization Any organization that is responsible for the individua of waste.
Waste Isolation Pilot Plant (WIPP) A facility near Carlsbad, New Mexico, authorize demonstrate safe disposal of defense-generated transuranic waste in a deep geologic
waste management The planning, coordination, and direction of those functions rela generation, handling, treatment, storage, transportation, and disposal of waste, as surveillance and maintenance activities.
waste management facility All contiguous land, structures, other appurtenances, an improvements on the land, used for treating, storing, or disposing of waste or spen facility may consist of several treatment, storage, or disposal operational units ( more landfills, surface impoundments, or combinations of them).
waste management program A systematic approach to organize, direct, document, and activities associated with waste generation, treatment, storage, or disposal. A wa program consists of all the functional elements, organizations, and activities that needed to properly manage waste. These functions and activities can be performed by organizations.
waste management systems assessment A systems assessment of the entire low-level wa management (or all of waste management) structure/program at a given site that cons storage, and disposal, as well as onsite and offsite points of generation with an e optimization of all aspects of the operations, including, but not limited to, prote and the environment, regulatory compliance, and cost effectiveness.
waste minimization An action that economically avoids or reduces the generation of source reduction, reducing the toxicity of hazardous waste, improving energy usage, These actions will be consistent with the general goal of minimizing present and fu human health, safety, and the environment.
waste receiving facility A facility that formally accepts waste from a waste gener for treatment, storage, or disposal.
waste segregation The process of separating (or keeping separate) individual waste forms in order to facilitate their cost-effective treatment and storage or disposal
waste stream A waste or group of wastes with similar physical form, radiological p U. S. Environmental Protection Agency waste codes, or associated land disposal rest standards. It may be the result of one or more processes or operations.
waste type The waste types being considered in this EIS are high-level waste, tran mixed low-level waste, low-level waste, hazardous waste, or nonhazardous waste.
water pool A type of facility usually used for the storage of irradiated nuclear m fuel. The water shields the material being stored while allowing it to be accessibl Sometimes referred to as a water pit.
water table The surface below which is saturated with water (an aquifer) and above saturated with water (the vadose zone).
weathering The process by which rocks are broken down and decomposed by the physic chemical actions of wind, rain, temperature change, plant colonization, and bacteri
weighing factor (W (T)) For an organ or tissue, (W (T)) is the proportion of the ri (cancer fatalities) resulting from irradiation of that organ or tissue to the total (cancer fatalities) when the whole body is irradiated uniformly.
wet storage Storage of spent nuclear fuel in a pool of water, generally for the pu and/or shielding.
zone of aeration See vadose zone.
zone of saturation That part of the earth's crust in which all voids are filled wi

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# APPENDIX F TECHNICAL METHODOLOGIES AND KEY DATA

## F-1 Socioeconomics

**SECTION F-1 CONTENTS**



TABLES

by fiscal year, including baseline effects

F-1-7. Baseline employment: Idaho National Engineering Laboratory direct employment, secondary employment, and total employment

**#F-1 SOCIOECONOMICS**

The socioeconomic impact analysis conducted for this Environmental Impact Sta potential effects of the proposed Idaho National Engineering Laboratory (INEL) alte economic resources of the region of influence, defined in terms of employment, inco education, and community services. The changes in U.S. Department of Energy (DOE) workforce, and payroll that would occur under each of the alternatives impact the c effects on regional business activity and employment. Changes in DOE expenditures services, as well as changes in household expenditures made by INEL employees, affe business activity generated within the region of influence, the demand for communit care and public education), and the ability of local government agencies to fund su

This analysis evaluates the effects of the proposed alternatives relative to conditions described in Section 4.3, Socioeconomics, in Volume 2 of this Environmen The existing and projected economic conditions in the region of influence provide t assessing the impacts of the socioeconomic effects that may result from implementat alternatives. The impact analysis, as described in the following methodology secti the alternatives on regional employment (the number of direct and secondary jobs) a wages and salaries, proprietors' income, and other labor income). These employment then generate potential changes in regional population and demand for housing and c

In general, the results of the impact analysis indicate that each of the prop generate initial increases in employment within the region of influence, primarily activities. Alternatives A (No Action) and C (Minimum Treatment, Storage, and Disp phaseout of the Expanded Core Facility, would result in employment declines by 2004 (Ten-Year Plan) and D (Maximum Treatment, Storage, and Disposal) would result in em However, the projected decreases in baseline expenditures and employment at INEL ar magnitude to offset any increases projected as a result of the proposed alternative cumulative socioeconomic impact of INEL activity over the forecast horizon would be employment and economic activity.

## F-1.1 Region of Influence

The analysis of socioeconomic impacts is limited to the seven-county area sur comprised of Bannock, Bingham, Bonneville, Butte, Clark, Jefferson, and Madison cou influence was determined according to the following criteria:

- Counties that contain the residences of at least 85 percent of the curr and construction workforce

- Counties in which the resident INEL workforce comprises 5 percent or gr county's civilian labor force.

## F-1.2 Methodology and Key Assumptions

The analysis of socioeconomic impacts considers both impacts on economic acti changes in employment and earnings, and the community, as measured by changes in po demand for housing and community services. The impact analysis conducted for Volum Nuclear Fuel and INEL Environmental Restoration and Waste Management Environmental (SNF and INEL EIS) estimates the potential social and economic impacts expected to of influence as a result of implementation of any of the proposed INEL environmenta management alternatives.

The socioeconomic impacts estimated in this analysis would be generated by th expenditures and employment at INEL, which includes employment at DOE and site-rela subcontractors, and would consider both direct and secondary effects. Direct impac changes in INEL employment and earnings that occur during the construction and oper

alternative over the period of analysis and the resultant effects on regional popul community services.

Secondary impacts include both indirect and induced impacts. Indirect impact regional economic activity that result from changes in DOE purchases of goods and s expected to occur under any of the alternatives. Induced impacts are the additiona economic activity that result from changes in the household spending of employees w by (a) the change in employment at INEL and (b) the change in employment at regiona from the indirect impacts to regional economic activity.

## F-1.2.1 Economic Activity

Analysis of socioeconomic effects utilized total output, employment, and earn region of influence, obtained from the U.S. Bureau of Economic Analysis Regional In System (RIMS II). Interindustry multipliers were prepared by the Bureau of Economi United States input-output table in combination with the most recent region-specifi the relationship of the regional economy to the national economy. The Bureau of Ec II model is based on research by Cartwright et al. (1981).

The direct economic impacts of each alternative were estimated based on proje descriptions developed by DOE, INEL contractors, and their representatives. The pr descriptions identify employment and expenditure requirements during the preconstru operations phases of each alternative. (For the purposes of this analysis, precons activities were combined.) Direct earnings were estimated based on average INEL wa direct employment impact under each alternative represents only the additional or n expected to occur under implementation of an alternative. The reassignment of exis would not represent a change in total INEL staffing; therefore is not included as p impact.

These direct effects were then multiplied, using RIMS II coefficients specifi economy, to provide estimated total employment and earnings associated with the pro Input-output sectors were selected to appropriately reflect the activities associat alternatives in order to capture the economic characteristics of each scenario with For the purposes of this analysis, the construction activities under each alternati Construction Industry, and the operations phase activities are represented by the C Refining Industry.

The number of in-migrant or out-migrant workers associated with implementatio was estimated according to a set of proportional assumptions. Most INEL employees which increases the likelihood of migration from the area. Construction and relate employed under service contracts at the site, many of which are in lower-skilled po the likelihood of out-migration.

## F-1.2.2 Population and Housing

Population changes associated with projected baseline conditions and the prop an important determinant of other socioeconomic and environmental impacts. These p three key components: (a) baseline growth, (b) relocation of workers and their dep increase of population (births minus deaths) over the long term. The projected pop region of influence, as presented in Section 4.3, assumed continuation of current o forecasts were then adjusted to reflect the impacts of projected baseline decreases the potential effects of each of the alternatives.

The relocation of workers in response to the projected declines in baseline a implementation of each of the alternatives was determined by utilizing the methods discussed in Section F-1.2.1. The number of dependents expected to relocate with t estimated based on household-size parameters derived from U.S. Census Bureau demogr

The population changes associated with the alternatives would result in furth demand. Housing demand impacts were estimated from migration projected for each sc in-migrating household would require one unit and each out-migrating household woul The number of relocating households was determined assuming that each relocating wo single household.

Expected housing availability was considered for the region of influence and on recent housing market conditions and vacancy trends. Projected demands associat were then assessed in the context of recent housing construction trends and vacanci

### F-1.2.3 Community Services and Public Finance

Potential impacts to local community services due to changes in demand associ proposed alternatives were determined for the region's key public services. Impact jurisdictions that have the closest linkages to INEL personnel and their dependents likely to be most affected by the activities planned under the alternatives.

Projected changes in public school enrollments were estimated based on the re analysis. The effects on public schools was based on the number of school-age chil households, current enrollment projections, and existing student/teacher ratios. L public services was determined based on the current levels and service and the expe the population to be served.

Local jurisdiction finances were evaluated based on changes in historic reven levels, changes in fund balances, and reserve bonding capacities. The effects of i alternatives and projected declines in baseline INEL activity were evaluated based

- Gains (or losses) of jobs in the region
- Population increases (or decreases) in each jurisdiction, including sch
- Earnings and income gains (or losses)
- Potential changes in each jurisdiction's property tax base.

## F-1.3 Key Assumptions

The following section documents the key assumptions used to establish baselin estimate economic and community impacts.

### F-1.3.1 Idaho National Engineering Laboratory Employment and Earnings

- The Argonne National Laboratory-West (ANL-W) workforce was assumed to b from Fiscal Year 1999 to Fiscal Year 2004.
- Baseline workforce data for INEL include the effects of contractor cons that the West Valley Demonstration Project is not included.
- The baseline workforce is assumed to be nonconstruction-related.
- All construction workers were assumed to be new personnel for the four on information received from construction contractors, 85 percent of co would be hired from existing labor force in the region of influence.
- Construction staffing was based on project descriptions. Where no staf available, the construction staff was assumed to be one full-time emplo million in expenditure. (The average expenditure per one full-time con was derived from those projects that had construction staffing data).
- 97.45 percent of new operation and construction employees were expected region of influence.
- Preconstruction staffing levels were determined by assuming one full-ti million dollars in construction expenditure.
- Operations staff requirements were based on information provided by pro and were assumed to be per year for the life of the project.
- Employees classified as existing were assumed to be transferred from ex

at INEL. Existing employees were considered to be part of the baseline

- Operations staffing requirements that would be filled by reassignment o personnel were not considered in the impact analysis. The impact analy personnel.

- An average annual wage of $27,168 was assumed for construction employee annual wage of $43,304 was assumed for operation employees at INEL (U.S Economic Analysis, INEL Finance Office).

- 19.7 percent of all nonpayroll expenditures were assumed to be spent wi influence.

## F-1.3.2 Idaho National Engineering Laboratory Funding

- Funding for environmental restoration and waste management does not inc Valley Demonstration Project.

- Ongoing projects identified by Science Applications International Corpo to be part of the baseline activities at INEL.

- Projects included under the alternatives were not included in baseline Funding data received from DOE were adjusted to take into account the e projects.

- Duration of projects was rounded down to the nearest full year.

- For projects for which the funding period was not provided, funding was over the project period.

- Funding for the Office of Civilian Radioactive Waste Management does no West Valley Demonstration Project.

- Argonne National Laboratory-West was assumed to operate at projected le Year 1999 and then hold constant through 2004.

## F-1.3.3 Idaho National Engineering Laboratory Related Population

- One household per INEL employee is assumed.

- The average household size per INEL household is assumed to be 3.47 peo

- An 80-percent migration rate is assumed for population effects related employment. A 10-percent migration rate is assumed for population effe change in secondary employment.

## F-1.3.4 Project Information

- Construction and Operations schedule, cost, and staffing data were obta summaries found in Appendix C of Volume 2 of this Environmental Impact

- Preconstruction and construction phases were combined for this analysis

- Project schedules were based on project summaries. If not provided, th was assumed to be 2004 (last year in analysis timeframe).

## F-1.4 Data Analysis

The following tables summarize the detailed economic data upon which the soci analysis was based. Table F-1-1 presents employment data derived from the project Appendix C). The employment data presented in the data sheets were categorized by and new workers for each project and then aggregated by alternative. Table F-1-2 s employment expected under each alternative and represents the direct employment imp presents the results of the multiplier effects, summarizing direct, secondary, and under implementation of each alternative. Table F-1-4 presents the direct, seconda expected under implementation of each alternative. Table F-1-5 presents the change region of influence that could occur under each alternative, including a breakdown secondary-related effects. Table F-1-6 presents the population change expected in to the declines in baseline INEL activity and the cumulative effect of the alternat presents historical and projected INEL baseline employment, INEL-related secondary direct and secondary employment.

## F-1.5 References

Cartwright, J. V., R. M. Beemiller, R. D. Gustely, 1981, RIMS II, Regional I U.S. Department of Commerce, Bureau of Economic Analysis, Washington, D.C.

DOE-ID (U.S. Department of Energy, Idaho Operations Office), 1994, INEL Hist INEL Projected Headcount, U.S. Department of Energy, Idaho Falls, Idaho, Marc

Tellez, C. L., 1995, Lockheed Idaho Technologies Company, Idaho Falls, Idaho U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho, subje Employment Numbers," CLT-4-95, January 9.

USBEA (U.S. Bureau of Economic Analysis), 1993, Regional Input-Output Modeli machine-readable regionalized input-output multipliers for the INEL region of Department of Commerce, Washington, D.C.

**TABLES**

**Table F-1-1. Construction and operations employment (existing and new) at the Idah** category and by fiscal year. ,b,c

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 200 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Alternative A (No Action) | | | | | |
| Construction | 409 | 424 | 223 | 77 | 155 | 80 | 0 | 0 | 0 |
| Existing | 44 | 43 | 27 | 2 | 0 | 0 | 0 | 0 | 0 |
| Subcontractors | 365 | 381 | 196 | 75 | 155 | 80 | 0 | 0 | 0 |
| Operations | 10 | 10 | 67 | 58 | -92 | -146 | -390 | -410 | -41 |
| Existing | 10 | 10 | 20 | 61 | 61 | 161 | 103 | 103 | 103 |
| Subcontractors | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New hires | 0 | 0 | 47 | -3 | -153 | -307 | -493 | -513 | -51 |
| | | | | Alternative B (Ten-Year Plan) | | | | | |
| Construction | 592 | 778 | 718 | 595 | 720 | 630 | 310 | 574 | 524 |
| Existing | 217 | 284 | 244 | 207 | 200 | 160 | 130 | 85 | 60 |
| Subcontractors | 375 | 494 | 474 | 388 | 520 | 470 | 180 | 489 | 464 |
| Operations | 10 | 10 | 171 | 251 | 252 | 432 | 280 | 280 | 277 |
| Existing | 10 | 10 | 118 | 198 | 196 | 276 | 230 | 230 | 230 |
| Subcontractors | 0 | 0 | 6 | 6 | 6 | 6 | 0 | 0 | 0 |
| New hires | 0 | 0 | 47 | 47 | 50 | 150 | 50 | 50 | 47 |
| | | | Alternative C (Minimum Treatment, Storage, and | | | | | | |
| Construction | 501 | 659 | 418 | 272 | 350 | 300 | 70 | 202 | 202 |
| Existing | 86 | 78 | 72 | 47 | 45 | 45 | 45 | 2 | 2 |
| Subcontractors | 415 | 581 | 346 | 225 | 305 | 255 | 25 | 200 | 200 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Operations | 10 | 10 | 97 | 97 | -53 | -107 | -351 | -371 | -37 |
| Existing | 10 | 10 | 50 | 100 | 100 | 200 | 142 | 142 | 142 |
| Subcontractors | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New hires | 0 | 0 | 47 | -3 | -153 | -307 | -493 | -513 | -51 |
| | | | Alternative D (Maximum Treatment, Storage, and | | | | | | |
| Construction | 642 | 933 | 873 | 754 | 1121 | 1036 | 746 | 826 | 801 |
| Existing | 267 | 289 | 249 | 216 | 251 | 216 | 216 | 161 | 121 |
| Subcontractors | 375 | 644 | 624 | 538 | 870 | 820 | 530 | 665 | 680 |
| Operations | 10 | 10 | 177 | 257 | 258 | 438 | 286 | 286 | 283 |
| Existing | 10 | 10 | 124 | 204 | 202 | 282 | 236 | 236 | 236 |
| Subcontractors | 0 | 0 | 6 | 6 | 6 | 6 | 0 | 0 | 0 |
| New hires | 0 | 0 | 47 | 47 | 50 | 150 | 50 | 50 | 47 |

a. Source: Project data sheets found in Volume 2, Appendix C, of this Environment
b. See Section F-1.3 for assumptions regarding existing and new personnel.
c. Totals may not add due to rounding.

**Table F-1-2. Direct construction and operations employment impacts in the Idaho Na** region of influence by alternative and by fiscal year. ,b,c

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 200 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Alternative A (No Action) | | | | |
| Direct employment | 347 | 362 | 232 | 68 | -2 | -223 | -480 | -500 | -50 |
| Construction | 347 | 362 | 186 | 71 | 147 | 76 | 0 | 0 | 0 |
| Subcontractors | 347 | 362 | 186 | 71 | 147 | 76 | 0 | 0 | 0 |
| New hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operations | 0 | 0 | 46 | -3 | -149 | -299 | -480 | -500 | -50 |
| Subcontractors | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New hires | 0 | 0 | 46 | -3 | -149 | -299 | -480 | -500 | -50 |
| | | | | | Alternative B (Ten-Year Plan) | | | | |
| Direct employment | 356 | 469 | 502 | 420 | 548 | 598 | 220 | 513 | 487 |
| Construction | 356 | 469 | 450 | 369 | 494 | 447 | 171 | 465 | 441 |
| Subcontractors | 356 | 469 | 450 | 369 | 494 | 447 | 171 | 465 | 441 |
| New hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operations | 0 | 0 | 52 | 52 | 54 | 152 | 49 | 49 | 46 |
| Subcontractors | 0 | 0 | 6 | 6 | 6 | 6 | 0 | 0 | 0 |
| New hires | 0 | 0 | 46 | 46 | 49 | 146 | 49 | 49 | 46 |
| | | | Alternative C (Minimum Treatment, Storage, | | | | | | |
| Direct employment | 394 | 552 | 375 | 211 | 141 | -57 | -457 | -310 | -31 |
| Construction | 394 | 552 | 329 | 214 | 290 | 242 | 24 | 190 | 190 |
| Subcontractors | 394 | 552 | 329 | 214 | 290 | 242 | 24 | 190 | 190 |
| New hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operations | 0 | 0 | 46 | -3 | -149 | -299 | -480 | -500 | -50 |
| Subcontractors | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| New hires | 0 | 0 | 46 | -3 | -149 | -299 | -480 | -500 | -50 |
| | | | Alternative D (Maximum Treatment, Storage, | | | | | | |
| Direct employment | 356 | 612 | 644 | 563 | 881 | 931 | 552 | 680 | 692 |
| Construction | 356 | 612 | 593 | 511 | 827 | 779 | 504 | 632 | 646 |
| Subcontractors | 356 | 612 | 593 | 511 | 827 | 779 | 504 | 632 | 646 |
| New hires | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Operations | 0 | 0 | 52 | 52 | 54 | 152 | 49 | 49 | 46 |
| Subcontractors | 0 | 0 | 6 | 6 | 6 | 6 | 0 | 0 | 0 |
| New hires | 0 | 0 | 46 | 46 | 49 | 146 | 49 | 49 | 46 |

a. Source: project data sheets found in Appendix C, Volume 2, of this Environmenta
b. See Section F-1.3 for assumptions regarding existing and new personnel.
c. Totals may not add due to rounding.

**Table F-1-3. Direct and secondary employment impacts in the Idaho National Enginee** influence by alternative and by fiscal year. ,b,c

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2 |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Alternative A (No Action) | | | | |
| Total employment | 835 | 872 | 566 | 164 | -28 | -585 | -1233 | -1283 | - |
| Direct | 347 | 362 | 232 | 68 | -2 | -223 | -480 | -500 | - |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Construction | 347 | 362 | 186 | 71 | 147 | 76 | 0 | 0 | 0 |
| Operations | 0 | 0 | 46 | -3 | -149 | -299 | -480 | -500 | - |
| Secondary | 489 | 510 | 334 | 96 | -26 | -361 | -752 | -783 | - |
| Construction-related | 489 | 510 | 262 | 100 | 207 | 107 | 0 | 0 | 0 |
| Operations-related | 0 | 0 | 72 | -5 | -233 | -468 | -752 | -783 | - |
| | | | | | Alternative B (Ten-Year Plan) | | | | |
| Total employment | 858 | 1130 | 1217 | 1020 | 1330 | 1465 | 537 | 1244 | 1 |
| Direct | 356 | 469 | 502 | 420 | 548 | 598 | 220 | 513 | 4 |
| Construction | 356 | 469 | 450 | 369 | 494 | 447 | 171 | 465 | 4 |
| Operations | 0 | 0 | 52 | 52 | 54 | 152 | 49 | 49 | 4 |
| Secondary | 502 | 661 | 715 | 600 | 781 | 867 | 317 | 731 | 6 |
| Construction-related | 502 | 661 | 634 | 519 | 696 | 629 | 241 | 654 | 6 |
| Operations-related | 0 | 0 | 81 | 81 | 85 | 238 | 76 | 76 | 7 |
| | | Alternative C (Minimum Treatment, Storage, and Dispo | | | | | | | |
| Total employment | 950 | 1330 | 909 | 507 | 315 | -184 | -1175 | -825 | - |
| Direct | 394 | 552 | 375 | 211 | 141 | -57 | -457 | -310 | - |
| Construction | 394 | 552 | 329 | 214 | 290 | 242 | 24 | 190 | 1 |
| Operations | 0 | 0 | 46 | -3 | -149 | -299 | -480 | -500 | - |
| Secondary | 555 | 778 | 535 | 297 | 175 | -127 | -719 | -515 | - |
| Construction-related | 555 | 778 | 463 | 301 | 408 | 341 | 33 | 268 | 2 |
| Operations-related | 0 | 0 | 72 | -5 | -233 | -468 | -752 | -783 | - |
| | | Alternative D (Maximum Treatment, Storage, and Dispo | | | | | | | |
| Total employment | 858 | 1474 | 1560 | 1363 | 2131 | 2266 | 1338 | 1647 | 1 |
| Direct | 356 | 612 | 644 | 563 | 881 | 931 | 552 | 680 | 6 |
| Construction | 356 | 612 | 593 | 511 | 827 | 779 | 504 | 632 | 646 |
| Operations | 0 | 0 | 52 | 52 | 54 | 152 | 49 | 49 | 4 |
| Secondary | 502 | 862 | 916 | 801 | 1250 | 1335 | 786 | 966 | 9 |
| Construction-related | 502 | 862 | 835 | 720 | 1164 | 1079 | 709 | 890 | 9 |
| Operations-related | 0 | 0 | 81 | 81 | 85 | 238 | 76 | 76 | 7 |

a. Sources: USBEA (1993) and project data sheets found in Volume 2, Appendix C, o
b. See Section F-1.3 for assumptions regarding population migration.
c. Totals may not add due to rounding.

**Table F-1-4. Direct and secondary earnings impacts in the Idaho National Engineeri** by alternative and by fiscal year (in thousands of dollars). ,b,c

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|
| | | | | | | Alternative A (No | |
| Total earnings | 18,213 | 19,011 | 13,396 | 3,512 | -4,035 | -19,624 | -37, |
| Direct | 9,421 | 9,834 | 7,042 | 1,809 | -2,456 | -10,891 | -20, |
| Construction | 9,421 | 9,834 | 5,059 | 1,936 | 4,001 | 2,065 | 0 |
| Operations | 0 | 0 | 1,983 | -127 | -6,457 | -12,955 | -20, |
| Secondary | 8,792 | 9,178 | 6,353 | 1,702 | -1,579 | -8,734 | -17, |
| Construction-related | 8,792 | 9,178 | 4,721 | 1,807 | 3,734 | 1,927 | 0 |
| Operations-related | 0 | 0 | 1,632 | -104 | -5,313 | -10,661 | 17,1 |
| | | | | | | Alternative B (Te | |
| Total earnings | 18,712 | 24,650 | 27,717 | 23,426 | 30,243 | 35,441 | 12,8 |
| Direct | 9,679 | 12,750 | 14,464 | 12,244 | 15,778 | 18,707 | 6,75 |
| Construction | 9,679 | 12,750 | 12,234 | 10,014 | 13,421 | 12,131 | 4,64 |
| Operations | 0 | 0 | 2,230 | 2,230 | 2,357 | 6,577 | 2,11 |
| Secondary | 9,033 | 11,900 | 13,253 | 11,181 | 14,465 | 16,734 | 6,07 |
| Construction-related | 9,033 | 11,900 | 11,418 | 9,346 | 12,526 | 11,321 | 4,33 |
| Operations-related | 0 | 0 | 1,835 | 1,835 | 1,939 | 5,412 | 1,73 |
| | | | | | Alternative C (Minimum Trea | | |
| Total earnings | 20,708 | 28,991 | 20,880 | 10,996 | 3,449 | -10,892 | -36, |
| Direct | 10,711 | 14,995 | 10,914 | 5,681 | 1,415 | -6,374 | -20, |
| Construction | 10,711 | 14,995 | 8,930 | 5,807 | 7,872 | 6,581 | 645 |
| Operations | 0 | 0 | 1,983 | -127 | -6,457 | -12,955 | -20, |
| Secondary | 9,997 | 13,995 | 9,967 | 5,316 | 2,034 | -4,518 | -16, |
| Construction-related | 9,997 | 13,995 | 8,335 | 5,420 | 7,347 | 6,143 | 602 |
| Operations-related | 0 | 0 | 1,632 | -104 | -5,313 | -10,661 | -17, |
| | | | | | Alternative D (Maximum Trea | | |
| Total earnings | 18,712 | 32,134 | 35,202 | 30,911 | 47,707 | 52,905 | 30,2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Direct | 9,679 | 16,621 | 18,335 | 16,116 | 24,811 | 27,741 | 15,7 |
| Construction | 9,679 | 16,621 | 16,105 | 13,886 | 22,454 | 21,164 | 13,6 |
| Operations | 0 | 0 | 2,230 | 2,230 | 2,357 | 6,577 | 2,11 |
| Secondary | 9,033 | 15,513 | 16,866 | 14,795 | 22,896 | 25,164 | 14,5 |
| Construction-related | 9,033 | 15,513 | 15,031 | 12,959 | 20,957 | 19,752 | 12,7 |
| Operations-related | 0 | 0 | 1,835 | 1,835 | 1,939 | 5,412 | 1,73 |

a. Sources: USBEA (1993) and project data sheets found in Appendix C, Volume 2, o
b. See Section F-1.3 for assumptions regarding wages and salaries.
c. Totals may not add due to rounding.

**Table F-1-5. Direct and secondary population impacts in the Idaho National Enginee** alternative and by fiscal year, not including baseline effects. ,b,c

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|
| | | | | | Alternative A (No Acti | | |
| Population impact | 350 | 365 | 340 | 62 | -346 | -916 | -159 |
| Direct-related | 180 | 188 | 224 | 29 | -337 | -791 | -133 |
| Secondary-related | 170 | 177 | 116 | 33 | -9 | -125 | -261 |
| | | | | | Alternative B (Ten-Yea | | |
| Population impact | 360 | 474 | 625 | 543 | 679 | 955 | 334 |
| Direct-related | 185 | 244 | 377 | 335 | 408 | 654 | 224 |
| Secondary-related | 174 | 229 | 248 | 208 | 271 | 301 | 110 |
| | | | | Alternative C (Minimum Treatment, Sto | | | |
| Population impact | 398 | 557 | 484 | 206 | -202 | -749 | -157 |
| Direct-related | 205 | 287 | 298 | 103 | -263 | -704 | -132 |
| Secondary-related | 193 | 270 | 186 | 103 | 61 | -44 | -249 |
| | | | | Alternative D (Maximum Treatment, Sto | | | |
| Population impact | 360 | 618 | 769 | 687 | 1015 | 1290 | 670 |
| Direct-related | 185 | 318 | 452 | 409 | 581 | 827 | 397 |
| Secondary-related | 174 | 299 | 318 | 278 | 434 | 463 | 273 |

a. Sources: USBEA (1993) and project data sheets found in Volume 2, Appendix C, o
b. See Section F-1.3 for assumptions regarding population migration.
c. Totals may not add due to rounding.

**Table F-1-6. Direct and secondary population impacts in the Idaho National Enginee** year, including baseline effects. ,b,c

| | | | | Fiscal year | | |
|---|---|---|---|---|---|---|
| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Baseline effects | | | | | | |
| Change from 1995 | 0 | -1451 | -1620 | -2715 | -3638 | -4534 |
| Direct-related | 0 | -1213 | -1355 | -2271 | -3042 | -3792 |
| Secondary-related | 0 | -237 | -265 | -444 | -595 | -742 |
| | | | | | Alternative A (No | |
| Population impact | 350 | -1085 | -1280 | -2653 | -3984 | -5451 |
| Direct-related | 180 | -1025 | -1131 | -2242 | -3380 | -4583 |
| Secondary-related | 170 | -60 | -149 | -411 | -605 | -868 |
| | | | | | Alternative B (Te | |
| Population impact | 360 | -977 | -994 | -2172 | -2959 | -3579 |
| Direct-related | 185 | -969 | -977 | -1936 | -2634 | -3138 |
| Secondary-related | 174 | -8 | -17 | -236 | -324 | -441 |
| | | Alternative C (Minimum Treatment, Sto | | | | |
| Population impact | 398 | -893 | -1136 | -2509 | -3840 | -5283 |
| Direct-related | 205 | -926 | -1056 | -2168 | -3306 | -4496 |
| Secondary-related | 193 | 32 | -80 | -342 | -535 | -786 |
| | | Alternative D (Maximum Treatment, Sto | | | | |
| Population impact | 360 | -833 | -851 | -2028 | -2623 | -3244 |
| Direct-related | 185 | -895 | -903 | -1862 | -2461 | -2965 |
| Secondary-related | 174 | 62 | 53 | -167 | -162 | -279 |

a. Sources: Tellez (1995), DOE-ID (1994), USBEA (1993), and project data sheets f
b. See Section F-1.3 for assumptions regarding population migration.

c. Totals may not add due to rounding.

**Table F-1-7. Baseline employment: Idaho National Engineering Laboratory direct em**

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | Fisca 1996 |
|---|---|---|---|---|---|---|---|
| | | | | | | | Di |
| Contractors | 7,500 | 7,985 | 7,901 | 7,820 | 7,700 | 6,097 | 6,047 |
| DOE-ID | 402 | 531 | 587 | 491 | 499 | 499 | 499 |
| Argonne National Laboratory-West | 786 | 882 | 905 | 943 | 890 | 880 | 860 |
| Naval Reactors Facility | 2,434 | 2,252 | 2,263 | 2,017 | 1,640 | 1,144 | 777 |
| Total direct employment | 11,122 | 11,650 | 11,656 | 11,271 | 10,729 | 8,620 | 8,183 |
| | | | | | | | Se |
| Secondary employment | 17,415 | 18,242 | 18,251 | 17,648 | 16,799 | 13,497 | 12,813 |
| | | | | | | | To |
| Total employment | 28,537 | 29,892 | 29,907 | 28,919 | 27,528 | 22,117 | 20,996 |

a. Sources: Tellez (1995), DOE-ID (1994b), USBEA (1993).
b. Direct employment is defined as historical and projected baseline employment a as non-DOE employment generated in the region as a result of baseline INEL employme is direct plus secondary employment.

# F-2 Geology and Water

**SECTION F-2 CONTENTS**

TABLES



**#F-2 GEOLOGY AND WATER**

This section describes the methodology used to support the conclusions regardi at the INEL site and local and regional water resource impacts for the four alterna of this Environmental Impact Statement. These conclusions resulted from an extensi documentation characterizing the geologic and hydrologic conditions at the INEL sit this material into a concise description of the existing conditions and potential i Appendix F directly supports the summaries provided in Sections 4.6 and 5.6 (Geolog (Water Resources) of Volume 2 of this Environmental Impact Statement.

## F-2.1 Geology

The evaluation of geology at the INEL site focused on the geologic hazards tha impact the environmental restoration, waste management, and spent nuclear fuel man proposed under the four alternatives. The following sections discuss the methods u magnitude and likelihood of the hazards associated with seismicity and volcanism at

### F-2.1.1 Seismic Hazards Assessment

Since the early 1970s, seismic hazards assessments have been conducted at the potential earthquake ground motions for establishing seismic design criteria. Sinc seismology hazard assessment and Federal regulations evolved. To keep pace with th deterministic evaluations were conducted for specific sites (WCC 1990), and determi seismic hazards assessments were conducted for the proposed New Production Reactor (WCC 1992). Also, an INEL site probabilistic seismic hazard assessment is underway contributions from potential local and regional earthquake sources on the magnitude motions and their estimated return periods for all facility areas (WCFS 1993).

**F-2.1.1.1 Current Deterministic and Probabilistic Evaluations. Both deterministic and**

probabilistic evaluations used the same geologic information and numerical techniqu deterministic evaluation (WCC 1990) and additional information collected under the Geologic/Seismological/Geotechnical Studies program, which was conducted during the Under this program, paleoseismic investigations were conducted on the Lemhi Fault t magnitude and recurrence, and a deep hole [1,520 meters (5,000 feet)] was drilled a Production Reactor site to determine the near-surface geology (core samples). Addi studies are being conducted to assess the seismogenic potential of the Arco Segment

The INEL site is located adjacent to the Basin and Range province, which is ch extensional tectonics and associated normal faulting earthquakes. Limited empirica motion attenuation exist from the Basin and Range province, necessitating the use o other regions and direct modeling results of ground motions using numerical techniq hazards evaluations, seismic wave transmission characteristics were developed using relationships based mostly on California data and a site-specific model based on th stratigraphy obtained from the deep hole. To model the effects of INEL site geolog stochastic ground motion modeling approach was used to develop site-specific attenu Band-Limited-White-Noise model, combined with random vibration theory, captures the ground motion with a minimum of free parameters (WCC 1990).

The sources for the New Production Reactor site deterministic evaluation inclu magnitude (MW) 7.0 earthquake on the Lemhi fault, (b) a MW 5.5 earthquake randomly kilometer (15.5 mile) radius of the proposed New Production Reactor site, and (c) a earthquake associated with the axial volcanic zone. Peak horizontal and vertical a spectra were estimated for the 50th and 84th percentiles based on the range of unce and ground motion model. The predicted 50th percentile peak horizontal acceleratio

Lemhi fault and 0.18g from the volcanic earthquake at the New Production Reactor si
accelerations would be approximately two-thirds of the horizontal accelerations (WC
The New Production Reactor site probabilistic evaluation considered ground mot
from the following earthquake sources: (a) Basin and Range faults, (b) Eastern Sna
rift zones and the axial volcanic zone, (c) the Eastern Snake River Plain areal sou
and (d) the Yellowstone Plateau and Idaho Batholith tectonic provinces (WCC 1992).
analyses performed with the input source parameters and choice of attenuation relat
size and location of the random earthquake and seismicity rates in the Eastern Snak
important contributors to the uncertainty in the hazard at high peak acceleration l
A probabilistic evaluation is underway to estimate site-specific seismic hazar
spectra for major INEL site facility areas. This evaluation will incorporate geolo
New Production Reactor geological, seismological, and geophysical studies and the r
fault paleoseismological studies. As with past studies, the results will undergo e
being considered for use in INEL site seismic design criteria. Preliminary results
motion levels, the Lemhi and Lost River faults are the largest contributors to the
motion levels, the hazard is dominated by the Eastern Snake River Plain areal sourc
because it considers the occurrence of an earthquake in the immediate INEL site vic

**F-2.1.1.2 Seismic Design Criteria. Following completion of the 1990 deterministic evaluation,**

the results were subjected to extensive peer review by the U.S. Geological Survey,
Engineering, INEL subcontractors, the U.S. Department of Energy (DOE), and the Defe
Safety Board. The deterministic peak accelerations were adopted into the INEL arch
standards in 1991 (DOE-ID 1993a). The results of the New Production Reactor 1992 d
probabilistic evaluations were extensively reviewed by a panel of experts. This pa
recognized experts in the fields of seismology, tectonics, statistics, and structur
convened by DOE through Lawrence Livermore National Laboratory to review and approv
recommendations for New Production Reactor structural design criteria (including se
Ground motion results of the 1990 and 1992 studies indicate that INEL seismic desig
appropriate for the estimated seismic hazards. The probabilistic seismic hazard as
1993) has undergone this review process.

## F-2.1.2 Volcanism

Hazards associated with INEL-area volcanism, as well as distant volcanic sourc
by several investigators. A Volcanism Working Group consisting of experts from the
laboratories, the U.S. Geological Survey, and universities was convened in 1990 to
volcanism on the INEL site (VWG 1990).
For volcanic areas such as the Eastern Snake River Plain with no historical vo
incomplete chronologic record of prehistoric volcanism, assessments of potential vo
volcanic risks are estimated based on interpretation of the long-term geologic reco
effects of historical eruptions in analog regions such as Iceland and Hawaii. Volc
site are related to future basaltic and rhyolitic eruptions along volcanic-rift zon
The most significant volcanic hazard to the INEL site is the inundation or burning
lava flows from volcanic-rift zones. A significant related hazard is disruption of
deformation accompanying magma intrusion along volcanic-rift zones: opening of fiss
and broad-region tilting and uplift within several kilometers of vents. Other, les
include volcanic-gas emission and disruption of groundwater.
Available geologic map data, flow volume estimates, and geochronometry of INEL
flows suggest maximum (most conservative) volcanic frequencies of 10-4 to 10-5 per
volcanic zone, and the Arco and Lava Ridge-Hell's Half Acre volcanic-rift zones. T
basalt-lava inundation or intrusion-related ground disturbance at a specific facili
be less than 10-5 per year for facilities on the southern INEL site. Risk from the
INEL site facilities is still lower because volcanism there has been less frequent
probability of significant impact from all other volcanic phenomena, such as growth
the Eastern Snake River Plain or thicker than 8-centimeter (3-inch) tephra fall fro
Plain vents, is estimated to be much less than 10-5 per year due to the combined ef
infrequency, low volume, and topographic or atmospheric barriers to the dispersal o

## F-2.2 Water Resources

The evaluation of potential consequences to water resources at the INEL site f potential and water quality and use. The following sections discuss the methods an determine impacts resulting from the implementation of environmental restoration an activities proposed under the alternatives.

### F-2.2.1 Surface Water

Surface water studies and data were reviewed during a literature search perfor Environmental Impact Statement (EIS). This section presents the methodology used f potential impacts of the proposed alternatives to natural and artificial (manmade) the vicinity of, the INEL site. These methods were used to determine existing surf potential (which could conceivably cause surface contamination to enter surface wat Geological Survey has been compiling surface water quality data for many years. In Geological Survey and INEL studies have been conducted concerning flood potential a

**F-2.2.1.1 Surface Water Quality. INEL site activities do not directly affect the quality of surface**

water outside the INEL site because the INEL site is located within a closed draina does not flow directly offsite (Hoff et al. 1990). All major drainages within the Big Lost River Playa in the northern portion of the INEL site. However, water from well as from seepage of evaporation basins and storm water injection wells, does in River Plain Aquifer.

Physical, chemical, and radioactive water quality parameters have been measure River, the Little Lost River, and Birch Creek. As a result of intermittent flow al consequently limited sampling opportunities, insufficient information is available comparisons. However, the water quality of these three intermittent streams is sim varied relatively little over time (USGS 1963-1993). Chemical and physical paramet three water tributaries do not exceed water quality standards (Estes et al. 1995), for all INEL site uses. However, surface water is not withdrawn from these tributa site.

The Big Lost River System (the Big Lost River, Little Lost River, Birch Creek, and playas) is defined as "waters of the United States" as specified by the Clean W Water Act, two National Pollutant Discharge Elimination System General Permits for Discharges were issued for the INEL site, one for industrial activities and one for permit requirements for both of these activities specify the development of a site- Prevention Plan. Any facility at the INEL site having the potential to discharge s River System associated with industrial or construction activities is subject to th requirements of the INEL Storm Water Pollution Prevention Plans (FR 1992a, b). The Pollution Prevention Plans (DOE-ID 1993b, c) were established to assess potential s sources; select and implement appropriate management practices and controls to prev storm water runoff; and implement monitoring, inspection, and notification programs are performed to determine the effectiveness of the plans to prevent storm water po

Many potential sources of surface water contamination are also identified in t Agreement/Consent Order. All potential contamination sources must be evaluated, in activities, material inventory, past spills and leaks, nonwater discharge, and exis data. Other activities required under the Federal Facility Agreement/Consent Order summarizing potential pollutants, identifying and implementing best management prac runoff maps, and identifying potential pollutants in the runoff.

**F-2.2.1.2 Flood Analysis. Several studies have been performed to evaluate the potential for**

flooding to occur at the INEL site. A frequency analysis of local basin snowmelt f INEL site was conducted in 1986 using historical data (Koslow and Van Haaften 1986) from the Central Facilities Area weather station for 1956 to 1985 were used in the data from the Central Facilities Area station were assumed to be representative of

INEL site (Koslow and Van Haaften 1986).

In general, flood plains at the INEL site are poorly defined, primarily becaus flood hydrographic data are not available for much of the INEL site. Studies are c determine the 100-year flood plain for the Big Lost River at the INEL site. These rigorous assessment of the relationship between the Mackay Dam failure probable max in Section F-2.2.1.3) and the INEL site 100-year flood plain for the Big Lost River Sagendorf (1991) for a design analysis conducted by Zukauskas et al. (1992) used me Central Facilities Area for 1950 through 1990 and, for the 25- and 100-year return maximum 24-hour precipitation amounts and 25- and 100-year maximum snow depths at t Waste Management Complex.

During the winter months, mid-November through mid-March, a rain-on-snow event the ground is frozen. The 25- and 100-year, 24-hour duration rainfall amounts for determined to be 2.3 and 2.9 centimeters (0.92 and 1.13 inches), respectively. Bas year, the 25- and 100-year, 24-hour duration amounts were found to be 3.5 and 4.2 c 1.64 inches), respectively. The expected 25-year maximum snow depth was determined centimeters (22.6 inches), and the 100-year maximum snow depth was found to be 77.7 inches). The peak discharges for the 25- and 100-year rainfall-on-snowmelt floods Management Complex watershed were estimated by Zukauskas et al. (1992) to be 18.2 a per second (643 and 704 cubic feet per second), respectively.

Zukauskas et al. (1992) conducted another flooding study at the Radioactive Wa Complex. The effects of natural topographic depressions, railroad embankments, and discharges at the Radioactive Waste Management Complex were evaluated. The study w parts. The first part was a hydrologic modeling study that evaluated the adequacy water drainage control system in preventing flooding of the Transuranic Storage Are year return interval, 24-hour duration storm events. The second part of the study drainage plan for the area.

The Zukauskas et al. (1992) study computed reservoir stages and peak discharge using the U.S. Army Corps of Engineering HEC-1 flood hydrograph package. Precipita inputs for modeling the 25- and 100-year return period events were derived from the Service records for the INEL site. Water surface profiles for the main channel flo elevations for computing culvert flow at critical locations were computed with the profiles program. The study concluded that, with some minor reconfigurations and g channel and the upgrading of two berms, the existing surface water drainage control flooding resulting from the 25- and 100-year, 24-hour rainfall/snowmelt storm.

McKinney (1985) documents flooding events that have occurred at the INEL Diver Big Lost River. The report presents an evaluation of Big Lost River flow records, System, the 1983 Mount Borah Earthquake, record low temperatures in December 1983, jam on the diversion system that forced the river to pond along and nearly overtop

Several flood routing studies have been conducted over smaller areas near spec One of these was conducted by Martineau et al. (1990) at the Subsurface Disposal Ar Radioactive Waste Management Complex. The objective of this study was to determine Subsurface Disposal Area berm is sufficient to prevent floodwater from entering the Area if Dike 2 fails. The Martineau et al. (1990) investigation showed that the Su berm could be in danger of being overtopped by a breach flood from Dike 2. For exa from Dike 2 could be initiated by a large flood in the Big Lost River.

**F-2.2.1.3 Probable Maximum Flood. Analysis of high-magnitude flooding caused by a dam**

failure relies on hydrodynamic theory to describe the dam-break wave and to propaga Closed-form solutions do not exist for the partial differential equations of unstea numerical techniques are employed to achieve solutions. Koslow and Van Haaften (19 DAMBRK model developed by the National Weather Service to simulate four different p Dam failure scenarios: seismic dam failure, hydraulic (piping) failure of the dam hydraulic (piping) failure with 500-year flood, and overtopping failure. DAMBRK ha tested against data from a number of actual dam failures, including the 1976 Teton Idaho.

Three functional elements are involved in DAMBRK: description of the dam fail conditions; computation of the time-varying flow and water surface elevations at th the flood through the downstream valley. These functions are accomplished using a elements, including breach description, reservoir inflow and storage characteristic resistance, flow losses, and downstream channel geometry. The DAMBRK simulation ro along the Big Lost River channel from Mackay Dam to Test Area North at the INEL sit river into the INEL site diversion channel were estimated by the broad-crested weir

DAMBRK. Koslow and Van Haaften (1986) used a total of 259 channel cross sections i flood analysis.

Peak flow rate, peak water surface elevation, flood wave arrival time, and max were presented for eight cross sections along the Big Lost River. In the event of any of the four scenarios, there would be flooding along the Big Lost River channel water depths on the INEL site. The water velocity on the INEL site would range fro second (0.6 to 3.4 feet per second), with water depths outside the banks of the Big 0.61 to 1.22 meters (2 to 4 feet) (Koslow and Van Haaften 1986). No significant di inundation was formed for the seismically induced dam failure and the piping failur 100- and 500-year floods. Significantly higher flow downstream and a greater exten the overtopping failure of the dam from a probable maximum flood.

The flat, open topography on the INEL site results in considerable spreading o facilities subject to encroaching floodwaters are the Idaho Chemical Processing Pla Facility, and the Loss-of-Fluid Testing Facility near Test Area North. As part of Koslow and Van Haaften (1986) of the flood potential at the INEL site facilities, S a probable maximum flood inflow hydrograph to the Mackay Reservoir.

The use of the probable maximum flood represents a conservative estimate of th because the amount of water resulting as inflow into the reservoir would be far gre year or 500-year storm events. Inflow resulting from the probable maximum flood wo meters per second (82,100 cubic feet per second) compared with 140 and 160 cubic me and 5,760 cubic feet per second) for the 100-year or 500-year storm event, respecti Haaften 1986). Modeling of the probable maximum flood scenario was performed assum rose above the dam and caused failure. This is likely because the spillways built able to release the flow fast enough. Results predict that 8,700 cubic meters per per second) would be released immediately downstream of the dam. This peak flow at meters per second (71,850 cubic feet per second) at the INEL Diversion Dam and to 9 second (34,810 cubic feet per second) at the Test Area North. The flood wave reach Dam in 10 hours with flow rates of 0.028 to 0.085 cubic meters per second (1 to 3 c the INEL site. These flow rates would not be great enough to cause structural dama facilities.

## F-2.2.2 Subsurface Water

Subsurface water quality and quantity, hydrologic properties, waste inputs, an gathered through a literature search. This section contains a summary of the docum used to characterize subsurface water quality and use at the INEL site and to suppo impacts to water resources from the proposed alternatives. Section F-2.2.2.1 discu techniques; Section F-2.2.2.2 presents methodologies and references utilized to cha resources. Section F-2.2.2.3 discusses modeling methodologies, individual modeling and the assumptions on which the models are based.

### F-2.2.2.1 Data Collection Techniques. Hydrologic parameters at the INEL site, specifically

hydraulic conductivity and transmissivity, are often determined by single-well pump Ackerman 1991). Storativity values must be determined from multi-well pumping test method for determining transmissivity involves pumping water from a well at a rate aquifer and creates drawdown in the well. The amount of drawdown is inversely rela of the aquifer. The drawdown in the well is recorded as a function of time. Time- are also used and involve measuring the water level recovery as a function of time Curve matching techniques that compare the observed curves against type curves are aquifer parameters (Freeze and Cherry 1979, Driscoll 1986, Domenico and Schwartz 19

Finite-difference computer modeling as performed by Garabedian (1992) can also the hydraulic parameters by matching observed water levels to simulated levels. Th finite-difference approximations of equations representing the hydrologic flow, whi hydraulic conductivity, storativity, porosity, hydraulic gradient, and transmissivi parameters until a match between actual and modeled water levels occurs, the parame Linear regression techniques have also been used to estimate transmissivity from sp 1991).

Groundwater chemistry data are obtained by water sampling and chemical analysi sampled are purged until field parameters (that is, pH, temperature, conductivity) This ensures that the water sampled is formation water and not residual water that

altered in the well. The U.S. Geological Survey has been routinely monitoring well 1949 and uses these methods of sampling (Barraclough et al. 1976, Pittman et al. 19 techniques used to determine concentrations of solutes include liquid scintillation testing for radionuclides; atomic adsorption for metals and anions; and gas chromot spectrometry for volatile organic compounds (Mann 1990, Driscoll 1986). Recently, inductively coupled plasma-mass spectrometry for chemical analysis of cations, whic limits and an expanded analyte list (McCurry et al. 1994).

**F-2.2.2.2 Water Resources Characterization. This section presents the methodologies and**

briefly summarizes sources of information used to characterize subsurface condition describing aquifer properties, water quality, and contaminant distribution are iden elements are highlighted. Factors affecting background water chemistry and groundw references for source term determination are also provided.

**F-2.2.2.2.1 Description of Physical Properties and Flow**

Characteristics-Determining the aquifer properties of the Snake River Plain Aquifer standing goal of the U.S. Geological Survey, INEL, and other investigators. Aquife include the hydraulic conductivity, transmissivity, specific capacity, flow rates a of static head levels. Because of the significant heterogeneity of the aquifer, th several orders of magnitude (tens to hundreds of meters) within the Snake River Pla 1991, Robertson et al. 1974). Several investigators attribute the heterogeneity to stratigraphy, which consists of numerous relatively thin basalt flows with rubble z sedimentary interbeds (Robertson et al. 1974, Whitehead 1992). Groundwater flow ve aquifer are greatest along fractures, rubble zones, and boundaries between basalt f 1994). Locally, the variance can be important; but on an intermediate (hundreds of regional (kilometers to tens of kilometers) scale, the properties are easier to mod average out (Garabedian 1986, 1992). References that address hydrologic property t hydrologic parameters, and modeling of properties in the Snake River Plain Aquifer Pittman et al. (1988), Ackerman (1991), Garabedian (1986, 1992), Robertson et al. ( et al. (1976).

Of these references, Ackerman (1991) and Garabedian (1986, 1992) are the most details on transmissivity distributions at the INEL site. Ackerman (1991) utilized well pumping tests within the Snake River Plain Aquifer to determine the distributi under the INEL site. Type-curve matching methods as discussed by Driscoll (1986) w linear regression of specific capacity-transmissivity relationships. Conclusions s values ranged from 0.6 to 70,000 liters per minute per meter (0.05 to 6000 gallons transmissivity values varied over six orders of magnitude from 0.09 to 90,000 squar 106 square feet per day). Garabedian (1986) used parameter estimation techniques t and estimated values ranged from 400 to 3.5 y 105 square meters per day (4,300 to 3 day) on a regional scale.

**F-2.2.2.2.2 Subsurface Water Quality and Contaminant Distribution-The natural**

groundwater chemistry of the Snake River Plain Aquifer is determined by inputs from anthropogenic inputs, and water-rock reactions (Wood and Low 1988). The background Snake River Plain Aquifer has been the subject of investigation and is important fo where elevated contaminant levels may exist. Robertson et al. (1974) provides a de recharge water quantity and quality entering the Snake River Plain Aquifer and pres evolution of the natural groundwater chemistry. The study was a mass balance appro inputs from the Mud Lake area, the Big Lost River System, and local precipitation.

Water-rock interactions taking place from the recharge to discharge zones of t natural water chemistry of the aquifer. Robertson et al. (1974) and Wood and Low ( mass balance studies consisting of a series of equations to explain chemical change southern part of the INEL site. The equations consist of dissolution reactions for anorthite, pyroxenes, and olivines, as well as precipitation reactions for calcite reactions, which are responsible for the formation of clays (Drever 1988), were als the calculations indicate that about 20 percent of the solutes in the groundwater c

dissolution reactions and that precipitation of quartz and calcite have an importan capabilities of the aquifer.

Knowledge of individual contaminant behavior is also necessary to understand c and residence times below the surface. Properties affecting contaminant behavior i dispersion, and radioactive decay. These parameters are used in transport models; are required. Retardation factors are typically determined by laboratory column an which are performed considering site-specific conditions (for example, soil and roc (Drever 1988, Domenico and Schwartz 1990). Retardation factors of 5-130, 1, and 2 tritium, and iodine-129, respectively, have been used for modeling studies at the I 1993, 1994).

Strontium-90 was chosen for modeling conducted in support of this EIS for seve cesium-137 and strontium-90 were both disposed of by direct injection into the Snak from 1953 to 1984, extensive aquifer sampling showed that cesium-137 had not migrat distance from the injection well, while strontium-90 has been detected in enough we geometry of plumes over time and space (Arnett and Rohe 1993). This observation su laboratory data regarding the relatively greater sorbtion and retardation propertie to strontium-90 (Arnett and Rohe 1993), clearly indicates that strontium-90 has mor INEL and regional water quality, and provides strontium-90 plume migration data for

Dispersivities used in contaminant transport models range from 91 to 140 meter the longitudinal and transverse directions, respectively. Radioactive decay is con and the values used for the radionuclides are 26.6, 12.5, and 15,700,000 years for iodine-129, respectively (Arnett and Rohe 1993, 1994; Schafer-Perini 1993; Robertso References that address the determination of retardation factors and dispersion coe use in transport equations include Freeze and Cherry (1979), Domenico and Swartz (1 (1988).

Contaminants interact differently below the surface, depending on whether they or the saturated zone. The vadose zone at the INEL site is very thick and acts as between the surface and the saturated zone. As a result, several studies have exam vadose zone, such as the infiltration rates of water in basalt and sediments, locat perched water zones, and location of contaminants sorbed to interbeds and the basal 1992, Marts and Barrash 1991, Ackerman 1992, Hubbell 1990, and Cecil et al. 1991). Bishop (1991), and Cecil et al. (1992) address infiltration rates of water in subsu Results indicate that the infiltration rates are highly dependent on the degree of Under highly unsaturated conditions, rates can be as slow as 0.36 centimeter per ye Bishop (1991) showed rates of water movement in a dry block of basalt to be approxi investigators have shown rates to be higher under saturated conditions in the vados

Water quality evaluation and determining distribution of contaminants in the S Aquifer beneath the INEL site is the primary goal of the U.S. Geological Survey mon U.S. Geological Survey has conducted routine sampling of monitoring wells and maint chemical analyses in a database (Barraclough et al. 1981). Typically, wells are sa basis for major anions and cations, radionuclides, some trace metals, and field phy temperature, conductivity, pH). Many wells constructed within the perched zones be ponds at the Test Reactor Area and Idaho Chemical Processing Plant are sampled quar parameters but include an expanded list of radionuclides (Cecil et al. 1991, Marts addition to the routine studies, special studies have been conducted to define the contaminants. For example, several studies evaluated the distribution of volatile 1990, Liszewski and Mann 1992, Mann and Knobel 1987). Routine monitoring is requir updated information characterizing the levels and distribution of contaminants. Th subsurface distributions of contaminants are transient. Hubbell (1990) describes t levels and perched water chemistry at the Radioactive Waste Management Complex as a Cecil et al. (1991) and Robertson (1977) discuss the relationship between waste inp chemistry at the Test Reactor Area. The distribution of contamination within the a over time. Golder (1994) discusses the time relation of contaminant distribution a of the plumes at various time intervals. Additional references addressing aquifer of contaminants include Robertson et al. (1974), Barraclough et al (1976), Cecil et et al. (1988), Whitehead (1992), and Barraclough et al. (1981).

**F-2.2.2.2.3 Source Terms-Many references provide information identifying and**

characterizing source terms of liquid effluents as well as discuss the processes th information is important for the overall characterization of the contaminant budget kept by INEL site facility operating personnel and from monitoring devices are used

inputs. Input data from 1953 to 1970 are sparse compared to after 1970, because re sampling programs were not as comprehensive as they are today. References addressi INEL site include Creed (1994), Lehto (1993), Arnett and Brower (1994), Arnett and Golder (1994), IDHW (1994), Arnett (1994a), and Bobo (1993).

Golder (1994), prepared for this EIS, describes the baseline contaminants in t history of contaminant plumes, background chemistry, concentrations of contaminants Plain Aquifer, and contaminants within the perched zones is summarized in this repo studies. Lehto (1993) was also prepared for this EIS and addresses the past histor summarizes the volumes and radionuclide concentrations disposed of at the Test Reac Chemical Processing Plant, Test Area North, and several inactive areas. Data in th from the Radioactive Waste Management Information System and Non-Radioactive Waste Information System and were used as input for the modeling performed by Arnett and Arnett (1994b).

Creed (1994) discusses source terms for a generic spent nuclear fuel storage f quality data from the Idaho Chemical Processing Plant Fluorinel and Storage Facilit nuclear fuel storage facility design (Hale 1994) used to identify impacts to the wa unintentional discharge of 18.9 liters per day (5 gallons per day) for 30 days cons radionuclide concentrations:

- Tritium - 10,000 picocuries per liter
- Strontium-90 - 810 picocuries per liter
- Antimony-125 - 100 picocuries per liter

- Cobalt-60 - 9,290 picocuries per liter
- Cobalt-58 - 148 picocuries per liter
- Cesium-137 - 101 picocuries per liter.

Creed (1994) also describes the scenario leading to the hypothetical leak, which co leakage from secondary containment around the spent nuclear fuel storage pools.

Constant process monitoring, mass-balance, and facility design in accordance w including double-walled confinement of all vessels and piping, would be used by DOE operational releases from a new spent nuclear fuel storage facility to a goal of es operational releases postulated would result from degraded equipment. Arnett (1994 that this leak would have on subsurface water resources. Results indicate that the contaminants above maximum contaminant levels at the INEL site boundary resulting f operational leak.

**F-2.2.2.2.4 Water Use-The amount of water consumed above the baseline differs for each**

alternative, with Alternative B (Ten-Year Plan) consuming the greatest quantity of alternative, the impacts to water quantity are expected to be minor compared to the under the INEL site yearly [1.77 y 109 cubic meters (470 y 109 gallons)] (Robertson 65 percent of the water consumed under current operations is returned to the aquife and infiltration. Similar returns to the aquifer are expected to occur regardless The amount of water to be consumed under each alternative is estimated based on an descriptions and conversations with project personnel.

**F-2.2.2.2.5 Data Limitations-Groundwater samples used to characterize subsurface water**

quality are taken from dedicated pumps that access the most permeable parts of the are homogenized by the pump and represent a composite of the entire well. Chemical depending on the particular interval being sampled, and some intervals may have hig others (McCurry et al. 1994). Hence, intervals with elevated concentrations of con detected.

Retardation coefficients and dispersivity values used in contamination transpo site are not well known and were initially estimated from previous investigations ( Arnett and Rohe 1993, 1994) The final values used are from calibration of the mode factor and dispersivity are varied until a match is obtained between the simulated concentrations for a 20-year timeframe. In that sense, they are fitting parameters derived parameters from field or laboratory experiments. The significant contamina considered as large-scale, long-term tracer tests that provide intermediate scale p factors obtained in this manner were lower than those obtained from laboratory scal retardation estimated by model calibration for strontium-90, for example, was five,

than obtained from laboratory tests. The lower, more conservative value was used i This is more important for the nonconservative contaminants because the value elements. An assumed retardation factor of one for conservative contaminants (indi used in all models for tritium and volatile organic compounds (Schafer-Perini 1993; 1994; Robertson 1974, 1977). A small value of two was used for iodine-129. Labora difficult to extrapolate to the field because of large scale differences. In addit specific laboratory conditions that may or may not accurately reflect real conditio are preferred because of the scaling towards a larger system. Other than the migra plumes themselves, no empirical studies to date have been performed at the INEL sit dispersivities or retardation coefficients for radionuclides. A large-scale aquife a site on the INEL to determine field-scale contaminant transport properties (Wood transport parameters, including retardation and dispersion used in contaminant tran EIS have been conservatively estimated to account for potential uncertainties in pa ensure that modeled impacts to the Snake River Plain Aquifer equal or exceed potent high degree of certainty (Arnett and Rohe 1993, 1994; Arnett 1994a, b).

Values for hydrologic parameters derived from pumping tests (for example, cond transmissivity) are difficult to determine in the Snake River Plain Aquifer because transmissivity and is difficult to stress. Formations yielding large volumes of wa rates, but drawdowns of more than a few feet are difficult to obtain (Ackerman 1991 Transmissivity values determined from pump tests are underestimated due to effects with the aquifer by the wells (Garabedian 1986, 1992). The effective portion of th understood, especially beneath individual wells (Ackerman 1991, Garabedian 1986, 19 (1992) compared modeled values to empirical values and determined that the empirica smaller values, because the wells tested are only completed in the upper portion of

Porosity values are a limiting factor in transport modeling. Highest porosity Plain Aquifer are the rubble zones and fractures, although saturated vesicular basa capacity. Porosity estimates range from near zero to 20 percent (Robertson et al. estimates of 5 to 10 percent are commonly used in modeling studies (Robertson 1974, Schafer-Perini 1993). Because the Snake River Plain Aquifer is semiconfined, stora equal to porosity, and values for storativity are also estimated.

The levels of contaminants in the vadose zone need further study because their moderately characterized and concentrations change with time (Cecil et al. 1991, Ma The lack of information is partially due to the lack of monitoring wells that acces water zones. Several perched water zones are known and have been characterized for water, but other perched zones may exist that have not been studied yet. Hubbell ( Marts and Barrash (1991), and Cecil et al. (1991) suggest the presence of possible the ones documented, located along deeper sedimentary interbeds. Known perched zon and characterized at the Idaho Chemical Processing Plant and Test Reactor Area with quarterly. Nonradiactive metallic contaminants in unsaturated parts of the vadose locally but would probably be bound to sediments by sorption.

Infiltration rates in the vadose zone are one of the most poorly characterized for modeling contaminant transport to the saturated zone. Two of the important stu of water in the surface sediments near the Radioactive Waste Management Complex hav Cecil et al. (1992) and Kaminsky (1991). Arnett and Rohe (1993) use a rate of 47 m per year) as a conservative assumption in modeling the flow of liquids from the Ida Plant and Test Reactor Area surface ponds to the saturated zone.

**F-2.2.2.3 Modeling Contaminant Transport. For this EIS, computer modeling was performed**

to predict the fate and transport of contaminants in the vadose and saturated zones 1994; Schafer-Perini 1993; Dames and Moore 1993; Arnett 1994b). The modeling chara contaminant behavior in the subsurface based on established theories of contaminant transport, and hydrologic flow. The models are capable of estimating contaminant m timeframe specified by the user and results provide information on future impacts. general approach to modeling, provides a discussion of the modeling studies used, a of limitations and assumptions on which the models are based. See Table F-2-1 for contaminant transport models used to evaluate consequences to subsurface water reso includes a brief model description, assumptions, calibration methods, modeling resu consequences to water resources.

**F-2.2.2.3.1 Techniques in Contaminant Fate and Transport Modeling-Fate and**

transport modeling requires an understanding of the subsurface in addition to under work. The steps involved in modeling include (a) data assembly and verification, ( conceptual model, (c) code selection, (d) model calibration, and (e) computer simul

Conceptual model development is one of the first steps in the modeling process a complicated system such as the aquifer located under the INEL site and making sim This simplification process involves defining (a) the geometry, including boundarie input and output; (c) locations of important features such as sedimentary interbeds wastes and rates of discharge. Depending on the area being modeled, several differ were developed for the models addressed in this EIS (Arnett 1994b; Arnett and Rohe Perini 1993; Dames and Moore 1993; Robertson 1974, 1977).

For the modeling conducted in this EIS, several codes are available to model c the Snake River Plain Aquifer. Arnett et al. (1993) provides a detailed discussion bases for selecting the codes used. The codes MODFLOW and MT3D were chosen because acceptance in the scientific community. GFLUX is a modification of a U.S. Nuclear code, GWSCREEN, which is widely used in the scientific

**Table F-2-1. Matrix of contaminant transport models used to evaluate consequences t**
(page 1)

**Table F-2-1. (page 2) Table F-2-1. (page 3) community and is accepted for use at th**
FLAME for modeling organic plumes.

Calibration is an important step in the modeling process, because the validity relies on the accuracy of the match between simulated groundwater flow patterns and and observed data. Calibration of a flow model of the regional aquifer involved pr contours for multiple time periods (Arnett and Brower 1994, Arnett 1994b). Time ve (hydrographs) were also prepared for selected wells. Hydrologic parameters were va resembled observed contours. This method required several iterations with manual p before a suitable match was obtained. Calibration of the contaminant transport mod approach (Arnett and Rohe 1994). Errors in calibration are usually associated with parameters are uncertain because of the high degree of heterogeneity within the ba transport modeling typically requires adjustment of the retardation and dispersion scale values are not known (Arnett and Rohe 1993, 1994; Schafer-Perini 1993, Dames Robertson 1974).

The general approach to groundwater modeling by computer simulation is to solv flow equation to predict hydraulic heads and to use the head distribution in the tr the advective flow (velocity). Hydrologic flow equations for transient conditions changing hydraulic gradient in time and space (water input and output), storativity compressibility, and transmissivity. Contaminant transport equations are a functio factors, dispersion coefficients, decay constants, advective transport, and rates o flow equations must be solved first because results provide input into contaminant flow and transport equations used in this EIS are widely accepted and utilized in m codes (Arnett 1994b; Arnett and Rohe 1993, 1994; Robertson 1974). Flow and contami are discussed in Freeze and Cherry (1979), Driscoll (1986), and Domenico and Schwar

A primary step in performing computer simulation is to establish the model's s then divided into a set of similar units of specified dimensions which are assigned Each node is assigned material properties. The edges of the domain are assigned bo information external to the model (Arnett 1994b; Arnett and Rohe 1993, 1994). In g the more accurate the predictions, but the longer the computational time. Grid pat Arnett and Rohe (1993, 1994), and Robertson (1974) consisted of a rectangular patte northwestern mountain range and east about 16 kilometers (10 miles) past the INEL s northern grid boundary was along the mountain front, and the southern boundary exte (5 miles) south of the INEL site. A submodel with a final grid was set up within t contaminant plumes for finer detail. The finite-element grid formed by Schafer-Per contained more complicated triangular elements near sources of contamination (for e injection well).

The flow and contaminant transport equations are solved by finite-difference o techniques (approximations of the partial differential equations) for each node wit predict hydraulic head and concentrations of contaminant distributions as a functio patterns are needed around some waste sources to simulate steeper hydrologic and ch element techniques have some advantages in these situations. Arnett (1994b), Arnet and Robertson (1974) used the finite-difference techniques, whereas Schafer-Perini element techniques. After completion of the simulation (that is, equations solved increments) the concentrations and hydraulic heads within the nodes are contoured,

plume maps and hydraulic head contours. The modeling grid used for this EIS was bo variable head and no-flow boundaries to the west. No-flow boundaries were assigned the mountains and Snake River Plain Aquifer, whereas variable head boundaries were areas such as mouths of the Big Lost River, Little Lost River, and Birch Creek. Sc considered variable head boundaries for the Test Area North model. Eastern and sou considered constant head and at sufficient distances from contaminant plumes such t defining the boundary conditions had a negligible effect on the simulated groundwat areas.

**F-2.2.2.3.2 Modeling Studies-Table F-2-1 presents the different models used in the**

assessment of predicted consequences to water resources. Table F-2-1 describes the results produced, potential impacts to the water resources, calibration of the mode models are based on. Modeling was performed by several investigators for the vados zone, for a bounding accident scenario, and for an unintentional release from a gen storage facility. Iodine-129, tritium, and strontium-90 plumes extending from the Idaho Chemical Processing Plant were modeled by Arnett and Rohe (1993). Organic co Area North and the Radioactive Waste Management Complex were modeled by Schafer-Per Dames and Moore (1993), respectively. In addition, an accident scenario for a high the Idaho Chemical Processing Plant was modeled. The accident scenario model concl would not extend beyond the INEL site boundary above maximum contaminant levels thr implementation period (Arnett 1994a). The results of the tank failure model were d amount of liquid in the tank being the only hydraulic driver; it appears reasonable be taken by authorities to mitigate the impacts of such an accident through capping means. The source terms for unintentional discharges at a generic spent nuclear fu negligible compared with the strontium-90 source terms in the high-level waste tank past strontium-90 discharges.

A simple, one-dimensional model was used to estimate flow and contaminant tran zone below the disposal ponds. Average vertical water velocity was calculated from time and vadose zone thickness. The conclusion that strontium-90 is strongly retar based on laboratory and theoretical data to a limited degree. It is based more on amounts of strontium-90 have been discharged to the Test Reactors Area radioactive past 40 years and very little, if any, strontium-90 (near detection limit) concentr aquifer directly beneath or near the Test Reactors Area perched water body. Again, data (which integrate the effects of local heterogeneities) were available to provi model parameter. In the case of strontium-90, the retardation factor was calculate 90 would experience break-through in the near future.

**F-2.2.2.3.3 Modeling Assumptions and Limitations-Table F-2-1 lists the**

assumptions that provide the bases for the different models used to support the env described in Section 5.8, Water Resources, of Volume 2 of this Environmental Impact following briefly discusses the assumptions and limitations.

- Transient versus steady-state modeling: Garabedian (1986, 1992), Arnett ( and Rohe (1993, 1994), and Robertson (1974) concluded that the Snake River system is best simulated by considering transient conditions and a transie Modeling can be conducted under transient (time-dependent) or steady-state Steady-state modeling is used when aquifer conditions (for example, water be considered constant for approximately the period of simulation. Mathem in hydraulic gradient with time is considered zero, and storativity terms assuming steady-state conditions. The steady-state assumption cannot be m levels and recharge volumes change with time.

- Aquifer anisotropy and two dimensional flow: Garabedian (1992) concluded regional scale the groundwater flow is predictable and can be simulated in Vertical flow was found to be several orders of magnitude less than horizo scales vertical flow may be significant, but on regional scales the assump

- No new discharge of radioactive wastes with concentrations above the maxim contaminant level or derived concentration guides: One of the primary ass for modeling and in the evaluation of impacts to the water resources is th

discharges of radioactive wastes with concentrations above the maximum con derived concentration guides will be discharged to the subsurface. Modeli fate and transport of contaminant plumes assumes this in evaluating baseli migration from the vadose zone to the saturated zone (Arnett and Rohe 1993 individual project descriptions indicates that wastes will be disposed of and liquid waste condensers. Sources of wastes are slowly declining due t management practices and engineering and institutional controls; therefore operating conditions no liquid wastes will have concentrations above maxim levels or derived concentration guides which would enter the subsurface. assumes no accidental or unintentional releases will occur. Bounding cond effects from a series of accidental spills indicate that even under conser will not likely affect water quality beyond the immediate facility area (A

- Boundary conditions: The boundary conditions imposed for the INEL site mo consisted of constant head, no-flow, and variable head. Boundaries to the to have sufficient distances from contaminant plumes such that reasonable boundary conditions have negligible effects on the simulated groundwater v areas. These boundaries were assigned constant heads. The boundaries alo border were considered to have no flow along the mountain fronts and varia recharge zones. Variable head boundaries were used on the Schafer-Perini northern recharge zones. Model calibration indicates that these boundarie because a suitable match between simulated and observed flow patterns was 1970-to-1990 time period (Arnett 1994b).

- Precipitation is insignificant to recharge: The amount of precipitation t the vadose zone and migrates to the aquifer is negligible when compared to underflow. This is a good assumption considering the amount of precipitat per year, 8.7 inches per year) and the evaporation rate (125 centimeters p year). Thirty percent of the average annual precipitation at the INEL sit content in snow (Bishop 1993). Snowmelt creates ponding in localized area infiltrates to the Snake River Plain Aquifer. However, this recharge is i the water flow under the INEL site each year is 1.77 billion cubic meters (Robertson et al. 1974).

- Contaminant transport occurs in the upper 74-100 meters (243-325 feet) of Several modelers assume that the contaminant transport occurs in the upper feet) of the aquifer because this is the portion with the highest hydrauli and Rohe 1993, 1994; Schafer-Perini 1993; Robertson 1974, 1977). Vertical wastes downward below this zone is considered insignificant. Several stud be the effective portion of the aquifer (Ackerman 1991; Robertson et al. 1 al. 1976, Garabedian 1986, 1992), hence for regional scale modeling this i assumption. On a local scale, downward vertical movement of contaminants

- No speciation of the contaminant of interest: The models that were used i consider speciation of contaminants (specifically strontium-90) with other The contaminants are assumed to be in their valance state and not bound to thus preventing sorption. Equilibrium modeling using the U.S. Environment Agency-developed code MINTEQA2 indicated that the contaminants of interest would be unspeciated and would be expected to sorb as discussed in the mod

The mathematics used in the models are founded on other assumptions that are n example, it is assumed that flow can be described by Darcy's Law and that the parti can be approximated for solution by numerical methods. For more detail, see Domeni (1990).

#### F-2.2.2.3.4 Potential Contaminant Migration from Solid Waste-Solid low-level

radioactive and transuranic waste have been disposed of in several pits at the Subs within the Radioactive Waste Management Complex since 1952, and these dispositions continue until 2020. Transuranic waste disposal at the complex was discontinued in of low-level radioactive waste is projected to continue until 2020. A preliminary radioactive waste disposal practices during the time period from 1952 to 1996 is cu as part of a Comprehensive Environmental Response, Compensation, and Liability Act

investigation is being conducted under the Federal Facility Agreement/Consent Order negotiations among DOE, the U.S. Environmental Protection Agency, and the State of purposes of this EIS, impacts are being evaluated from 1995 to 2005. Results of th assessment indicate that contaminants would not reach the INEL site boundary exceed drinking water standards through 2005 (Loehr et al. 1994). For the next 100 years, highest 30-year average concentration in groundwater are predicted to be carbon-14 4,510 picocuries per liter, respectively. These levels are well below DOE's Derive established for carbon-14 (70,000 picocuries per liter) and the U.S. Environmental Maximum Contaminant Level established for tritium (20,000 picocuries per liter).

A radiological performance assessment was also conducted for low-level waste b Radioactive Waste Management Complex from 1984 through present operations and proje disposed through 2020 (Maheras et al. 1994). The results of the assessment indicat pathway exposure occurring by the year 2060 at the INEL site boundary would be less year (Maheras et al. 1994). No significant impacts are expected to occur within th the EIS. However, further information is required before an accurate evaluation of contaminant transport from the Radioactive Waste Management Complex to the environm completed. Information is currently being compiled to characterize source terms, m water, infiltration rates through soil coverings, sorptive characteristics of conta information. A Remedial Investigation/Feasibility Study and a risk assessment is b the potential impacts of past, present, and future activities at the Radioactive Wa but is not available for this EIS.

New wastes resulting from sources outside the INEL site identified under the p would not be addressed by the Remedial Investigation/Feasibility Study or the risk new wastes transported to the INEL site under the alternatives would be addressed u Environmental Policy Act documentation, and/or as specified under the Resource Cons and the Comprehensive Environmental Response, Compensation, and Liability Act.

Loehr et al. (1994) and Maheras et al. (1994) used computer models including G PORFLOW to predict the levels of contaminants that would occur at the INEL site bou considered the leaching and migration of contaminants through the vadose zone and i For a detailed discussion of methods used in the modeling approach, refer to these

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# F-3 Air Resources

**SECTION F-3 CONTENTS**

FIGURES



TABLES



**#F-3 AIR RESOURCES**

Section F-3 provides supplemental information on methodology and other techni for the air resources sections of Volume 2 of the Spent Nuclear Fuel and INEL Envir Restoration and Waste Management Environmental Impact Statement (SNF and INEL EIS).

## F-3.1 Overview

Activities proposed under the Environmental Restoration and Waste Management Program at the Idaho National Engineering Laboratory (INEL) site may affect the qua air resources in various ways. The alternative courses of action proposed under thi consequences that vary both in nature and magnitude. These consequences must be tho characterized to provide information needed to support the selection of proper cour Assessments have been performed to characterize the existing conditions of radiolog nonradiological air quality, as well as the consequences of alternative courses of presents background information related to these assessments, including description

- The regulatory framework under which air quality standards and criteria established and administered
- Airborne emissions of radiological and nonradiological pollutants from e

site facilities and proposed projects

- The data, methods, and computer models applied to estimate concentration pollutants at various locations as a result of airborne emissions.

The information presented herein supports the summary results presented in Se 5.7 (Air Resources) of Volume 2 of the SNF and INEL EIS, which respectively describ environment and consequences of alternatives on air quality. In addition to establi basis for those summary results, this section presents detailed emissions estimates proposed facilities. Additional details on the assessment results, including predic all combinations of alternative and waste management options and selected individua (including incineration at the Waste Experimental Reduction Facility), are presente Support Document for Air Resources, INEL Environmental Restoration and Waste Manage Programs (Belanger et al. 1995a).

## F-3.1.1 Scope

The assessments described in Section F-3 consider both nonradiological and ra quality related to baseline conditions, projected increases to the baseline, and th ER&WM alternative courses of action. Specifically, the scope includes background in air resources, air quality regulation, and assessments related to (a) existing cond actual emissions from INEL site facilities (termed the actual emissions baseline), would be experienced if existing facilities operated to the maximum extent allowed permits or limits (termed the maximum emissions baseline), and (c) the estimated co emissions from projects associated with each of the four ER&WM alternatives.

The assessments focus on conditions or impacts that result at onsite and offs the release of contaminants from various categories of sources. The types of emissi include radionuclides and the two major categories of nonradiological pollutants-th pollutants and toxic air pollutants. The categories of sources assessed include sta as facility stacks and vents), mobile sources, and sources related to construction locations for which baseline conditions and impacts are assessed include major work INEL site, locations along the INEL site boundary and public roads, and the Craters Wilderness Area. Assessment results are summarized in Sections 4.7 and 5.7 (Air Res main text and are presented in additional detail in Belanger et al. (1995a).

## F-3.1.2 Supporting Documentation

Section F-3 summarizes the methods of independent analyses performed by sever specialists from contractor organizations. In some cases, those analyses are docume prepared for this EIS. These documents are considered key references. Their content manner in which they were used in the air resources assessments are summarized as f

- A report prepared by Science Applications International Corporation (Belanger 1995a), which provides additional detail on assessment methodology and result including projected emissions and impacts for specific projects and waste man options.
- Two reports prepared by Science Applications International Corporation (Rauds al. 1995 and Belanger et al. 1995b), which provide specific information on th assessment of Prevention of Significant Deterioration.
- A report prepared by EG&G Idaho, Inc. (Leonard 1993), which presents estimate radiological doses resulting from airborne radionuclides released by faciliti INEL site. This report was used as a basis for the existing radiological air conditions.
- A document prepared by Ecology and Environment, Inc. (E&E 1994), describing t methods and results of the assessment of baseline conditions for toxic air po These results were used to establish the actual and maximum baseline levels o air pollutants.
- An Engineering Design File prepared by EG&G Idaho, Inc. (Leonard 1994), which presents estimated radiation doses to the maximally exposed worker and offsit individual and population dose resulting from specific projects associated wi ER&WM alternative actions. These results were used as the basis for estimatin radiological doses for radionuclide emissions associated with specific altern

waste stream management options.

- Engineering Design Files prepared by EG&G Idaho, Inc, describing the source t estimated for no action projects (Staley 1993a) and proposed action projects 1993b). These source terms were used as input to the air quality assessments projected increases to the baseline and ER&WM alternatives, which included no action and proposed action projects.

- A document prepared by Ecology and Environment, Inc. (E&E 1993), describing t methods and results of assessments to estimate impacts from mobile and constr source emissions. These results were used as a basis for estimating consequen mobile sources and construction activities related to ER&WM alternatives.

Section F-3 attempts to integrate the descriptions of methods, assumptions, a information from the analyses cited above into a single source.

### F-3.1.3 Organization

The remainder of this section is organized as follows:

- Section F-3.2 presents the background environmental information on the including background levels of radiation. radioactivity, and nonradiol
- Section F-3.3 contains a description of air quality regulations and gu discussion of how they apply to sources at the INEL site
- Section F-3.4 describes the methods and assumptions used to estimate e assess conditions and impacts for releases of radiological and nonradi pollutants and presents listings of these emissions for specific proje ER&WM alternatives.

## F-3.2 The Idaho National Engineering Laboratory Site Environment

This section describes background levels of radiation, airborne radioactivity nonradiological air quality in the environs of the INEL site.

### F-3.2.1 Radiation and Airborne Radioactivity

The population of the Eastern Snake River Plain is exposed to environmental r both natural and anthropogenic sources (that is, sources of human origin). This sec background levels of radiation and airborne radioactivity in this geographical regi of population exposure not related to INEL site emissions. Monitoring data for area influence of INEL site emissions are also presented. Additional information related conditions (including monitoring results and airborne radioactivity associated with facilities) is presented in Hoff et al. (1993).

#### F-3.2.1.1 Sources of Radiation Exposure Not Related to Idaho National

Engineering Laboratory Site Operations. The predominant source of radiation in the the natural radiation background, a term that refers to natural sources of radiatio are continuously exposed. Background radiation includes sources such as cosmic rays naturally present in soil, rocks, and the human body; and airborne radionuclides of (such as radon). The dose from background radiation results from sources that can b (outside the body) or internal (within the body). External sources consist primaril and radioactivity within soil and rocks. Internal sources include radioactivity nat the human body and airborne radioactivity that can deposit in the lungs when inhale background dose is increased by radioactivity still remaining in the environment as atmospheric testing of nuclear weapons, although this increase is very minor (less

Table F-3-1 presents a summary of the estimated background dose by various ex categories for residents of the Eastern Snake River Plain. As can be seen from thes cumulative annual dose, 351 millirem, is due largely to the inhalation of airborne

radioactivity consists almost entirely of radioactive particles formed by the decay occurring radon.

In addition to natural background sources, residents of the Eastern Snake Riv exposure from radiation sources of human origin (anthropogenic sources), including nuclear medicine diagnostic procedures, consumer products (such as televisions, smo self-luminous products), and radioactivity remaining in the environment as a result testing of nuclear weapons. Collectively, these result in an animal dose of about 6 average U.S. population member, with most of this dose (about 54 millirem per year) the medical use of radiation (NCRP 1987). This dose does not include the contributi radioactivity in tobacco products, which results in a substantial radiation dose (s to the lungs of smokers.

**Table F-3-1. Summary of environmental radiation dose from natural background source** of the Eastern Snake River Plain for 1991.^a

| Source | Annual dose (millirem) |
|---|---|
| External sources^b | |
| Terrestrial radioactivity | 73 |
| Cosmic rays | 39 |
| Total external | 112 |
| Internal sources^c | |
| Airborne (inhaled) radioactivity | 200 |
| Radioactivity in the body | 39 |
| Total internal | 239 |
| Total dose | 351 |

a. Dose is expected to vary by a small amount from year to year.
b. Source: Hoff et al. (1992).
c. Regional data are not available; internal dose values are effective doses for a member of the U.S. population but are likely to be representative of the Eastern S Plain (NCRP 1987).

**F-3.2.1.2 Radiological Environmental Monitoring. Over the years, radiological**

conditions in the INEL Site environs have been characterized by various monitoring Monitoring refers to a variety of activities (for example, sampling, analysis, and performed to measure ambient radiation exposure rates and airborne radioactivity le Environmental Surveillance Program includes a comprehensive network of 23 continuou samplers. Twelve of the sampling locations are located within the boundaries of the are located offsite, including seven stations near the INEL site boundary and four located within the communities of Blackfoot, Idaho Falls, and Rexburg, and in Crate Wilderness Area. It is assumed that results from onsite and boundary community loca contributions from background conditions and INEL site emissions, while distant loc background conditions beyond the influence of INEL site emissions. A summary of gro beta activity measurement results for distant and INEL site boundary community loca in Table F-3-2, indicates that there is no significant difference in airborne radio these locations. Additional details regarding this program are provided in Hoff et

The Environmental Surveillance Program also includes direct measurements of a (environmental) radiation levels using thermoluminescent dosimeters (TLDs). These d

**Table F-3-2. Airborne radioactivity levels for Idaho National Engineering Laborator** boundary communities, and distant locations for 1991.^a

Average concentration^b
(10^-15 microcuries per milliliter)

| Location | Alpha | Beta |
|---|---|---|
| Distant | 2.0 +/- 0.2 | 27 +/- 1 |
| Boundary | 1.8 +/- 0.1 | 28 +/- 1 |
| Onsite | 1.7 +/- 0.1 | 29 +/- 1 |

a. Source: Hoff et al. (1992).
b. Values are arithmetic means with 95 percent confidence interval.

ionizing radiation exposure rates due to the combined sources of natural radioactiv soil, cosmic rays, residual fallout from nuclear weapons tests, and radioactivity f operations. Dosimeters are placed at seven distant community locations and six boun The average annual exposure measured by the thermoluminescent dosimeters for 1991 w 123 milliroentgen (which corresponds to a dose of 127 millirem) for distant locatio 121 milliroentgen (125 millirem) for boundary community locations (Hoff et al. 1992

### F-3.2.2 Background Nonradiological Air Quality

As used here, the term background air quality refers to the levels of nonrad pollutants in ambient air that are not attributable to INEL site activities. Limite available for characterization of background air quality levels, since only particu monitored at locations beyond the influence of the INEL site. The INEL Environmenta Surveillance Program, which is conducted by the Department of Energy (DOE) Idaho Op Office Radiological and Environmental Sciences Laboratory (RESL), monitors airborne matter concentrations at INEL Site boundary communities and distant and onsite loca illustrated in Figure F-3-1. Onsite data are considered to include background leve from INEL site activities. Results for airborne particulate monitoring at distant, and onsite locations for the period 1988 through 1992 are presented in Table F-3-3. other pollutant levels, including nitrogen dioxide and sulfur dioxide, is performed Nitrogen dioxide is monitored at two locations onsite to fulfill one of the conditi Construct issued by the State of Idaho. Sulfur dioxide is also measured at one of t

Figure F-3-1. The airborne raioactivity monitoring network operated by the Radiolog

**Table F-3-3. Environmental surveillance program particulate matter monitoring data** National Engineering Laboratory for 1988 through 1992.^a

| Year | Concentration^b (micrograms per cubic meter) Distant group | Boundary group | Onsite group |
|---|---|---|---|
| 1988 | 50 +/- 20 | 35 +/- 9 | 32 +/- 13 |
| 1989 | 40 +/- 14 | 30 +/- 7 | 17 +/- 2 |
| 1990 | 36 +/- 12 | 32 +/- 8 | 20 +/- 9 |
| 1991 | 30 +/- 20 | 28 +/- 12 | 18 +/- 3 |
| 1992 | 26 +/- 19 | 23 +/- 10 | 13 +/- 2 |

a. Source: Hoff et al. (1993).
b. Values are arithmetic group means of quarterly composites of weekly samples with 95 percent confidence level for the mean.

The State of Idaho has conducted particulate monitoring at the Craters of the Wilderness Area. Monitoring results for this activity, which was discontinued in 19 in Table F-3-4. Since this location is approximately 20 kilometers (12.4 miles) fro boundary (and much further from most major emmisions sources), these levels can be representative of general background.

**Table F-3-4. Summary of total suspended particulate matter monitoring data for Crat** Wilderness Area.^a

| | Concentration |
|---|---|

(micrograms per cubic meter)

| Year | 24-year maximum | Standard^b | Annual average | Stand |
|---|---|---|---|---|
| 1984 | 41 | 260 | 6 | 75 |
| 1985 | 48 | 260 | 10 | 75 |
| 1986 | 41 | 260 | 10 | 75 |
| 1987 | 35 | 260 | 15 | 75 |
| 1988 | 43 | 260 | 14 | 75 |

a. Source: IDHW (1991). Data are for the last five years for which results are ava
b, These are primary State standards for total suspended particulates; secondary s 150 micrograms per cubic meter for 24-hour total suspended particulates and 60 mic cubic meter for annual average.

## F-3.3 Air Quality Standards and Regulations

To protect the public from potential harmful effects of air pollution, air qu have been established by Federal and State agencies. These regulations are based on strategy that incorporates the following principal elements:

- Designation of acceptable levels of pollution in ambient air to protect
- Establishment of limits on emissions of air pollutants from vehicular an sources
- Implementation of a permitting program to regulate (control) emissions f stationary (nonvehicular) sources of air pollution
- Issuance of prohibitory rules, such as rules prohibiting open burning.

At the INEL, programs have been developed and implemented to ensure complianc quality regulations by (a) identifying sources of air pollutants and obtaining nece Federal permits, (b) providing adequate control of emission of air pollutants, (c) sources and ambient levels of air pollutants to ensure compliance with air quality (d) operating within permit conditions, and (e) obeying prohibitory rules.

This section describes Federal and State air quality regulations that are app proposed actions and programs established by DOE to comply with environmental, safe requirements in general and air quality requirements in particular.

### F-3.3.1 Federal and State Air Quality Requirements

The Federal Clean Air Act establishes the framework to protect the nation's a public health and welfare. The U.S. Environmental Protection Agency (EPA) and the S are jointly responsible for establishing and implementing programs that meet the re Act. Facilities planned or currently operating at the INEL are subject to air quali standards established under the Clean Air Act and by the State Department of Health (IDHW), Division of Environmental Quality, and to internal policies and requirement quality standards and programs applicable to INEL operations are summarized in Figu Volume 2 of this EIS and are described in further detail below.

**F-3.3.1.1 Ambient Air Quality Standards. The Federal Clean Air Act establishes**

National Ambient Air Quality Standards (NAAQS) to protect public health and welfare standards define the ambient concentration of an air pollutant below which no adver human health is expected. A second category of standards (called secondary standard established to prevent adverse impacts on public welfare, including aesthetics, pro vegetation. Certain standards apply to long-term (annual average) conditions; other applying to conditions that persist for periods ranging from one hour to three mont the toxic properties of the pollutant in question. Ambient standards have been deve

few specific contaminants, namely, respirable particulate matter (particles not lar 10 micrometers in diameter, which tend to remain in the lung when inhaled), sulfur dioxide, carbon monoxide, lead, and ozone. In addition, the State of Idaho has als additional State ambient air quality standard for total suspended particulates (all regardless of size) and a standard for fluorides in vegetation. (a) These pollutant criteria air pollutants. A listing of National Ambient Air Quality Standards is pro

**Table F-3-5.**

The U.S. Environmental Protection Agency and State of Idaho have monitored am quality in an attempt to define areas as either attainment (that is, the standards nonattainment of the ambient air quality standard, although many areas are unclassi of regional monitoring data. The attainment status is specific to each pollutant an Designation as either attainment or nonattainment not only indicates the quality of also dictates the elements that must be included in local air quality regulatory co Unclassified areas are generally treated as being in attainment. The elements requi nonattainment areas are more comprehensive (or stricter) than in attainment areas.

a. In the assessments performed for this EIS, all particulate matter was assumed to (termed PM-10), with the exception of fugitive dust sources. Since the standard for than that for total particulates, the former standard was used as basis for compari assessment for flourides in vegetation was omitted in favor of a more stringent co of toxic air pollutants in air (see Section F-3.3.1.5). Therefore, discussions that detail on total suspended particulates and flourides.

**Table F-3-5. National Ambient Air Quality Standards and increment values for Preven** Significant Deterioration (micrograms per cubic meter).

| Pollutant | Averaging time | Standard: Primary | Standard: Secondary | Increment: Class II area | Increment: Cla |
|---|---|---|---|---|---|
| Sulfur dioxide | 3-hour | (a) | 1300 | 512 | 25 |
| | 24-hour | 365 | (a) | 91 | 5 |
| | Annual | 80 | (a) | 20 | 2 |
| Particulate matter^b | 2-hour | 150 | 150 | 30 | 8 |
| | Annual | 50 | 50 | 17 | 4 |
| Nitrogen dioxide | Annual | 100 | 100 | 25 | 2.5 |
| Carbon monoxide | 1 hour | 40,000 | (a) | (a) | (a) |
| | 8-hour | 10,000 | (a) | (a) | (a) |
| Lead | Quarterly | 1.5 | 1.5 | (a) | (a) |
| Ozone | 1-hour | 235 | 235 | (a) | (a) |

a. No standard or increment for this pollutant or averaging time.
b. Refers to particulate matter less than 10 microns in size (PM-10). Includes rece promulgated increment for PM-10.

encompasses the environs of the INEL has been classified as attainment or unclassif National Ambient Air Quality Standards, meaning that air pollution levels are expec considered healthful. The nearest nonattainment area lies some 50 miles south of th Power and Bannock Counties. This area has been designated as nonattainment for the related to respirable particulate matter.

**F-3.3.1.2 Prevention of Significant Deterioration. The Clean Air Act contains**

requirements to prevent the deterioration of air quality in areas designated as att ambient air quality standards. These requirements are contained in the Prevention o Deterioration (PSD) amendments and are administered through a program that limits t specific air pollutants above the levels that existed in what has been termed a bas year. The amendments specify maximum allowable ambient pollutant concentration incr increments. Increment limits for pollutant level increases are specified for the na (designated as Class II areas), and more stringent increment limits (as well as cei

for designated national resources, such as national forests, parks, and monuments ( Class I areas). In Southeastern Idaho, the Craters of the Moon Wilderness Area is t area. Increment values applicable to the INEL site are presented in Table F-3-5.

The State of Idaho Department of Health and Welfare, Division of Environmenta (DEQ), administers the Prevention of Significant Deterioration Program. Proposed ne emissions at the INEL site and modifications are evaluated to determine the expecte emissions of all pollutants. The INEL site is considered a major source, since faci of some air contaminants exceed 250 tons per year. As such, a Prevention of Signifi Deterioration analysis must be performed whenever any modification would result in increase of any air pollutant. Levels of significance range from very small quanti pound) to over 100 tons per year, depending on the toxic nature of the substance. F significance levels range from any increase in emissions to that which would result of 0.1 millirem per year or greater, depending on total facility emissions. If an I requires a Prevention of Significant Deterioration permit, it must be demonstrated

- Will be constructed using best available control technology (a level o technologically feasible and considered cost-effective) to control sig in air emissions
- Will operate in compliance with all prohibitory rules
- Will not cause a detriment to ambient air quality at the nearby Crater Wilderness Area, a Prevention of Significant Deterioration Class I are
- Will not result in an exceedance of an ambient air quality standard.

The evaluation also includes an assessment of potential growth and associated quality-related values-visibility, vegetation, and soils. Generally, all Prevention Deterioration projects must go through a public comment period with an opportunity review. The INEL has been granted a total of 23 Prevention of Significant Deteriora construct by the Division of Environmental Quality; applications for an additional been submitted and are pending approval (Hoff et al. 1992).

**F-3.3.1.3 National Emission Standards for Hazardous Air Pollutants, In addition to**

ambient air quality standards and Prevention of Significant Deterioration requireme Act designates requirements for sources that emit substances designated as hazardou These requirements are specified in a program termed National Emission Standards fo Pollutants (NESHAPs). This program was substantially amended in 1990 and has yet to implemented. However, one section of the National Emission Standards for Hazardous program that currently applies to INEL Operations is contained in Title 40 of the C Regulations (CFR) Part 61, Subpart H, National Emissions Standards for Radionuclide Department of Energy Facilities. This regulation establishes a limit to the dose th by a member of the public due to operations at the INEL. The annual dose limit (10 applies to the maximally exposed offsite individual and is designed to be protectiv with an adequate margin of safety. The regulation also establishes requirements for emissions from facility operations and analysis and reporting of dose.

The INEL complies with the requirements of the National Emission Standards f Air Pollutants through programs to monitor radionuclide emissions, evaluate dose to residences, and report doses annually to the U.S Environmental Protection Agency. P sources of emissions at the INEL and modifications are evaluated to identify the ex to dose to nearby residents. If specified levels (fractions of the acceptable dose Operations) are exceeded, a National Emission Standards for Hazardous Air Pollutant application is prepared for submittal to the U.S Environmental Protection Agency. N also evaluated to determine emissions monitoring requirements The INEL currently h National Emission Standards for Hazardous Air Pollutants Permits granted by the U.S Protection Agency (Hoff et al. 1992).

In addition to radionuclides, emissions standards have been established unde Emission Standards for Hazardous Air Pollutants Program for several nonradiological pollutants, including benzene, asbestos, and others. The INEL complies with the req evaluation, control, and permitting of nonradiological hazardous air pollutants thr are also administered by the U.S. Environmental Protection Agency. In accordance wi Amendments to the Clean Air Act, maximum achievable control technology (MACT) will by the U.S. Environmental Protection Agency for various sources. Those sources will implement programs or controls to achieve maximum achievable control technology by implementation date and analyze residual risk. If the residual risk is above specif limits, additional controls will be required. Only a few maximum achievable control levels have been proposed, and the INEL is not yet directly affected. It is expecte

controls will be required as maximum achievable control technology levels are promu
categories, including (but not limited to) waste treatment, storage and disposal fa
boilers, process heaters, stationary internal combustion engines, hazardous waste i
remediation activities.

**F-3.3.1.4 State of Idaho Permit Programs. The Idaho Air Pollution Control Program,**

administered by the Division of Environmental Quality, requires that permits be obt
sources of air pollutants. Unless the source is specifically exempt from permitting
Permit to Construct must be obtained before a Source can be constructed. The list o
very specific and limited; most new INEL sources and modifications to existing sour
subjected to a Permit to Construct. Under Title V of the 1990 Clean Air Act Amendme
would also be subjected to an Operating Permit, which must be renewed periodically.
typically issued with specific emissions limits and conditions for operation. This
process allows the State to determine that emissions will be adequately controlled,
comply with all emission standards and regulations, and public health and safety wi
Protected. Generally, Operating Permit reviews must go through a public review peri
opportunity for public comment.

In addition to the Prevention of Significant Deterioration permits cited in S
as of January 1992 the State had issued 29 Permits to Construct for Sources at INEL
do not exceed the threshold for Prevention of Significant Deterioration; the estima
these sources are less than 10 percent of levels deemed significant by the Division
Quality and Prevention of Significant Deterioration analysis is not required (DOE-I

**F-3.3.1.5 State of Idaho Rules for Toxic Air Pollutants. The Idaho Division of**

Environmental Quality has recently promulgated rules and methodologies to estimate
potential human health impacts of toxic air pollutants (pollutants which by their n
human or animal life or vegetation) from new or modified sources. These rules are c
Title 1, Chapter 1, of the Rules for the Control of Air Pollution in Idaho (IDHW 19
implemented through the air quality permit program described above. Emission levels
have been established for about 700 toxic air pollutants, based on the known or sus
these substances. Expected emissions above administrative screening levels must be
standard air dispersion modeling techniques (computerized programs to predict pollu
concentrations based on source emissions, release characteristics, and meteorologic
risk assessment methodologies to assess potential impacts. A facility will not be g
unless it can be shown that the emissions will comply with all applicable toxic air
for carcinogenic (cancer-causing) and noncarcinogenic substances (IDHW 1994). As pa
permit evaluation process, requirements related to toxic air pollution control equi
modifications, and materials substitutions may be specified to limit ambient levels
pollutants.

The State has defined acceptable ambient concentration levels for many toxic
including both carcinogenic and noncarcinogenic contaminants. These levels are incr
existing levels and apply only to sources that became operational after May 1, 1994
contaminants known or suspected to cause cancer in humans, this level has been defi
acceptable ambient concentration for a carcinogen (AACC). The acceptable ambient co
a carcinogen is based on risk and corresponds to that concentration at which the pr
contracting cancer is one in a million, assuming continuous exposure over a 70-year
acceptable ambient concentration for a carcinogen differs for each carcinogenic sub
carcinogenic potency, as defined by the U.S. Environmental Protection Agency. (The
assess cancer health risk associated with air emissions from current INEL site faci
actions is summarized in Section F-4, Health and Safety, of this appendix.) The Sta
permit if the calculated incremental risk due to project emissions does not exceed
ambient concentration for a carcinogen (that is, does not result in an individual e
greater than one in a million). If this level is expected to be exceeded, a permit
if (a) the calculated risk does not exceed ten in a million and (b) toxic reasonabl

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a. This probability is often described as an "individual excess cancer risk." Exces
here, means above the normal cancer incidence rate, which is currently about one in
An individual excess cancer risk of one in a million or less is generally considere

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technology (which is similar to best available control technology, or BACT) is empl emissions of carcinogenic substances.

Many air contaminants are not carcinogens but may contribute to other health as respiratory or eye irritants, or impacts to the cardiovascular, reproductive, ce other body systems. Levels of significance for noncarcinogenic substances are calle concentrations (AAC). The acceptable ambient concentration is based on acceptable e for occupational workers and other reference sources of information for the contami For an added margin of safety, the State generally sets the acceptable ambient conc hundredth of the acceptable occupational exposure level. Permits are granted if inc from the new or modified source are expected to result in annual average concentrat acceptable ambient concentration. However, if the acceptable ambient concentration exceeded, a permit may still be granted based on consideration of other factors, su the substance and anticipated level of exposure.

The acceptable concentration levels specified in the regulation are increment standards that apply to new and modified stationary sources. They are used as guide comparison (called reference levels) with the results of the toxic air pollutant as in Section 5.7, Air Resources, of Volume 2 of this EIS.

## F-3.3.2 Department of Energy Orders and Guides

The DOE has developed and issued a series of orders and guides to ensure that comply with applicable environmental, safety, and health regulations and DOE intern including the concept of maintaining emissions and exposures to the public and work are as low as reasonably achievable (ALARA). The as-low-as-reasonably-achievable co employed in the design and operation of all facilities and applies to all types of example, radionuclides, carcinogens, and toxic and criteria air pollutants). Order designed for protection of environment, safety, and health are

- DOE Order 5400.1, "General Environmental Protection Program," establishes environmental protection program requirements pertaining to air and other environmental media intended to ensure that operations comply with applicable Federal, State, and local laws and regulations, as well as DOE internal polic Order defines environmental protection requirements established in more gener terms in DOE Order 5480.1B.
- DOE Order 5480.1B, "Environment, Safety, and Health Program for Department of Energy Operations," details overall requirements for environmental, safety, a programs.
- DOE 5480.4, "Environmental Protection, Safety, and Health Protection Standard specifies and provides requirements for the application of mandatory standard applicable to DOE and contractor operations.
- DOE Order 5400.5, "Radiation Protection of the Public and the Environment," prescribes exposure limits for exposure of the public to radiation from sitew activities that are equivalent to the 40 CFR 61 limits described in Section F As of December 1994, this order was in the process of being codified as Title Part 834, of the Code of Federal Regulations (that is, 10 CFR 834).
- DOE policy further requires effluent and environmental air monitoring program determine whether the public and the environment are adequately protected and whether operations are in compliance with applicable regulations. The "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance" (DOE 1991) has been issued to assist operating fa in implementing this policy and specifies the required elements of a radiolog monitoring program.
- DOE Order 5483.1A, "Occupational Safety and Health Program for DOE Contractor Employees at Government Owned, Contractor Operated Facilities," establishes requirements and procedures to ensure that worker protection is consistent wi afforded private industry employees by the Occupational Safety and Health Act 1970.
- DOE Order 5480.11, "Radiation Protection for Occupational Workers," establish standards for protection of workers from occupational exposure to radiation. Order has been codified as Title 10, Part 835, of the Code of Federal Regulat (that is, 10 CFR 835).

## F-3.4 Air Quality Impact Assessment Methodology

Distinct types of assessments have been performed to assess air quality for e and future actions. These are

- Radiological air quality assessments, which are performed for radionuc from stationary sources
- Nonradiological air quality assessments, which are performed for crite pollutant emissions from stationary (stack and diffuse) operational so dust and combustion product emissions associated with construction equ some operational sources
- Degradation of visibility assessments, which are performed for certain emissions from stationary sources
- Assessments of criteria pollutant emissions from mobile sources.

This section describes the methodology used in each type of air quality asse the general approach to source term estimation and atmospheric dispersion modeling, specific information on related assumptions, methods, and data used in the analyses

### F-3.4.1 Source Term Estimation

The type and quantity of pollutants emitted to air from a specific source, o is often referred to as the source term. This Section summarizes methods used to es radiological and nonradiological source terms for current and projected INEL site f

**F-3.4.1.1 Source Terms for Existing Facilities. The source terms used for existing**

radiological conditions were obtained primarily from Engineering Design Files (EDFs prepare the 1991 INEL National Emission Standard for Hazardous Air Pollutants, Annu (DOE-ID 1992a) and Supplement (DOE-ID 1992b). Other source term-related data were o from the INEL Radioactive Waste Management Information System (RWMIS) (Litteer et a Taylor 1994) and from operating contractors of existing facilities. Radiological so existing INEL site facilities are summarized in Table 4.7-1 of Volume 2 of this EIS in Leonard (1993).

The maximum hourly and annual average emission rates for criteria and toxic from existing facilities and anticipated projects are listed in Table 4.7-2 of Volu Criteria pollutant emission rates for existing facilities are based on data contain Emissions Inventory for 1991 (DOE-ID 1992c). Toxic pollutant emission rates are fro Toxic Air Pollutant Emissions Inventory for 1989 (DOE-ID 1993a). These are the two years for which the required data are available. To characterize a maximum emission actual emission rates were increased by appropriate scaling factors. In general, th are based on maximum emission rates allowed by facility operating permits or on max throughput or capacity of the process producing the emissions. The rationale and me process is described in further detail in E&E (1994) and Belanger et al. (1995a).

Emission rates are estimated for all criteria pollutants. However, since the toxic air pollutants (many of which are released in only trace quantities), analyst approach to reduce the number requiring assessment to only those toxic emissions th potential to result in concentrations approaching applicable standards or guideline assessment, this was done by comparing current (1989) emission rates to the screeni proposed by the State of Idaho (IDHW 1994). Emission rates below this level are con State as not likely to have significant impacts and therefore do not warrant furthe the proposed State regulations would apply only to new (and not existing) facilitie screening emission levels are useful as indicators of potentially significant emiss

Some projects that were originally considered part of Alternative A (No Actio considered as projected increases to the baseline (that is, it was assumed, at the that they would become operational prior to the implementation start date for the E alternatives). Source terms for these projects were estimated as described below f alternative projects but are reported on Table 4.7-2.

#### F-3.4.1.2 Source Term Estimation for Environmental Restoration and Waste

Management Alternatives. Emission rates were estimated for each project associated more of the ER&WM alternatives. Source terms for specific projects associated with alternatives were estimated using conservative engineering calculations based on kn proposed facility or activity. Typically, these evaluations considered the processe materials to be used, activities to be performed within the systems, and operating similar systems. For some projects, emissions estimates had previously been made an as part of an Environmental Assessment, Permit to Construct, or other action. In su previously estimated source terms were either used directly or were revised to refl information. Where applicable, the analysis used emission factors from authoritativ sources, such as EPA (1992a).

Source term estimates for ER&WM projects include the following components:

- Radionuclide emissions from projected facility operation: as a minimum radionuclides that collectively contribute 95 percent or more of the p specified individually
- Criteria pollutant emissions from facility operations: all criteria po included in the estimates
- Toxic air pollutant emissions from facility operations: the toxic air assessed were those that were either (a) included in the baseline asse emitted by any proposed project or (b) emitted by proposed projects in quantity that exceeds the screening level emission rate proposed by th (even if the toxic was not assessed in the baseline)
- Fugitive dust and criteria pollutant emissions from construction and d is, decontamination and decommissioning projects) activities

- Fugitive dust and criteria pollutant emissions from mobile sources.

The radiological and nonradiological source terms for ER&WM projects are docu Staley (1993a, 1993b) for no action and proposed action projects, respectively. How time those documents were prepared, projects have been added, deleted, or changed i definition. Emissions data have been revised to reflect updated project information emission rates for radionuclides, criteria pollutants, and toxic air pollutants are Tables F-3-6, F-3-7, and F-3-8, respectively. These tables present emission rates f which emissions are expected, as well as the ER&WM alternative and waste stream or which each project is associated.

### F-3.4.2 Radiological Assessment Methodology

This section summarizes information on the data and methods used to assess ra conditions and dose to individuals at onsite and offsite locations due to routine e radionuclides from existing and proposed INEL site facilities.

#### F-3.4.2.1 Model Selection and Application. The computer program GENII (Napier et

al. 1988) was used to calculate doses from all pathways and modes of exposure likel significantly to the total dose from airborne releases. These are

- External radiation dose from radionuclides in air
- External dose from radionuclides deposited on ground surfaces
- Internal dose from inhalation of airborne radionuclides
- Internal dose from ingestion of contaminated food products.

GENII incorporates algorithms, data, and methods for calculating doses to various t and for determination of effective dose equivalent, based on the recommendations of

**Table F-3-6. Listing of projected Idaho National Engineering Laboratory site radion**

| Project, location, and program or streama | Assoc-iated altern-ativeb | Carbon monoxide | | Nitrogen di |
|---|---|---|---|---|
| | | Max.hr. | Annual | Max.hr. |

| | | | | |
|---|---|---|---|---|
| | | (g/hr) | (kg/yr) | (g/hr) |
| Radiological and Environmental Sci Laboratory Replacement, CFA, infrastructure | A,B,C,D | 14 | 118 | 66 |
| BORAX-V D&D, EBR-I/BORAX-V area, D&D | | | | |
| Emergency generator | A,B,C,D | 200 | 176 | 940 |
| Demolition (blasting) | | (c) | 292 | (c) |
| Pit 9 Retrieval, RWMC, remediation | A,B,C,D | | | |
| Retrieval of waste and soil | | (c) | (c) | (c) |
| Thermal treatment | | 4,250 | 16,600 | 32,600 |
| Boiler | | 418 | 3,680 | 1,880 |
| Transuranic Storage Area Enclosure Storage, RWMC, transuranic waste | A,B,C,D | 1,660 | 14,500 | 3,530 |
| Waste Characterization Facility, R transuranic waste | A,B,C,D | 1,700 | 3,450 | 6,800 |
| Waste Handling Facility, ANL-W, low-level waste | A,B,C,D | 122 | 23 | 564 |
| Waste Immobilization Facility,d IC igh-level waste | | | | |
| With separations | C,D | 1,300 | 420 | 190,000 |
| With direct vitrification | B | 0.04 | 0.4 | 190,000 |
| Mixed/Low-Level Waste Treatment Facility, RWMC,e low-level and mixed low-level waste | D | | | |
| Incineration | | 24 | 137 | 232 |
| Sizing, compaction, treatment | | (c) | (c) | (c) |
| Emergency generator | | 4,060 | 211 | 18,800 |
| Fort St. Vrain Spent Nuclear Fuel eipt and Storage, ICPP, spent nuclear fuel | B,D | 5.0 | 0.17 | 25 |
| Idaho Waste Processing Facility,f RWMC, transuranic, low-level, and mixed low-level waste | | | | |
| Incineration | B | 6,790 | 17,650 | 18,430 |
| Incineration | D | 7,810 | 20,300 | 21,200 |
| Emergency generator | B,D | 7,290 | 379 | 27,700 |
| Heating boiler | B,D | 386 | 1,270 | 4,250 |
| RWMC modifications to support priv sector treatment of alpha-contaminated mixed low-level waste, RWMC, transuranic waste | B,D | 1,200 | 11,000 | 5,500 |
| Waste Experimental Reduction Facil Incineration,g PBF, low-level and mixed low-level waste | B,D | 330 | 1,900 | 400 |
| Plasma Hearth Process, ANL-W, mixe low-level and hazardous waste | B,D | 82 | 257 | 2,200 |
| Totalh | | 29,550 | 74,295 | 316,686 |

a. Only those projects with criteria pollutant emissions are listed; CFA = Central Reactor Experiment-V; EBR-I = Experimental Breeder Reactor-I; D&D = decontamination Waste Management Complex; ICPP = Idaho Chemical Processing Plant; PBF = Power Burst Laboratory-West.
b. A = Alternative A (No Action); B = Alternative B (Ten-Year Plan); C = Alternati Disposal); D = Alternative D (Maximum Treatment, Storage, and Disposal).
c. No emissions of this type are predicted for the project.
d. The Waste Immobilization Facility may operate in either of two modes: direct v separations (under Alternative C or D).
e. The precise location for these facilities has not yet been determined; for purp is slightly east of RWMC.
f. Incinerator emissions under Alternative D are assumed to be 15 percent higher t Alternative B; similar emissions would also be projected for the Private Sector Alp Treatment Facility, which is a competing project that would have a similar design a
g. This project includes incineration only; other waste processing is assessed as

h. This total would apply only to Alternative D and only if all facilities were op for totals by alternative and program or waste stream.

**Table F-3-8. Listing of projected Idaho National Engineering Laboratory site toxic** rates by project and alternative.

| Project name, location, and associated program or source groupa | Asso-ciated alter-nativeb | Compound | Emission rate<br>Maximum hourly (Grams per hour) | ( h |
|---|---|---|---|---|
| Radiological and Environmental Science Laboratory Replacement, Central Facilities Area, infrastructure | A,B,C,D | Hydrochloric acid | 1.5 y 101 | 3 |
| | | Hydrofluoric acidc | 3.0 y 100 | 6 |
| | | Nitric acid | 7.0 y 100 | 1 |
| | | Sulfuric acid | 2.0 y 101 | 4 |
| Boiling Water Reactor Experiment V (BORAX-V) Decontamination and Decommissioning, Experimental Breeder Reactor-I/BORAX-V area, decontamination and decommissioning | A,B,C,D | Ammonia | 1.1 y 102 | 2 |
| | | Benzene | 3.0 y 100 | 6 |
| | | Formaldehyde | 5.8 y 100 | 1 |
| Pit 9 Retrieval, Radioactive Management Complex, remediation | A,B,C,D | Asbestos | 1.1 y 10y1 | 2 |
| | | Benzene | 4.7 y 100 | 1 |
| | | Beryllium | 9.8 y 10y3 | 2 |
| | | Carbon tetrachloride | 5.7 y 100 | 1 |
| | | Chloroform | 1.3 y 100 | 2 |
| | | Chromium | 6.4 y 10-2 | 1 |
| | | Formaldehyde | 5.2 y 101 | 1 |
| | | Hydrochloric acid | 2.1 y 101 | 4 |
| | | Mercury | 9.3 y 10y1 | 2 |
| | | Nickel | 7.3 y 10-1 | 1 |
| | | Perchloroethylene | 1.3 y 100 | 2 |
| | | Trichloroethylene | 1.9 y 100 | 4 |
| Transuranic Storage Area Enclosure and Storage, Radioactive Waste Management Complex, transuranic waste | A,B,C,D | Asbestos | 5.0 y 10y9 | 1 |
| | | Benzene | 8.4 y 100 | 1 |
| | | Beryllium | 7.5 y 10y13 | 1 |
| | | Cadmium | 1.1 y 10y11 | 2 |
| | | Carbon tetrachloride | 2.3 y 10y1 | 5 |
| | | Chromium | 6.8 y 10y2 | 1 |
| | | Formaldehyde | 9.3 y 101 | 2 |
| | | Methylene chloride | 1.5 y 10y2 | 3 |
| | | Nickel | 7.8 y 10y1 | 1 |
| | | Perchloroethylene | 2.3 y 10y2 | 5 |
| | | Trichloro-trifluoroethane | 1.4 y 10y1 | 3 |
| | | Trichloroethylene | 1.5 y 10y1 | 3 |
| Vadose Zone Remediation, Radioactive Waste Management Complex, remediation | A,B,C,D | Carbon tetrachloride | 2.7 y 101 | 6 |
| | | Chloroform | 9.0 y 10y1 | 2 |
| | | Perchloroethylene | 1.1 y 100 | 2 |

| | | | | |
|---|---|---|---|---|
| | | Trichloroethylene | 4.7 y 100 | 1 |
| Waste Characterization Facility, Radioactive Waste Management Complex, transuranic waste | A,B,C,D | Asbestos | 2.9 y 10y9 | 6 |
| | | Benzene | 1.9 y 10y1 | 4 |
| | | Beryllium | 2.2 y 10y10 | 4 |
| | | Cadmium | 3.2 y 10y12 | 7 |
| | | Carbon tetrachloride | 4.5 y 10y1 | 9 |
| | | Chromium | 1.2 y 10y4 | 2 |
| | | Formaldehyde | 2.1 y 100 | 4 |
| | | Mercury | 1.5 y 10y9 | 3 |
| | | Methylene chloride | 1.1 y 103 | 2 |
| | | Nickel | 1.3 y 10y3 | 2 |
| | | Nitric acid | 1.0 y 102 | 2 |
| | | Polychlorinated biphenyls | 9.0 y 10y9 | 2 |
| | | Perchloroethylene | 4.5 y 10y2 | 9 |
| | | Sulfuric acid | 1.4 y 101 | 3 |
| | | Trichloro-trifluoroethane | 2.8 y 10y1 | 6 |
| | | Trichloroethylene | 1.6 y 10y1 | 3 |
| Waste Immobilization Facility, (separations)d, Idaho Chemical Processing Plant, high-level waste | C,D | Cadmium | 8.1 y 10y5 | 1 |
| | | Chromium | 2.6 y 10y5 | 5 |
| | | Hydrofluoric acidc | 1.2 y 102 | 2 |
| | | Mercury | 2.7 y 101 | 5 |
| | | Nickel | 9.1 y 10y6 | 2 |
| | | Tributyl phosphate | 1.1 y 102 | 2 |
| Waste Immobilization Facility, (direct vitrification)e, Idaho Chemical Processing Plant, high-level waste | B | Cadmium | 3.4 y 10y6 | 7 |
| | | Chromium | 4.4 y 10y5 | 9 |
| | | Hydrofluoric acidc | 1.2 y 102 | 2 |
| | | Mercury | 2.7 y 101 | 5 |
| | | Nickel | 1.4 y 10y8 | 3 |
| Mixed/Low-Level Waste Treatment Facility, east of Radioactive Waste Management Complex, low-level and mixed low-level waste | D | Arsenic | 1.4 y 10y1 | 3 |
| | | Benzene | 6.0 y 101 | 1 |
| | | Cadmium | 1.9 y 10y1 | 4 |
| | | Chromium | 5.6 y 10y1 | 1 |
| | | Formaldehyde | 1.2 y 102 | 2 |
| | | Mercury | 1.5 y 101 | 3 |
| | | Polychlorinated biphenyls | 4.8 y 10y3 | 1 |
| Fort St. Vrain Spent Nuclear Fuel Receipt and Storage, Idaho Chemical Processing Plant, spent nuclear fuel | B,D | Benzene | 5.6 y 10y2 | 1 |
| | | Formaldehyde | 1.1 y 10y1 | 2 |
| Idaho Waste Processing Facility, site not determined (reference site is east of Radioactive Waste Management Complex); transuranic, low-level, and mixed low-level waste | B | Asbestos | 1.8 y 10y1 | 4 |
| | | Benzene | 3.4 y 101 | 7 |
| | | Beryllium | 2.7 y 10y2 | 5 |

| | | | | |
|---|---|---|---|---|
| | | Cadmium | 4.0 y 10y2 | 8 |
| | | Carbon tetrachloride | 3.4 y 100 | 7 |
| | | Chromium | 2.5 y 10y1 | 5 |
| | | Formaldehyde | 8.1 y 101 | 1 |
| | | Hydrochloric acid | 2.7 y 103 | 5 |
| | | Hydrofluoric acidc | 1.3 y 101 | 2 |
| | | Mercury | 6.0 y 10-4 | 1 |
| | | Methylene chloride | 6.7 y 10y2 | 1 |
| | | Nickel | 2.9 y 100 | 6 |
| | | Polychlorinated biphenyls | 3.7 y 101 | 8 |
| | | Perchloroethylene | 3.4 y 100 | 7 |
| | | Trichloro-trifluoroethane | 3.4 y 100 | 7 |
| | | Trichloroethylene | 1.0 y 101 | 2 |
| Idaho Waste Processing Facility,f site not determined (reference site is east of Radioactive Waste Management Complex); transuranic, low-level, and mixed low-level waste | D | Asbestos | 2.1 y 10y1 | 4 |
| | | Benzene | 3.4 y 101 | 7 |
| | | Beryllium | 3.1 y 10y2 | 6 |
| | | Cadmium | 4.6 y 10y2 | 1 |
| | | Carbon tetrachloride | 3.9 y 100 | 8 |
| | | Chromium | 2.5 y 10y1 | 5 |
| | | Formaldehyde | 8.1 y 101 | 1 |
| | | Hydrochloric acid | 3.1 y 103 | 6 |
| | | Hydrofluoric acidc | 1.5 y 101 | 3 |
| | | Mercury | 7.0 y 102 | 1 |
| | | Methylene chloride | 7.7 y 10y2 | 1 |
| | | Nickel | 2.9 y 100 | 6 |
| | | Polychlorinated biphenyls | 4.3 y 101 | 9 |
| | | Perchloroethylene | 3.9 y 100 | 8 |
| | | Trichloro-trifluoroethane | 3.9 y 100 | 8 |
| | | Trichloroethylene | 1.2 y 101 | 2 |
| Radioactive Waste Management Complex Modifications to Support Private Sector Treatment of Alpha Mixed Low-Level Waste Treatment of Alpha Mixed Low-Level Waste, Radioactive Waste Management Complex, transuranic waste | B,D | Asbestos | 2.0 y 10y8 | 4 |
| | | Benzene | 9.4 y 100 | 2 |
| | | Beryllium | 3.0 y 10y12 | 6 |
| | | Cadmium | 4.3 y 10y11 | 9 |
| | | Carbon tetrachloride | 9.0 y 10y1 | 2 |
| | | Chromium | 1.9 y 10y1 | 4 |
| | | Formaldehyde | 1.0 y 102 | 2 |
| | | Methylene chloride | 5.8 y 10y2 | 1 |
| | | Nickel | 2.1 y 100 | 4 |
| | | Perchloroethylene | 9.0 y 10y2 | 2 |
| | | Trichloro-trifluoroethane | 5.4 y 10y1 | 1 |
| | | Trichloroethylene | 5.8 y 10y1 | 1 |
| Nonincinerable Mixed Waste, Power Burst Facility, mixed low-level waste | B,D | Mercury | 5.5 y 10y3 | 1 |
| Waste Experimental Reduction Facility Incineration,g Power Burst Facility, low-level and mixed low-level waste | B,D | Arsenic | 8.4 y 10y2 | 1 |

| | | | | |
|---|---|---|---|---|
| | | Beryllium | 1.9 y 10y2 | 4 |
| | | Cadmium | 2.0 y 10y1 | 4 |
| | | Chromium | 3.8 y 10y3 | 8 |
| | | Hydrochloric acid | 1.8 y 103 | 4 |
| | | Mercury | 2.5 y 101 | 5 |
| | | Nickel | 2.0 y 10y1 | 4 |
| | | Trichloroethylene | 1.4 y 100 | 3 |
| Plasma Hearth Process, Argonne National Laboratory-West, mixed low-level and hazardous waste | B,D | Arsenic | 4.5 y 10y3 | 9. |
| | | Beryllium | 8.5 y 10y6 | 1 |
| | | Cadmium | 9.1 y 10y3 | 2 |
| | | Chromium | 2.0 y 10y3 | 4 |
| | | Hydrochloric acid | 4.5 y 101 | 9 |
| | | Mercury | 2.3 y 10y2 | 5 |
| | | Nickel | 1.4 y 10y1 | 3 |
| Spent Fuel Processing, Idaho Chemical Processing Plant, spent nuclear fuel | D | Ammoniah | 1.8 y 104 | 4 |
| | | Hydrofluoric acidc | 3.8 y 100 | 8 |
| | | Methyl isobutyl ketone | 2.7 y 103 | 5 |
| | | Tributyl phosphate | 8.6 y 100 | 1 |
| Totali | | | 2.9 y 104 | 6 |

a. Only those emissions that meet assessment criteria are listed (see text for exp
b. A = Alternative A (No Action); B = Alternative B (Ten-Year Plan); C = Alternati
Alternative D (Maximum Treatment, Storage, and Disposal).
c. Hydrofluoric acid is not listed as a toxic air pollutant by IDHW (1994), but is
d. Separations process is proposed under Alternatives C and D.
e. Direct vitrification process is proposed under Alternative B.
f. Under Alternative D, similar emissions would also be projected for the Private
Facility, which is a competing project that would have a similar design and process
g. Includes incineration only; other waste processing is assessed as foreseeable i
h. Includes emissions of ammonium hydroxide.
i. Total would apply only to Alternative D and only if all facilities were operati

Commission on Radiological Protection (ICRP), as contained in Publications 26 and 3 1979). This model has several technical advantages over other available methods, in ability to assess dose from many different release scenarios and exposure pathways. conforms to the strict quality assurance requirements of NQA-1, Basic Requirement 3 and Supplementary Requirement 3S-1 (Supplementary Requirements of Design Control), requirements for verification and validation of computer codes.

An additional dose model, CAP-88 (Clean Air Act Assessment Package), is routi the INEL for the specific purpose of evaluating compliance with National Emission S Hazardous Air Pollutants standard 40 CFR 61. As prescribed by that standard, CAP-88 calculate the highest offsite dose to any member of the public resulting from annua radionuclide emissions from cumulative INEL site operations. The result must be bel to demonstrate compliance with the standard. The CAP-88 model was used in the presc to support the 1991 and 1992 INEL National Emission Standards for Hazardous Air Pol Reports (DOE-ID 1992a, b; 1993). As part of that effort, detailed comparisons betwe obtained with GENII and CAP-88 were made and documented (Maheras 1992, Ritter 1992) comparison of GENII and CAP-88 dose results for the maximally exposed individual is

**Table F-3-9. In both cases, the dose results represent a summation of the external** equivalent (EDE) from the ground deposition and air immersion pathways and the 50-y effective dose equivalent (CEDE) from the inhalation and ingestion pathways. These directly comparable in that there were minor differences in the source terms used. the GENII and CAP-88 codes for application at the INEL site has been performed and (Maheras et al. 1994). These tests provide confidence that the application of GENII source term and receptor-related assumptions used in this Environmental Impact Stat results that are likely to be conservative.

**F-3.4.2.2 Release Modeling- Releases from stacks or vents may be modeled as either**

elevated or ground-level releases. For this EIS, the decision whether to model a gi as a stack or ground-level release was based on guidelines issued by the U.S. Envir Protection Agency (EPA 1993a) and the National Council on Radiation Protection and NCRP 1986). In essence, if the height of the release point is less than or equal to height of attached or nearby buildings, turbulent (wake and downwash) effects are a

**Table F-3-9. Comparison of doses to maximally exposed individual due to Idaho Natio** Engineering Laboratory site emissions as calculated by the GENII and CAP-88 compute

| Source category | Dose to maximally exposed individual (millirem) | | |
|---|---|---|---|
| | GENII 1991^a | CAP-88 1991^b | CAP-88 1992^c |
| Monitored | 9.8 X 10^-3 | 4.1 X 10^-3 | 1.4 X 10^-3 |
| Diffuse | 3.0 X 10^-3 | 2.4 X 10^-5 | 3.1 X 10^-5 |
| Unmonitored | 3.0 x 10^-4 | 1.2 X 10^-4 | 1.0 x 10^-4 |
| Total | 1.3 X 10^-2 | 4.2 X 10^-3 | 1.5 X 10^-3 |

a. Source: Leonard (1993); calculation for monitored source emissions from Idaho Ch Processing Plant has been revised (Leonard, 1994).
b. Source: 1991 INEL National Emission Standards for Hazardous Air Pollutants Repor Supplement (DOE-ID 1992a, b).
c. Source: 1992 INEL Annual National Emission Standards for Hazardous Air Pollutant (DOE-ID 1993b).

influence the release, effectively lowering the release height to ground level. In were modeled as individual release points; in other cases, sources were grouped tog as a single release point. For example, elevated sources at the Power Burst Facilit Experimental Reduction Facility North and South Stacks, and the Power Burst Facilit modeled as individual elevated releases. Conversely, effluents from various vents a Reactors Facility were summed and treated as a single ground-level release. The man specific sources were modeled is described In Leonard (1993, 1994). Additional rela including specific facility locations and stack data, are presented in Belanger et

**F-3.4.2.3 Meteorological Data. The atmospheric transport modeling performed as part of**

these radiological assessments was based on actual meteorological conditions measur different locations at the INEL site. In particular, the data files prepared for th derived from observations at INEL site weather stations over the period 1987 throug was assumed to be representative of conditions during the years covered by the Envi Statement (1995 through 2005). The method used for incorporating these data into wi be used by the GENII program is documented in Leonard (1992).

**F-3.4.2.4 Receptor Locations. Doses were assessed for individuals located at the onsite**

and offsite locations of highest predicted dose and for the surrounding population, follows. In each case, the dose was assessed for baseline conditions, projected inc baseline, and ER&WM alternatives.

Maximally Exposed Individual. The offsite individual whose assumed loc habits are likely to result in the highest dose is referred to as the maximally exp (MEI). The location of the maximally exposed individual was identified on the basis receptor distance and direction combination that yielded the highest predicted offs INEL Site area, radionuclide concentrations were calculated for the minimum distanc site boundary for each of the 16 compass directions. Since this location was assess emissions from each of the INEL site areas, the maximally exposed individual recept merely points on the INEL site boundary and do not correspond to any actual residen

These maximum impacts were conservatively summed to derive cumulative impacts, alth occur at spatially distant locations. (The actual maximally exposed individual loca major INEL site facilities are all located along a segment of the southern boundary facilities in question.) Although unrealistic, this cumulative maximally exposed in process serves to establish the upper-bounding dose. Despite the inherent conservat obtained were low; and further resolution of the actual maximally exposed individua dose was not necessary. The same general method for dose determination to the maxim individual is used in the annual National Emission Standards for Hazardous Air Poll evaluation.

Population Dose. Dose was assessed for the collective population resid circular area defined by a radius of 80 kilometers (50 miles) extending out from ea facility. Population data used were based on 1990 census data provided by the U.S. For projects associated with ER&WM alternatives and for projects expected to become before June 1, 1995, growth projections for the counties surrounding INEL were appl growth estimates are approximately 10 percent per decade. Since the period of analy extends to the year 2005, the population doses reported in Section 5.7, Air Resourc of this EIS are the highest obtained for any year throughout this period.

INEL Site Worker. INEL site workers may be exposed to radiation attributable INEL sources both as a direct result of job performance (such as work within a radi controlled area) and incidentally (such as from airborne releases from facilities w as well as more distant sources within the INEL site). Onsite concentrations of rad incidental exposure were assessed as described in this section. (Direct, job-relate exposure is discussed in Section 4.12, Health and Safety, of Volume 2 of this EIS.) who would receive the highest dose due to incidental exposures is termed the maxima worker. The dose to the maximally exposed worker was assessed for all major INEL si as a result of radionuclide emissions from all current and projected sources. The d using the general methodology described in previous sections. One major difference the worker dose calculations did not include the food ingestion pathway, since work consume food products grown onsite.

### F-3.4.3 Nonradiological Assessment Methodology

Air pollutant levels have been estimated by the application of air dispersion that incorporate mathematical functions to simulate transport of pollutants in the modeling methodology conforms to that recommended by the U.S. Environmental Protect (EPA 1993a) and the State of Idaho (DOE-ID 1991) for such applications. The models application methodology are designed to be conservative; that is, they employ data designed to prevent underestimating the pollutant concentrations that would actuall the methods used to assess consequences of proposed actions were identical to those baseline assessments. Minor exceptions (such as the use of refined versus screening will be noted where applicable. The primary objective of the assessments is to esti nonradiological pollutant concentration and other impacts in a manner that facilita (a) to applicable standards or guidelines and (b) between alternative courses of ac

The types of pollutants assessed include the criteria pollutants and certain pollutants. Criteria pollutant concentrations were estimated for locations and over corresponding to State of Idaho and National Ambient Air Quality Standards. Since t apply only to ambient air (that is, locations to which the general public has acces concentrations were assessed for offsite locations and public roads traversing the nonradiological assessment did not specifically address impacts related to ozone fo (a) volatile organic compound emission levels are below the significance level desi of Idaho; (b) no simple, well-defined method exists to assess ozone formation poten 1993); and (c) while the Idaho Division of Environmental Quality has no ozone monit the vicinity, it is not aware of problematic ozone levels in the area (Andrus 1994)

Offsite levels of carcinogenic and noncarcinogenic toxic air pollutants were basis of annual average emission rates and compared with annual average standards ( recently promulgated by the State of Idaho. Toxic air pollutants were also assessed locations because of potential exposure of workers to these hazardous substances. O specific toxins were calculated using maximum hourly emission rates and compared wi exposure limits set for these substances by either the Occupational Safety and Heal (OSHA) or the American Conference of Governmental Industrial Hygienists (the lower limits being used).

**F-3.4.3.1 Atmospheric Dispersion Models for Criteria and Toxic Air Pollutant**

Evaluations. Atmospheric dispersion models used to estimate upper-bound levels of t criteria impacts, as well as impacts to visibility and highway hot spots, are descr

**F-3.4.3.1.1 Model Description and Application- The modeling effort employed**

two levels of sophistication-screening-level and refined. Screening-level modeling cases where a source's contribution to air quality levels was expected to be minima below acceptable standards). This method is less rigorous mathematically than refin results in an overestimation of pollutant concentrations (greater than that of refi

The short-term version of the U.S. Environmental Protection Agency Industrial Complex-2 (ISC-2) computer code (EPA 1992a) is a refined model that was used to est concentrations resulting from routine operational emissions of criteria pollutants. incorporates site-specific data (such as meteorological observations from INEL site This model takes into account effects such as stack tip downwash and turbulence ind presence of nearby structures. Account was taken for building wake effects in the b assessments of criteria pollutant emissions. However, it was not feasible to includ calculations into the proposed action assessments, since building dimensions and di been defined. This is not expected to show appreciable differences in results other in very close proximity of sources. In addition, the model accommodates multiple so calculates concentrations for user-specified receptor locations. Concentrations can a range of durations, from one-hour maximum values to annual averages. The ISC-2 mo well suited for conditions where the receptor elevation exceeds the stack height. H the case for the INEL; the terrain is generally flat enough to avoid use of models complex terrain (DOE-ID 1991). In summary, dispersion modeling using ISC-2 allows f reasonable prediction of the impacts of proposed facilities and, therefore, is idea the Environmental Impact Statement process.

The SCREEN model (EPA 1992b) was used to estimate toxic air pollutant concen SCREEN is a relatively simple model that incorporates conservative data and methods limited to the calculation of only one-hour maximum concentrations from a single so user-specified or predefined distances and performs iterations to determine the dis concentration at the point of maximum impact. Persistence factors (averaging time a factors) recommended by the U.S. Environmental Protection Agency or the Idaho Divis Environmental Quality were used to scale one-hour SCREEN results to other required times. A persistence factor of 0.125 was used to scale one hour results to annual a as recommended by IDHW (1994). For onsite concentrations, a factor of 0.7 was used hour results to eight-hour estimates suitable for comparison to occupational exposu

Since SCREEN can only accommodate a single source, most cases required multip within an area to be grouped and treated as a single source. This model incorporate algorithms; however, in the manner employed herein (that is, combining impacts from and simulating as a single source), this feature was not used. Wind direction is no account; therefore, impact levels were assumed to be equal in all directions from t SCREEN was used in these assessments only to estimate baseline concentrations of to and to identify which of these pollutants warranted further refined modeling. For c SCREEN model predicted that toxic air pollutant concentrations were close to (withi so) an acceptable level, remodeling with ISC-2 was performed to provide a more real

Those operations that would result in the generation of fugitive dust, includ activities and equipment, travel on paved or unpaved roads, the concrete batch plan pouring, and gravel pit and landfarming operations, were assessed using the U.S. En Protection Agency-recommended Fugitive Dust Model (FDM) (Winges 1991). The Fugitive Model was designed specifically for computing concentration and deposition impacts dust sources through improved algorithms for deposition. Sources may be either poin Model execution may include up to 20 particle size classes, with calculation of gra and deposition velocity for each hour. Similar to ISC-2, concentrations may be calc range of durations, from one-hour maximum values to annual averages; 24-hour and an assessments were conducted. Modeling of fugitive dust sources with the Fugitive Du been shown to be superior to ISC-2 for area ground-level ambient temperature releas (Winges 1991).

**F-3.4.3.1.2 Model Input Data- The use of air dispersion models requires emission**

parameters, such as stack height and diameter and exhaust gas temperature and flow (for example, disturbed areas related to construction sources); and pollutant emiss most part, emission parameter data were obtained from the INEL site air emissions i discussed above. In some cases, data were observed to be missing or in error. The m were replaced by substituting parameter values from similar sources at the INEL sit data for emergency generator combustion engines were obtained from other generators capacity.) The specific values used for stack-related parameters (height, diameter, temperature) are presented in Belanger et al. (1995a).

The estimation and evaluation of impacts from fugitive dust sources was depen type of source (see Section F-3.4.3.2). For construction sources, the size of the d assumed to be two times the construction project footprint. For example, constructi 100-meter building is expected to disturb a 200-by-200-meter area during constructi watering was assumed, providing a 50 percent reduction in fugitive emissions and pr removing larger-diameter particles. The resultant distribution was estimated to con dust of respirable size. (This follows methods developed by EPA (1993b)]. Construct emissions were averaged over the expected hours of construction activity- 12 hours per week, for 26 weeks per year. Fugitive dust emissions were similarly calculated projects. Emissions related to the use of unpaved roads were divided equally across Emissions of dust from paved roads were assumed to be generated primarily by the IN These emissions include tire wear and road dust but exclude exhaust particulates, w calculated separately in the evaluation of mobile source emissions. Paved road use site is heaviest along State Route 33 and U.S. Route 20/26. All emissions, therefor to occur along these routes. Because approximately 11.4 percent of the buses travel North, 11.4 percent of the total paved road emissions was assigned to State Route 3 route to the Test Area North facility, and 88.6 percent to U.S. Route 20/26. The es emissions from employee vehicles assumed 1.5 persons per vehicle, 100 mile round tr trips per year in light-duty (pickup) trucks.

**F-3.4.3.1.3 Meteorological Data- The modeling effort made use of two types of**

meteorological data: (a) ISC-2 and the Fugitive Dust Model modeling incorporated da measurements of meteorological conditions (temperature, wind speed and direction, a stability, and so forth) made at the INEL site by the National Atmospheric and Ocea Administration (NOAA); and (b) SCREEN modeling used a standard (not specific to INE meteorological data, which are incorporated into the model to derive a worst-case a pollutant concentrations. The following description pertains only to the site-speci ISC-2 and the Fugitive Dust Model.

Meteorological data collected by the National Oceanic and Atmospheric Admini meteorological monitoring towers located at Grid 3 (lower, north of Central Facilit Area North, and Argonne National Laboratory-West were used in the assessment of sou Conditions at these three locations are representative of the three major wind flow INEL Site (Clawson et al. 1989). Sources at Test Area North and Argonne National La were modeled with meteorological data from those respective locations. Ail other so modeled using data from the Grid 3 Station. The locations of these and other meteor monitoring stations on and around the INEL are shown in Figure F-3-2. The meteorolo used contained hourly observations of wind speed, direction, temperature, and stabi years 1991 and 1992. Data required for the calculation of mixing height are current at the INEL but are not available for these periods. Therefore, default mixing heig For short-term assessments, a value of 150 meters (500 feet), which represents the measured at the INEL site, was used. For annual average evaluations, 800 meters (2, used. This value has been calculated by the National Oceanic and Atmospheric Admini recommended for use in dispersion modeling assessments (Sagendorf 1991). Each case separately using data from these years, and the highest of the predicted concentrat

**F-3.4.3.1.4 Receptor Locations- The ISC-2 and Fugitive Dust Model are capable**

Figure F-3-2. Locations of meteorological monitoring stations at the Idaho National

of determining air quality impacts at receptor locations using either a grid layout user-specified receptor points. Based on modeling efforts performed previously, max ambient receptor locations are expected to occur either (a) along public roads that site or (b) along the INEL site boundary. No points of maximum impact are expected locations beyond the INEL site boundary. Thus, only discrete receptors at those loc opposed to a gridded array) have been used for regulatory air assessments at those Craters of the Moon Wilderness Area. (Gridded arrays were used, however, in modelin to identify the areas where fine spacing of discrete receptors points is necessary.

Due to the large areal extent of the INEL site, fine spacing of discrete rece regular intervals is not feasible. Therefore, an approach has been employed that ut coarse and fine receptor intervals, ranging from 100 meters (330 feet) to 2,500 met depending on the potential for maximum impact. The process used to develop the rece as a starting point the complete coarse grid of ambient air locations described in Permitting Handbook (DOE-ID-1991). This grid incorporates receptor locations spaced approximately 500-meter (1,640 foot) intervals along (a) the entire perimeter of th (b) public roads traversing the INEL site; and (c) the eastern and northern boundar of the Moon Wilderness Area. Fine-grid modeling [using intervals of approximately 1 (330-foot) x-y coordinate spacing] was then performed, and the results were plotted areas where closer receptor spacing was warranted. A substantial margin of conserva provided by extending the range of 100-meter (330-foot) spacing to well beyond the maximum impact (from several hundred to several thousand meters, depending on the u the case.) Once these ranges were established, Universal Transverse Mercator (UTM) were determined for receptor locations at 100-meter (330-foot) intervals along thes coordinates were incorporated into the receptor array file. The modeling also revea are clearly beyond the locations of maximum impact and that could be eliminated fro array. Additional details of the method for identifying the receptor areas of maxim including examples of isopleth plots used for this purpose, are presented in Belang and Raudsep et al. (1995).

Ambient air impacts, including Prevention of Significant Deterioration increm consumption, have also been assessed for the Craters of the Moon Wilderness Area, t nearest the INEL site. Previous modeling has shown that there is only minor variati concentrations between coarsely spaced receptor locations at the Craters of the Moo not surprising in light of the substantial distance between this Class I area and t Thus, Class I area increments have been assessed at discrete receptor locations alo northern boundaries at intervals of 2,500 meters (8,200 feet) (that is, using every receptor point).

Concentrations of air pollutants at onsite facility areas were assessed to in levels to which workers may be subjected. For the onsite assessments, 11 separate r were developed. In general, these were 2-by-2-kilometer (1.2-by-1.2-mile) grids wit 330-foot} spacing centered on the major source groups at each facility. The grids f North, Power Burst Facility, and Central Facilities Area were made larger to accomm distribution of sources within those areas. These grids are described in detail in (1995b) and were used to determine maximum impacts as a result of emissions from so low release elevations or building effects are prevalent. In addition to a fine gri each facility area also included discrete receptor locations of other facilities. F assessments for sources at the Central Facilities Area included discrete receptor p Chemical Processing Plant, Power Burst Facility, and other facilities. In this way, contributions of sources at locations other than the facility being assessed were r concentration.

**F-3.4.3.2 Summation of Results. An important function of the modeling effort is to**

identify the location of highest predicted impact and the magnitude of the impact. by the fact that there are numerous sources in widely dispersed locations at the IN determination of the highest concentration must consider the contributions from eac Also, in some cases, sources at different facility areas required different meteoro These factors precluded the execution of a single modeling run in which all sources arrays could be included and necessitated the application of computer-aided data co techniques. Since a common receptor array was used for all ambient air assessments, concentrations at each receptor point as a result of emissions from each source was value and location of highest impact were identified by entering the results from i runs for a specific type of assessment (for example, maximum one-hour carbon monoxi concentrations) into a spreadsheet program, summing the values for each receptor po

identifying the maximum value and corresponding location. The same process was used contributions from baseline sources, projected increases to the baseline, and propo

As provided by applicable regulations, the estimated impacts from temporary f sources, including construction and demolition activities, were characterized and e respect to ambient air quality standards (but not for Prevention of Significant Det which exclude these types of activities from review). The cumulative emissions from sources of a more permanent nature, including vehicle travel on paved and unpaved r and concrete batch plant operations, were assessed for compliance with ambient air However, these sources were not analyzed for Prevention of Significant Deterioratio became operational prior to the baseline date and are not associated with net emiss

The onsite assessments used separate grids, and the results had to be process This involved summing the contribution from each area to each area-specific discret This discrete receptor summation was then added to the maximum value calculated wit fine-grid network for the area under review. For example, maximum impacts at the Ce Area consist of the maximum-predicted impact from sources within the Central Facili sum of contributions from all other areas. In this way, it was ensured that contri at locations other than the facility being assessed were represented in the total c

**F-3.4.3.3 Impacts on Visibility. Atmospheric visibility has been specifically designated as**

an air quality-related value under the 1977 Prevention of Significant Deterioration Clean Air Act. Therefore, in the assessment of proposed projects that invoke Preven Significant Deterioration review (see Section F-3.1.1.2), potential impacts to visi evaluated and shown to be acceptable in, designated Class I areas and associated in Craters of the Moon Wilderness Area, located approximately 20 kilometers (12.4 mile the INEL site, is the only Class I area in the Eastern Snake River Plain.

The U.S. Environmental Protection Agency has designed methodologies to estima plume visual impacts due to emissions of proposed sources. The methodologies includ of sophistication. Level-1 is designed to be very conservative; it uses assumptions methodologies that will predict plume visual impacts larger than those calculated w input and modeling assumptions. Level-2 visual impact modeling employs more site-sp informatiOn than that of Level-1. It is still conservative and designed to overesti visibility deterioration. Level-3 visual impact modeling is more intensive in scope provide a more realistic treatment of plume visual impacts. The U.S. Environmental Agency has developed computer codes to implement the calculations associated with e visual impact modeling. The VISCREEN model is designed to implement the methodology Level-1 analysis (EPA 1992c).

The VISCREEN model was used to evaluate the potential visual impact of the c emissions of proposed sources at the INEL site on the Craters of the Moon Wildernes stated above, Level-1 screening is designed to provide a conservative estimate of p impacts, that is, to estimate impacts that would be larger than those calculated wi input and modeling assumptions. This conservatism is achieved by the use of worst-c meteorological conditions, including extremely stable (class F) stability coupled w speed (1 meter per second) persisting for 12 hours, with a wind that would transpor directly adjacent to a hypothetical observer in the Class I area. Maximum short-ter emission rates of particulates and nitrogen oxides and minimum and maximum distance source to the Class I area are used. The U.S. Environmental Protection Agency recom values for various model parameters. In this analysis, default values were used for with the exception of background ozone concentration, for which a site-specific val per million was used. Use of this value has been agreed to by the Idaho Division of Quality (DOE-ID 1991) and the National Park Service (NPS) (Notar 1993a). The annual background visual range as measured by the National Park Service at Craters of the estimated to be 140 kilometers (87 miles) Notar 1993b); however, as suggested by th Service, the maximum seasonal average of 158 kilometers (98 miles) was used in this (Notar 1993a, b).

The objective of the VISCREEN analysis was to calculate the potential visual plume of specified emissions for specific transport and dispersion conditions. If s calculations using VISCREEN demonstrate that during worst-case meteorological condi is either imperceptible or, if perceptible, is not likely to be considered objectio of plume visual impact would not be required (EPA 1992c). The VISCREEN model determ whether a plume is visible by calculating contrast. If a viewed object, such as a s is brighter than its background, it will have a positive contrast; alternatively, i than its background, its contrast is negative. In VISCREEN, contrasts at three visu

calculated to characterize blue, green, and red regions of the visual spectrum to d will be brighter, darker, or discolored compared to its viewing background. If plum positive, the plume is brighter than its viewing background; if negative, the plume contrasts are different at different wavelengths, the plume is discolored. If contr plume is indistinguishable from its background. With a range of wavelengths, a meas must recognize both overall intensity and perceived color; perceptibility is a func both brightness and color. To address the dimension of color, a parameter called de the primary basis for determining the perceptibility of plume visual impacts in scr order to ascertain whether the plume from a facility has the potential to be percep observers under worst-case conditions, the VISCREEN model calculates both delta E a two assumed plume-viewing backgrounds: the horizon sky and a dark terrain object. R provided for two assumed worst-case sun angles (to simulate forward and backward sc light), with the sun in front and behind the observer, respectively. If either of t is exceeded, more comprehensive and realistic analyses should be carried out. The f delta E value of 2.0; the second is a green contrast value of 0.05. Regional haze, multiple sources throughout a region, is not calculated or estimated with the VISCR

For this assessment, the potential impact of incremental emissions of partic oxides of nitrogen associated with each project was evaluated. Cumulative impacts w each alternative as the sum of the impacts from specific projects associated with t waste stream options. Current operations were considered in the baseline [that is, current emission levels is monitored at the Craters of the Moon, resulting in a 158 (98-mile) value for maximum seasonal visual range]; however, projected increases to were also evaluated and added to the cumulative assessment for each alternative. Al sources were included except construction emissions and emergency diesel generators evaluated in a Prevention of Significant Deterioration assessment.

**F-3.4.3.4 Mobile Source Assessment Methodology. Ambient air quality impacts at**

offsite receptor locations due to INEL bus fleet operations, INEL fleet light- and privately owned vehicles, and heavy-duty commercial vehicles servicing the INEL sit quantitatively predicted using emission factors and screening-level methodologies d U.S. Environmental Protection Agency. The methodology included the use of a compute mathematical model, CALINE-3 (Benson 1979), recommended for analysis of highways ch by uninterrupted traffic flows (EPA 1993a). CALINE-3 is designed to simulate traffi conditions and pollutant dispersion from traffic and was used to predict maximum on air concentrations of carbon monoxide and inhalable particulate matter. Regulatory-averaging time adjustment factors were used to scale results for other applicable a receptor locations were selected within 3 meters (10 feet) from the edge of the roa accordance with U.S. Environmental Protection Agency guidance.

Receptor locations were selected in accordance with DOE guidance for air per (DOE-ID 1991), including locations in the City of Idaho Falls near the central bus streets that are heavily travelled by INEL buses, and at selected ambient air locat routes to the INEL site. The receptor locations on the INEL site are accessible to where INEL traffic is heaviest. These locations include the INEL site main entrance Highway 20, the northern access point to Test Area North from State Highway 33, and where public highways carrying INEL site traffic cross site boundaries.

Modeling was conducted for the year 1993 to quantify the current impact due and traffic and projected impact of projects that would be constructed before 1995, projected impacts of alternatives. Additional details on the methodology used for m presented in E&E (1993).

## F-3.5 Data Analysis

The previous subsections describe the methodology used to perform and the te the air analysis for this Environmental Impact Statement. The results of these anal summarized in Sections 4.7 and 5.7 (Air Resources) of Volume 2 of this Environmenta Statement and are not repeated here. Additional details on the analysis, including consequences for various combinations of alternative and waste management options a individual projects, are presented in the Technical Support Document for Air Resour National Engineering Laboratory Environmental Restoration and Waste Management Prog

(Belanger et al. 1995a).

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# F-4 Health and Safety

**SECTION F-4 CONTENTS**



**#F-4 HEALTH AND SAFETY**

Potential health impacts to the public and workers can arise from a variety several distinct circumstances. The appropriate methods for evaluating health impac different under each of these conditions. This appendix describes the methods used key data required for evaluating the health effect impacts reported in this EIS.

The methods presented here are organized under three broad categories: (a) he from effluent releases, (b)normal workplace hazards, and (c) chemical releases unde conditions. The first category includes effluent releases of radioactivity, carcino chemical toxins to air and water, and addresses health effects to both the public a second category includes radiological and nonradiological hazards to INEL workers i conduct of their jobs. The final category of methods addresses the special case of released under accident conditions.

## F-4.1 Background Information

This section provides essential background information on health effects to I the public surrounding the INEL. The information provides a historical perspective safety concerns, and a basis for projecting future impacts to workers from normal o hazards.

## F-4.1.1 Public Health and Safety

The primary public health and safety concern at the INEL is the potential for surrounding public to radioactivity. The principal pathway by which the public may radioactivity is through releases to the atmosphere. Radiation doses to members of airborne releases at the INEL are calculated annually by the Radioactive and Enviro Laboratory using information from the Radioactive Waste Management Information Syst (Chew and Mitchell 1988, Hoff et al. 1989, 1990, 1991, and 1992). Table F-4-1 prese of these calculations for the five years of site operation from 1987 through 1991. that offsite radiation doses to any individual member of the public from normal ope

**Table F-4-1. Estimated doses to members of the public from Idaho National Engineeri** airborne releases 1987 to 1991.

| Year | Maximally exposed individual (millirem) | Principal radionuclides | Percent of dose | Population d (person-rem |
|---|---|---|---|---|
| 1987 | 0.54 | Sb-125 | 96.0 | 4.3 |
| | | I-129 | 1.1 | |
| | | Ar-41 | 1.0 | |
| 1988 | 0.13 | Sb-125 | 68.0 | 1.7 |
| | | I-129 | 19.6 | |
| | | Ar-41 | 6.1 | |
| 1989 | 0.01 | Ar-41 | 59.9 | 0.04 |
| | | Kr-88 | 12.3 | |
| | | Xe-138 | 11.6 | |
| 1990 | <0.01 | Ar-41 | 82.2 | 0.04 |
| | | Kr-88 | 6.3 | |
| | | I-129 | 3.4 | |
| 1991 | 0.02 | Ar-41 | 45.1 | 0.06 |
| | | I-129 | 40.3 | |
| | | Cs-137 | 4.8 | |

substantially less than 1 millirem per year over the 5-year period examined. Curren releases of airborne radioactivity from DOE facilities to no more than 10 millirem member of the public.

The principal radionuclides contributing to offsite doses reflect the operati facilities. During 1987 and 1988, for example, the fuel dissolution facility at the Processing Plant was operating and the antimony-125 releases characteristic of that largest contributors to offsite dose. The fuel dissolution facility at the Idaho Ch Plant did not operate during 1989 or 1990. Consequently, offsite doses were smaller dominated by releases of argon-41 and other noble gases from the Advanced Test Reac the New Waste Calcining Facility operated for part of the year and contributed a sm other radionuclides such as iodine-129 and cesium-137.

Collective doses to the population residing in the vicinity of the INEL are annually by the Radioactive and Environmental Sciences Laboratory (Chew and Mitchel Hoff et al. 1989, 1990, 1991, and 1992). These calculations sum the potential radia population of approximately 121,000 people living within 80 kilometers (50 miles) o facilities. As indicated in Table F-4-1, site operations have resulted in an offsit 6.3 person-rem for a five-year period. The average for the period 1987 through 1991 person-rem.

Past activities at the INEL have resulted in larger doses to the public than Estimates of these doses have been made for all years of INEL operation before 1989

1991). The largest doses were during the late 1950s and mid-1960s and ranged betwee millirem. The organ receiving the largest dose has been the thyroid during years wh quantities of radioactive iodine were released, or the skin during years when relea by radioactive noble gases. Since the early 1970s, there has been a steady decline controls on emissions have improved and various reactor programs at the INEL have b

To put the offsite doses from the INEL into perspective, it is useful to com levels of natural background radiation in the vicinity of the INEL. Table F-4-2 sum estimated annual dose equivalent from natural sources for an individual living on t Plain (DOE-ID 1991).

Doses from airborne releases over the operating history of the INEL site hav compared to doses from sources of natural background radiation, a maximum of 3 perc natural background effective dose equivalent in 1956. Since the early 1970s, doses releases have been small, even when compared to the variability in natural backgrou

## F-4.1.2 Occupational Health and Safety

**F-4.1.2.1 Radiological Hazards. Because of the nature of the work done at the INEL site,**

Occupational radiation exposures above background levels will inevitably occur for The radiation protection programs required by regulations and DOE orders are design no worker receives doses larger than the applicable limits and that worker doses ar reasonably achievable. In addition, Federal regulations and DOE orders require that occupational exposure are maintained. Reports of radiation doses are provided annua worker. Summary reports are also provided to DOE and published periodically.

**Table F-4-2. Estimated natural background radiation dose for the Snake River Plain.**

| Source | Annual effective dose equivalent (mi |
|---|---|
| External | |
| Terrestrial | 75 |
| Cosmic | 39 |
| Subtotal | 114 |
| Internal | |
| K-40 and others | 40 |
| Inhaled nuclides^b | 200 |
| Subtotal | 240 |
| Total | 334 |

a. From: Idaho National Engineering Laboratory Historical Dose Evaluation, Volume 1 DOE/ID-12119 (DOE-ID 1991).
b. The dose from inhaled radionuclides is due primarily to short-lived decay produc and varies widely with geographic location. The value shown represents the United S population average.

Workers at the INEL site may be exposed either internally or externally to ra exposures arise when radioactive materials are deposited in the body through inhala absorption through intact skin or wounds in the skin External exposures in the wor received from radiation-emitting sources outside the body.

All workers in areas with a potential for airborne or surface contamination a routinely for internal radioactivity using bioassay techniques. Whole body counting internally deposited gamma emitters. Urinalysis and fecal analysis are used to dete emitters that cannot be measured adequately using whole body counting, for instance uranium and plutonium uptakes. Radiation workers participate in the bioassay progra potential that they could receive intakes resulting in a dose of 100 millirem or mo period following an intake. If routine bioassay results indicate measurable intakes participate in follow-up bioassay programs to determine the date and source of the estimate the radiation dose received. Internal radiation doses constitute a small f occupational dose at the INEL site. All cases of measurable internal radioactivity thoroughly to determine the cause and to assess the potential for additional intern workforce.

External radiation dose is the largest fraction of the occupational dose rece site. There are many more facilities at the INEL site with a potential for external than there are with a potential for internal exposure, Facilities with a potential exposure are those containing large quantities of gamma-emitting radioactive materi devices, such as accelerators, x-ray machines, and nuclear reactors, can produce ex exposure while operating, whether or not radioactive materials are present. In add potential for external radiation dose during any maintenance, construction, environ or decontamination activities at facilities where gamma radioactive materials have in the past.

Personnel that could potentially receive annual external radiation exposures millirem are assigned a thermoluminescent dosimeter that must be worn at all times the INEL site. The dosimeter measures the amount and type of external radiation dos receives.

All INEL site facilities are required to keep records of the individual expos employee. For normal INEL site operations, the summary establishes a baseline for c potential impacts of alternatives considered in this EIS. Reported doses resulting site operations for a recent five-year period of site operation are representative operations, and are used here as a baseline for routine operational activities. Tab collective dose equivalent measured on personnel dosimeters for each of the last fi The number of individuals monitored for radiation exposure over the last five years about 6,000. Of these, an average of about 31 percent receive measurable radiation average dose equivalent of those individuals with measurable exposure ranges from a millirem. The average dose equivalent of all monitored individuals ranges from 27 t

The average radiation dose rate to all INEL site workers over this five-year millirem per year. This is the dose rate that is used to project doses to workers a under each of the alternatives of this EIS.

**Table F-4-3. Total collective dose equivalent for Idaho National Engineering Labora** from normal operations.

| Year | Number of individuals monitored | Number of individuals with measurable exposure | Collective dose equivalent^a (person-rem) | Average dose equivalent^b per individual for all monitored individuals (millirem) | A e i m e ( |
|---|---|---|---|---|---|
| 1987 | 5,588 | 1,831 | 290 | 52 | |
| 1988 | 5,799 | 2,201 | 288 | 50 | |
| 1989 | 5,883 | 2,118 | 351 | 60 | |
| 1990 | 6,381 | 2,138 | 381 | 60 | |
| 1991 | 6,646 | 1,224 | 182 | 27 | |
| Five-year average | 6,060 | 1,902 | 298 | 49 | |

a. Collective Dose Equivalent: The sum of the dose equivalents to all members of a if 100 workers each received a dose equivalent of 0.1 rem, the collective dose equi (100 persons x 0.1 rem).

b. Average Dose Equivalent: The average dose to members of a group of interest. For dose equivalent for a group of 100 wokers was 1 person-rem, then the average dose e the group would be 0.01 rem (1 person-rem / 100 persons).

**F-4.1.2.2 Workplace Hazards Other Than Radiation. There is widespread diversity of**

the types and quantities of chemicals used at the various INEL facilities. Conseque hygiene monitoring and sampling programs are designed to ensure that personal and/o monitoring strategy is directed toward the chemicals that pose the greater risks an aspects of the toxic chemical control program are designed to reduce risks and main

exposures to hazards as low as reasonably achievable. The sampling and monitoring p INEL provide data to enable assessments for characterizing the more common material chemicals, such as asbestos, lead, cadmium, beryllium, formaldehyde, benzene, hydro nitric acid, sulfuric acid, hydrogen fluoride, sulfur dioxide, welding by-products, fired generation plants, solvents, NOx, and other potentially hazardous substances. common physical agents encountered include noise, heat stress, nonionizing radiatio ergonomic factors. Use of chemical carcinogens at the INEL is extremely limited and when absolutely required for a specific activity, and no other practical substitute used, every effort is made to minimize the potential of exposure to as low as reaso levels and to limit the size of and access to the work area.

The primary source of information on nonradioactive hazards to the workers at reports of occupational injuries. Data for DOE contractors were obtained from the E Performance Measurements System to provide comparative statistics for total recorda illness cases, lost workday cases, and lost workdays for 1987 to 1991 (EG&G Idaho 1 There were 1,337 total recordable injury/illness cases experienced at the INEL from an average of 8,385 employees that worked a total of 79,654,000 hours (EG&G Idaho 1 total recordable injury/illness cases rate of 3.4 for the INEL was slightly above t 2.9, but less than half the Bureau of Labor Statistics rate of 8.5.

Of the 1,337 total recordable injury/illness cases at the INEL from 1987 to 1 (50 percent) of the cases resulted in lost workdays or lost workdays restricted (EG The INEL lost workdays rate of 1.7 was slightly higher than the DOE-wide rate of 1. half the Bureau of Labor Statistics rate of 4.0. A total of 8,497 lost workdays res lost workdays cases. The INEL lost workdays rate of 21.3 is nearly half that of the of 36.0, and almost four times better than the Bureau of Labor Statistics rate of 7

Of the 1,337 total recordable injury/illness cases at the INEL, 114 cases wer occupational illnesses falling into the following six categories: (a) 34 cases were disorders, (b) 55 cases were repeated trauma disorders, (c) 13 cases were respirato because of toxic agents, (d) 4 cases were disorders caused from physical agents, (e diseases of the lungs, and (f) 6 cases were from all other illnesses (EG&G Idaho 19

Other measures of occupational hazards include motor vehicle accidents and pr to fire and other causes. The average number of government vehicles driven at the I the five-year period of 1987 to 1991 (EGG 1993d). The INEL experienced 90 recordabl vehicle accidents (over $500 loss) during 64,711,000 miles of travel (EG&G Idaho 19 resultant accident rate of 1.4 compares very favorably with the DOE-wide rates for period of 2.4, and is nearly nine times better than the National Safety Council fiv

The INEL Motor Vehicle accident loss was a total of $202,000 for the 1987 to (EG&G Idaho 1993d). An average loss rate of $3.11 per 1,000 miles traveled is only the DOE-wide average loss of $4.76 per 1,000 miles of travel (EG&G Idaho 1993d) and less than the National Safety Council rate of $12.47 for the same five-year period. rate for each of the five years is considerably below the DOE-wide average loss.

The INEL fire loss experience for the five-year period from 1987 to 1991 show reportable losses over $1,000. A loss in 1989 resulted in $25,000 damage and one in $63,000 in damage loss. The INEL experienced a total of 20 reportable non-fire prop losses (over $1,000) from 1987 to 1991. The total value of the loss from these 20 c $1,292,000. In 1988, seven cases accounted for a loss of $1,026,000, which represen the five-year total.

## F-4.2 Health Effects Methodology

This section describes the methods used to evaluate (a) potential adverse hea workers and members of the public from releases of radioactive and nonradioactive e environment under routine operating conditions, and (b) hazards to workers from nor conditions. The scope of the health effects evaluation in the EIS follows the recom specified by the DOE Office of National Environmental Policy Act Oversight in their Recommendations for the Preparation of Environmental Assessments and Environmental Statements (DOE 1993a).

### F-4.2.1 Health Effects from Effluent Releases to the Environment

In general, health impacts are estimated for releases of radioactive and nonr

contaminants to air and groundwater. However, the "sliding scale" concept has been evaluation of health effects by considering the relative importance of specific con exposure pathways. For example, there are no permanent surface waters on the INEL s surface drainage from the INEL to offsite locations. Therefore, this EIS does not i analysis of this exposure pathway

For routine or accidental releases from facilities, the following three catego individuals are addressed as a minimum: (a) maximally exposed individual located at boundary, (b) population within 80 kilometers (50 miles) of the operating facilitie workers. For routine releases, the population within an 80-kilometer (50-mile) radi For releases from accidents, the most populous section of a 16-point compass sectio In special circumstances, a fourth receptor location may be appropriate for evaluat releases at individual sites. For example, at the INEL, where the site is traversed highways, it is possible that a member of the public on or near the highway could b some potential accidents.

For offsite transportation accidents, four categories of exposed individuals (a) maximally exposed individual located 100 meters downwind of the accident scene, population density (3,861 persons per square kilometer), (c) suburban population de per square kilometer), and (d) rural population density (6 persons per square kilom transportation accidents are treated similar to facility accidents. However, onsite accidents may be treated using the methods described for offsite transportation acc deemed appropriate on a case-by-case basis. Impacts from transportation are present 5.11 of this EIS.

Health effects from radioactive and nonradioactive contaminants are reported are not summed. Adding these impacts can be misleading because of the differences i modeling methodology, health effect end-point, and basis for the risk factors used. distinctly different types of effects are reported for chemical exposures (that is, noncarcinogenic) they are reported separately and not summed.

**F-4.2.1.1 Radiological Health Effects from Effluent Releases. Estimation of health**

effects from radionuclides are based on the 1990 Recommendations of the Internation On Radiological Protection (ICRP 1991). The risk factors from Table F-4-4 were used

In the interests of clear and consistent presentation and to allow ready com impacts from other sources, such as chemical carcinogens, the measure of impact use of potential radiation exposures in this EIS is risk of fatal cancers. Population e

**Table F-4-4 Risk of fatal cancers and other health effects from exposure to radiati**

| | Fatal cancer | Nonfatal cancer | Genetic effects | Tota |
|---|---|---|---|---|
| Workers | 4.0 x 10^-4 | 8.0 x 10^-5 | 8.0 x 10^-5 | 5.6 x 10^ |
| General public | 5.0 x 10^-4 | 1.0 x 10^-4 | 1.3 x 10^-4 | 7.3 x 10^ |

a. Units when applied to an individual are "lifetime probability of cancer per rem applied to a population of individuals are "excess number of cancers per person-rem effects apply to populations, not individuals.

collective radiation dose (in person-rem) and the estimated number of fatal cancers population. The maximum individual effects are reported as individual radiation dos the estimated lifetime probability of fatal cancer. Estimates of health effects fro accidental radiation exposures are based on the 1990 Recommendations of the Interna Commission on Radiological Proteaton (ICRP 1991). The risk factors to be used in th consistent with those recommended by the DOE Office of National Environmental Polic Oversight and contained in the Preamble to Standards for Protection Against Radiati

The risk factors in Table F-4-4 are applicable for all cases involving low in (<20 rem) and low individual dose rates (<10 rem/hour). At higher doses, near-term than cancer are the primary concern. Those unusual accident situations that may res radiation doses to individuals are considered as special cases.

As indicated in Table F-4-4, the risk per unit of radiation exposure is sligh workers than for the general public. This is because the working population is made age group that excludes infants, children, and the elderly.

Other health impacts could result from environmental and occupational levels radiation. Additional health effects that contribute to total impacts include nonfa exposed population and genetic effects in subsequent generations. The combined inc adverse health effects determines the "total detriment."

Risk factors have been provided in Table F-4-4 so that anyone desiring to cal impacts and total detriment from the fatal cancer risk estimates reported in this E example, total detriment from radiation exposures for a given case can be obtained latent cancer fatality estimate by a factor of 1.4 for workers and by 1.46 for the cases, risks expressed as total detriment are only slightly larger than the fatal c

For the calculation of health effects from exposure to airborne radionuclide modeled exposure (in either rem for individuals or person-rem for populations) prov 4.7 and 5.7 of this EIS is multiplied by the appropriate risk factor from Table F-4 of impact used for evaluation of potential radiation exposures in this EIS is risk Population effects are reported as collective radiation dose (in person-rem) and th of fatal cancers in the affected population. The maximum individual effects are rep radiation dose (in rem) and the estimated lifetime probability of fatal cancer.

The concentration of radionuclides in water is reported in Sections 4.8 and To calculate health effects from radionuclide concentrations in water, the total qu ingested must be converted to an effective dose equivalent and then the appropriate applied. This is accomplished by multiplying the concentration of radionuclide in t (microcurie per liter) by the consumption rate (liter per day) and by the consumpti obtain the quantity of radionuclide ingested. This ingested quantity (microcurie) i the appropriate exposure to dose conversion factor (millirem per microcurie) to obt is then multiplied by the appropriate risk factor.

Exposure to dose conversion factors were obtained from Federal Guidance Repor Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Fa Inhalation, Submersion, and Ingestion (EPA 1988). These dose conversion factors wer convert a quantity of intake to an effective dose equivalent for the subsequent app appropriate risk factor obtained in ICRP (1991). The dose-to-conversion factors use have been provided in Table F-4-5.

**F-4.2.1.2 Nonradiological Health Effects from Effluent Releases. For public**

exposures data concerning the toxicity of carcinogenic and noncarcinogenic constitu from dose-response values approved by the U.S. Environmental Protection Agency. The include slope factors and unit risks for evaluating cancer risks, reference doses, concentrations for evaluating exposure to noncarcinogens, and primary National Ambi

**Table F-4-5. Exposure to dose conversion factors.**

| Isotope | Exposure to dose conversion fa (millirem per microcurie) |
|---|---|
| Tritium | $6.4 \times 10^{-2}$ |
| Iodine-129 | $2.76 \times 10^{2}$ |
| Strontium-90 | $1.42 \times 10^{2}$ |

Standards (CFR 1977) for evaluating criteria pollutants. When possible, all values the Integrated Risk Information System database (EPA 1994). If the information was the Integrated Risk Information System database, other sources were used, primarily Environmental Protection Agency's Health Effects Assessment Summary Tables (EPA 199 National Ambient Air Quality Standards (CFR 1977).

For occupational exposures, data were obtained from occupational standards. T eight-hour time-weighted averages established by either the American Conference of Industrial Hygienists (ACGIH 1993) or Occupational Safety and Health Agency and pro standards for carcinogens from new sources under State of Idaho Rules for the Contr Pollution in the State of Idaho (IDHW 1994).

Per U.S. Environmental Protection Agency's guidance, each contaminant was cat carcinogenic or noncarcinogenic. Exposures to contaminants were then evaluated for effects. The method used was dependent on whether the exposure was to the public or and whether the contaminant was classified as a carcinogen or a noncarcinogen. Heal

reported separately and were not summed where distinctly different types of effects chemical exposures (that is, carcinogenic and noncarcinogenic).

The organization of the following sections is based on the difference in eval used for nonradiological health effects to the public and to workers.

**F-4.2.1.2.1 Nonradiological Health Effects to the Public- For carcinogens,**

risks are estimated as the incremental probability of an individual developing canc a result of exposure to the potential carcinogen (that is, incremental or excess in cancer risk).

Values for slope factors and unit risk were taken from the Integrated Risk In database (EPA 1994). If the information was not available in the Integrated Risk In database, other sources were used, primarily the Health Effects Assessment Summary 1993).

For carcinogenicity, the probability of an individual developing cancer over estimated by multiplying the slope factor (milligram per kilogram-day) for the subs chronic 70-year average) daily intake. Hence, the slope factor converts estimated d averaged over a lifetime of exposure directly to incremental risk of an individual This risk is considered a conservative estimate because the upper bound estimate fo is used with the "true" risk likely being less.

The unit risk that is calculated from the slope factor is an estimate in term microgram per liter drinking water, or risk per microgram per cubic meter air conce assessing the carcinogenic potential of a chemical, the Human Health Assessment Gro Environmental Protection Agency classifies the chemical into one of the following g to the weight of evidence from epidemiologic and animal studies:

- Group A-Human Carcinogen (sufficient evidence of carcinogenicity in hu
- Group B-Probable Human Carcinogen (B1 - limited evidence of carcinogen humans; B2 - sufficient evidence of carcinogenicity in animals with in lack of evidence in humans)
- Group C-Possible Human Carcinogen (limited evidence of carcinogenicity and inadequate or lack of human data)
- Group D-Not Classifiable as to Human Carcinogenicity (inadequate or no
- Group E-Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies).

Quantitative carcinogenic risk assessments are performed for chemicals in Gro and on a case-by-case basis for chemicals in Group C. Cancer slope factors [formerl potency factors in the Superfund Public Health Evaluation Manual (EPA 1989)] are es the use of mathematical extrapolation models, most commonly the linearized multista estimating the largest possible linear slope (within the 95 percent confidence limi extrapolated dose that is consistent with the data. The slope factor or risk is cha upperbound estimate, that is, the true risk to humans, while not identifiable, is n the upper-bound estimate and in fact may be lower.

Unit risk estimates for inhalation and oral exposure can be calculated by div appropriate slope factor by 70 kilograms and multiplying by the inhalation rate (20 day) or the water consumption rate (2 liters per day), respectively, for risk assoc concentration in air or water. Hence,

risk per ug/m^3 (air) = (risk per mg/kg/day) x 1/70 kg X 20 m^3/day x 10^-3 (

risk per ug/L (water) = (risk per mg/kg/day) X 1/70 kg x 2 L/day X 10^-3 (mg/

Ingestion and inhalation slope factors are best estimates (that is, median or values) of the age-averaged, lifetime excess cancer incidence (fatal and nonfatal c of activity inhaled or ingested, expressed as risk per picocurie or risk per becque

In the interest of simplicity, and to ensure a bounding assessment, all U.S. Protection Agency weight-of-evidence classes were pooled and Class C (those with eq of carcinogenicity) were included with Classes A and B.

Noncarcinogenic and criteria pollutant health effects are presented using the in the Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Ma (EPA 1989). This approach presents noncarcinogenic effects in terms of a hazard quo the ratio between the calculated concentrations in air or drinking water and the re reference concentration, respectively. Doses or concentrations for each chemical an pathway are compared with the route-specific reference dose or reference concentrat index (the summed hazard quotients) for all chemicals and pathways exceeds one, the exist for noncarcinogenic health risks. If the hazard quotient is less than one, th effects are expected. In situations where simultaneous exposure to maximum baseline

concentrations is not feasible, the hazard quotients are reported separately and ar

For criteria pollutants (ozone, carbon monoxide, nitrogen dioxide, sulfur dio matter, and lead) that are regulated through the National Ambient Air Quality Stand for health effects was based on a hazard quotient given by the ratio of calculated the appropriate regulatory limit. Because the primary National Ambient Air Quality 1977) and the inhalation reference concentration serve essentially the same functio National Ambient Air Quality Standards have extensive databases rigorously reviewed National Ambient Air Quality Standards with annual averaging times was used in lieu reference concentration. Primary standards are designed to protect public welfare.

The measures used to describe the potential for noncarcinogenic toxicity to o individual are not expressed as the probability of an individual suffering an adver the potential for noncarcinogenic effects is evaluated by comparing an exposure lev time period (for example, lifetime) with a reference dose derived from a similar ex This ratio is called a hazard quotient and is described below.

Noncancer Hazard Quotient = E/RfC

where:

E = exposure level (or intake)

RfC = reference concentration

E and RfC are expressed in the same units and represent the same exposure period (t subchronic, or shorter term).

The noncancer hazard quotient assumes that there is a level of exposure (that concentration) below which it is unlikely for even sensitive populations to experie effects. If the exposure level (E) exceeds this threshold (that is, if E/RfC exceed be concern for potential noncancer effects. As a rule, the greater the value of E/R greater the level of concern. Be sure, however, not to interpret ratios of E/RfC as probabilities; a ratio of 0.001 does not mean that there is a 1 in 1,000 chance of Further, it is important to emphasize that the level of concern does not increase l reference dose is approached or exceeded because reference concentrations do not ha accuracy or precision and are not based on the same severity of toxic effects. Thus dose-response curve in excess of the reference concentration can range widely depen substance.

Where appropriate, to assess the overall potential for off-site (public) nonc posed by more than one chemical, a hazard index (HI) approach was used following th Environmental Protection Agency's Guidelines for Health Risk Assessment of Chemical 1986). This approach assumes that simultaneous subthreshold exposure to several che result in an adverse health effect. It also assumes that the magnitude of the adver proportional to the sum of the ratios of the subthreshold exposures to acceptable e hazard index is equal to the sum of the hazard quotients, as described in the box b exposure level and the reference concentration represent the same exposure period ( subchronic, chronic, or shorter-term). When the hazard index exceeds unity, there m for potential health effects. While any single chemical with an exposure level grea value will cause the hazard index to exceed unity, for multiple chemical exposures, can also exceed unity even if no single chemical exposure exceeds its reference con

Noncancer Hazard Index = E1/RfC1 + E2/RfC2 + ... + Ei/RfCi

where:

Ei = exposure level (or intake) for the i^th toxicant

RfCi = reference concentration for the i^th toxicant

E and RfC are expressed in the same units and represent the same exposure period (t subchronic, or shorter-term).

**F-4.2.1.2.2 Nonradiological Health Effects to Workers- The primary difference**

between health effects evaluation of nonradiological exposures to workers and to th exposure duration. For the public, exposure is assumed to occur, at the given conce individual's lifetime (70 years). For the worker, exposure occurs only in the workp therefore, of a limited duration.

The potential for occupational health effects from exposure to all chemical evaluated using the method outlined for public exposures to noncarcinogens, with th all occupational concentrations were compared with the applicable occupational stan hazard quotient for occupational exposure then becomes the ratio of the chemical co occupational standard.

Table F-4-6 provides the appropriate reference concentrations, unit risk fact Ambient Air Quality Standards, and occupational standards for evaluating exposure t air. To estimate the potential for health effects, these values were applied to the concentrations given in Sections 4.7 and 5.7 of Volume 2, of this EIS. Note that al in this table were obtained from the reference published as of January 1, 1994.

**F-4.2.1.3 Additional Assumptions. In addition to the values reported in Tables F-4-4**

through F-4-6, the following assumptions were made. Where modeled plume concentrati predicted to impact site drinking water, the following assumptions were made:

- The facility worker consumes 1 liter of water (one-half of the total d from a contaminated onsite well.
- Consumption of the contaminated water is assumed to occur for a sample sample interval is the time between samples plus two weeks). The addit weeks is used to allow sufficient time for the sample to be analyzed a the analysis returned to the appropriate water control personnel.
- All workers at the facility are assumed to obtain water from the same
- The level of drinking water contamination is equal to the modeled grou concentration (no allowance is made for treatment).

Table F-4-6. Chemical Contaminant risk evaluation factors (airborne).

- sample results are obtained.

Where actual facility drinking water data are used, the following assumptions

- The facility worker consumes 1 liter of water (one-half of the total d from the contaminated drinking water distribution system.
- Consumption of the contaminated water occurs 5 days per week for 30 ye

Offsite health effects were calculated assuming:

- The individual would have access to the highest modeled or measured of contaminant concentration.
- The individual's entire water consumption would be from the contaminat supply.
- The consumption would occur for 70 years.

## F-4.2.2 Hazards to Workers from Normal Workplace Conditions

The primary impacts to workers at the INEL are not a result of effluent relea from occupational exposure to radioactivity and other workplace hazards. This secti methods used to evaluate these occupational hazards.

**F-4.2.2.1 Radiological Exposure and Health Effects. The activities to be performed by**

workers under each of the alternatives are similar to those currently performed at Therefore, the potential hazards encountered in the workplace will be similar to th exist. Further, these hazards will be controlled by occupational and radiological s operating under the same regulatory standards and limits that currently apply at DO these reasons, the average collective radiation dose to the INEL workforce is antic proportional to the number of workers employed under each alternative.

The average annual dose rate for INEL workers was derived from the measured d reported over the period 1987 to 1991, as presented in Table F-4-3. The value used doses to the INEL workforce is 27 millirem per worker per year. The number of worke alternative is based on the values reported in this Appendix F, Section F-1, Socioe

**F-4.2.2.2 Workplace Hazards Other than Radiation. The measures of impact for**

workplace hazards used in this EIS are (a) total reportable injuries and illness, a workforce. Injury and fatality rates for construction workers are considered separa relatively more hazardous nature of construction work. Table F-4-7 gives the rates

injury and illness and for workplace fatalities for DOE and its contractors. The r construction workers include both categories reported by DOE, that is, direct DOE c contractors) and their subcontractors (lump contractors). These rates are applied t workforce under each alternative to evaluate potential occupational health effects. workers under each alternative is based on the values reported in this Appendix F, Socioeconomics.

The average rates for private industry in the United States are also provided While the reporting practices of the DOE and the National Safety Council are not id similar enough to provide a good basis of comparison between DOE and private indust

## F-4.2.3 Accidents

For evaluation of accident scenarios, health effects from exposure to radiati using the methodology outlined in Section F-4.2.1.1. However, due to acute exposure under accident scenarios, it is inappropriate to apply either occupational or publi chemical releases. Therefore, the following methods have been used to evaluate chem concentrations under accident scenarios.

**F-4.2.3.1 Nonradioactive Releases from Accidents. For accident conditions, possible**

impacts to human health are assessed by comparing the airborne concentrations of ea specified downwind locations to standard accident exposure guidelines for chemical

**Table F-4-7. Average occupational injury/illness and fatality rates at the Idaho Na** Laboratory.^a

| | All labor categories | | Construction workers |
|---|---|---|---|
| | Total injury/illness | Fatalities | Total injury/illnes |
| DOE and contractors^b | 3.2 | 0.0032 | 6.2 |
| Private industry^c | 8.4 | 0.0097 | 13 |

a. All incidence rates are given per 100 worker-years.
b. 1988-1992 averages (DOE 1993b).
c. 1983-1992 averages (NSC 1993).

Where available, Emergency Response Planning Guideline values are used for th (Homann 1988). The Emergency Response Planning Guideline values are estimates of ai concentration thresholds above which one can reasonably anticipate observing advers Emergency Response Planning Guideline values are specific for each substance, and a each of three general severity levels:

- Exposure to concentrations greater than Emergency Response Planning Gu values results in an unacceptable likelihood that one would experience adverse health effects, or perception of a clearly defined objectionab
- Exposure to concentrations greater than Emergency Response Planning Gu values results in an unacceptable likelihood that one would experience irreversible or other serious health effects, or symptoms that could i ability to take protective action.
- Exposure to concentrations greater than Emergency Response Planning Gu values results in an unacceptable likelihood that one would experience threatening health effects.

Where Emergency Response Planning Guideline values have not been derived for substance, other chemical toxicity values are substituted, as follows:

- For Emergency Response Planning Guideline-1, Threshold Limit Value, T Weighted Average values (ACGIH 1993) are substituted: The Time-Weight Average is the time-weighted average concentration for a normal eight and a 40-hour workweek, to which nearly all workers may be repeatedly

after day, without adverse effects.

- For Emergency Response Planning Guideline-2, Level of Concern values of Immediately Dangerous to Life or Health) are substituted: Level of defined as the concentration of a hazardous substance in air, above w be serious irreversible health effects or death as a result of a sing relatively short period of time (EPA/FEMA/DOT 1987).
- For Emergency Response Planning Guideline-3, Immediately Dangerous to Health values are substituted: Immediately Dangerous to Life or Healt the maximum concentration from which a person could escape within 30 without a respirator and without experiencing any effects which would ability to escape or irreversible side effects (NIOSH 1990).

Possible health effects associated with exceeding an Emergency Response Pla 2 or -3 are specific for each substance of concern, and must be characterized in th concentrations are found to exceed an Emergency Response Planning Guideline or subs the specific toxicological effects for the chemicals of concern are considered in d health effects associated with exceeding a threshold value.

Emergency Response Planning Guideline values are based upon a one-hour expos member of the general population. In this EIS, exposures resulting from the release chemicals during an accident condition were postulated to occur over a period of 1 allow for a direct comparison to the Emergency Response Planning Guideline values. provides an additional element of conservatism in the evaluation of accidents with much less than one hour.

## F-4.3 Data Analysis

The previous subsections describe the methodology used in evaluating the pote impacts to the public and workers for this EIS. The results of these analyses are s Sections 4.12 and 3.12 (Health and Safety) of this EIS and are not repeated here.

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# F-5 Facility Accidents

**SECTION F-5 CONTENTS**

TABLES



## #F-5 Facility Accidents

### F-5.1 Introduction

Section F-5 provides background information for Volume 2, Section 5.14 (facili the INEL associated with environmental restoration and waste management operations receipt, storage, and handling of spent nuclear fuel). For this EIS, the likelihood been categorized into events that are abnormal (for example, minor spills), design facility was designed to withstand), and beyond design basis (accidents a facility withstand). This section presents analyzed consequences of facility accidents in th member of the public at the nearest INEL site boundary, for the collective populati kilometers (50 miles), and for workers.

An accident is an unplanned sequence of events that results in undesirable co Initiating events for accidents were defined in three broad categories: external in initiators, and natural phenomena initiators. All types of initiators were defined events that cause or may lead to a release of materials and energy by failure or by confinement.

To obtain a perspective on potential accidents involving spent nuclear fuel management and environmental restoration operations at the INEL, the approach was a

- Summarize historical accidents at the INEL
- Review previous accident analyses for spent nuclear fuel, waste manageme environmental restoration activities
- Perform an independent analysis of the accidents with the greatest poten consequences.

This section describes the selection of locations or operations for analysis identify maximum reasonably foreseeable accident scenarios, the basis for evaluatin scenarios, and the selection of computer codes and modeling assumptions used to est effects consequences. The analyses of accidents are intended to be conservative in where uncertainties exist, assumptions that bound the potential for credible enviro consequences are used.

## F-5.2 Methodology

### F-5.2.1 Accidents with Potential Release of Radioactive Material

Radioactive materials are involved in a wide variety of operations at the INE scientific research and engineering development for both domestic and national defe the past four decades, the INEL has been the world's most notable research and deve for testing of nuclear power reactor concepts, their fuels, their stability, and th accidents, as well as a center for the reprocessing of spent nuclear fuel. Radioact encompass potentially valuable resources, such as spent nuclear fuels and various i include waste products ranging in form from contaminated laboratory equipment and m contaminated trash and liquids. These resources and wastes present a potential for radioactive materials caused by human error, equipment failure, or severe natural p earthquakes.

This section describes the selection of facilities and operations for analysi computer codes used in the analysis. The assumptions concerning atmospheric dispers and generic data used to calculate consequences is presented in Section F-5.3.

#### F-5.2.1.1 Selection of Facilities and Operations for Radiological Accident

Scenarios.

Radiological accident scenarios were selected and classified as described in sections.

##### F-5.2.1.1.1 Selection Process- The accident analysis considered all INEL nonreactor

nuclear facilities (accidents at the Naval Reactors Facility are considered in Appe 1). U.S. Department of Energy (DOE) Order 5480.23 (DOE 1994) defines nonreactor nuc facilities as those with activities or operations that involve radioactive and/or f such form and quantity that a nuclear hazard potentially exists to the employees or Excluded from the definition are facilities with generation of radioactive emission x-ray machines, industrial lasers, radiography sources, or electron microscopes).

After excluding offices and facilities without radioactive materials (that is nonreactor nuclear facilities), facilities were screened using preexisting "hazard Contractors operating nonreactor nuclear facilities are required by DOE Order 5480. and DOE guidance (DOE 1992a) to perform a hazard classification of a facility to as consequences of an unmitigated release of radioactive and/or hazardous material in following categories:

- Category 1. The hazard analysis shows the potential for significant offs
- Category 2. The hazard analysis shows the potential for significant onsi
- Category 3. The hazard analysis shows the potential for only significant consequences.

These categories (or the equivalent classifications performed under the previ were used as a screening threshold. Category 3 (low) hazard facilities were exclude in these facilities would be bounded by those in Category 2 (moderate) or Category facilities. Those facilities with a hazard classification of Category 2 or greater further. They were ranked on the basis of their total quantities of radioisotopes, likelihood of an accident occurring, and their relationship with surrounding facili projected inventories by alternative at the various facilities were considered.

##### F-5.2.1.1.2 Determination of Qualitative Likelihood of "Reasonably

Foreseeable" Accidents- The estimated frequency of each postulated accident was bas identification of the physical basis for the accident and estimates of the frequenc independent events combined with the conditional probability of the dependent event accident to occur. Once the frequency was estimated for each accident, they were cl

frequency range. Descriptions of the accidents and data obtained from a variety of to estimate accident frequency. Once an accident frequency was estimated, it was ca one of the likelihood ranges described below. In addition, a brief description was basis of the frequency determination for each accident.

The three frequency ranges chosen, based on the frequency of an accident per are as follows:

| Category | Frequency range (accidents per year) |
|---|---|
| Abnormal events | frequency > 1 x 10^-3 |
| Design basis events | 1 X 10^-3 > frequency >/= 1 X 10^-6 |
| Beyond design basis events | 1 X 10^-6 > frequency >/= 1 X 10^-7 |

Results of the screening process are given in Section F-5.4.

**F-5.2.1.2 Computer Modeling to Estimate Radiation Doses. To determine dose from**

radioactive material releases using computer codes, factors such as receptor locati uptake parameters, material transport mechanisms, and radionuclide inventory are re variables. This section explains these input parameters, notes the degree of conser describes computer models used to perform dose estimates. Generic input parameters accident analyses are summarized in Section 3.

The Radiological Safety Analysis Computer Program (RSAC-5) (Wenzel 1993) was computer code chosen for estimating radiation doses resulting from the accidental a radionuclides. Two other computer codes, ORIGEN2. 1 (Croff 1983, RSIC 1991), and Mi 3.13 (Grove 1988) are used for some accident scenarios to calculate radionuclide in to RSAC-5.

**F-5.2.1.2.1 RSAC-5 Code- The computer code RSAC-5 was developed for the DOE**

Idaho Operations Office by Westinghouse Idaho Nuclear Co., Inc. (Wenzel 1993) and i domain.

RSAC-5 simulates potential radiation doses to maximally exposed individuals o groups from accidental airborne releases of radionuclides to the environment. From RSAC-calculated source term users can calculate the environmental transfer, uptake, exposure. Individual doses are determined at specific distances onsite, at the site away from the site via airborne plume immersion, ground surface contamination (shin and ingestion. (The ingestion pathway applies only where food is raised locally and consumed there.) Population doses are the product of individual dose and the number the affected population.

Source Term Calculation. For most accident scenarios, the radioactive so calculated separately by the analyst for input to RSAC-5. Alternatively, for accide involving reactor fuel, the source term can be calculated by RSAC-5 directly. The l useful for calculating fission product inventories. However, activation products an inventories (for example, uranium and plutonium) must be calculated separately and analyst. RSAC-5 includes an option to calculate radioactive decay of the entire rad or selected specific nuclides.

Atmospheric Dispersion Calculations. Because this analysis addresses acc are calculated for discrete releases of specific quantities of radioactive material

The RSAC-5 code uses a two-dimensional Gaussian atmospheric-dispersion model the dispersion of the radioactive-material plume at various distances downwind from release. INEL-specific values of these dispersion coefficients are built into RSAC- dispersion factors (x/Qs).

The user has the option of directly entering x/Q or having the x/Qs calculat Other code options for calculating atmospheric transport include plume depletion by deposition and building wake effects.

Dose Calculations. As recommended by the International Commission on Rad Protection (ICRP 1974, 1979), RSAC-5 uses weighting factors for various body organs committed effective dose equivalent" (CEDE) from radioactivity deposited inside the inhalation or ingestion.

RSAC-5 calculates an effective dose equivalent (EDE) for the external exposur (immersion in plume, from ground surface contamination) and a 50-year CEDE for the exposure pathways (inhalation, ingestion). The sum of the EDE from external pathway CEDE from internal pathways is called the "total effective dose equivalent" (TEDE). summation is performed external to RSAC-5.

Doses may be calculated for an individual at a specified receptor location Ou kilometers (62 miles) or for a population within a 80 kilometer (50-mile) radius of release. Population doses are determined by calculating an average individual TEDE (10-mile) radial intervals of a compass sector and then multiplying by the number o that average TEDE applies.

#### F-5.2.1.2.2 ORIGEN2.1: Isotope Generation and Depletion Code-ORIGEN

(Croff 1983, RSIC 1991) is a computer code system for calculating the buildup, deca processing of radioactive materials (fission products, actinides, and activation pr two computer codes recommended by the NRC (1977a) for calculating the radioactivity present and later produced in an inadvertent nuclear chain reaction in a fuel repro

ORIGEN2.1 was used in accident analyses involving significant contribution activation products to the radioactive source term associated with spent fuel and i chain reaction accidents. The radioactivity of each such radionuclide (in curies) i damaged by the accident, as calculated by ORIGEN2.1, was multiplied by the appropri fraction and supplied as input to subsequent RSAC-5 calculations.

#### F-5.2.1.2.3 Microshield 3.13- Microshield (Grove 1988) is a radiation shielding code

developed for analysis of shielding design, container design, and selection of temp Another use of Microshield, employed in some of the accident analyses performed for calculation of source strength on the basis of radiation measurements from a shield material and dimensions. This calculation is an iterative process of estimating val strength until the measured radiation values are matched by the calculation.

Microshield has solution algorithms for 14 different geometries, including so as points, lines, spheres, disks, cylinders, slabs, and rectangular solids. Microsh library of approximately 500 radionuclides. The user selects the nuclides appropria application and enters the activity in curies for each. A later version of Microshi been issued. The changes from Microshield 3.13 do not affect the validity of the ca in the EIS.

### F-5.2.2 Accidents With Potential Release of Hazardous Material

Like radioactive materials, hazardous materials are involved in a variety of opera INEL. As a result of these operations, a potential exists for releases of hazardous human error, failure or malfunctioning of equipment, and serve natural phenomena su This section describes the selection of facilities and operations for analysis and computer codes used in the analysis. The assumption about weather conditions, atmos dispersion, scenarios, and generic data utilized to calculate consequences are pres F-5.3.2.1.

#### F-5.2.2.1 Selection of Facilities and Operations for Hazardous Material Accident

Scenarios.

#### F-5.2.2.1.1 Selection of Hazardous Material Accident Scenarios- Starting with a

compilation of INEL hazardous chemicals (Priestley 1992) used in the preparation of Amendments and Reauthorization Act of 1986 (SARA) 112 Report for 1992 (CFR 1993a), was made for those chemical quantities that were (a) in excess of 227 kilograms (50 (b) in excess of reportable quantities (usually one pound) on the U.S. Environmenta Agency (EPA) Title III List of Lists (EPA 1990), which includes hazardous chemicals following lists:

- SARA Section 302 Extremely Hazardous Substances (CFR 1993a)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Hazardous Substances (CFR 1993b)
- SARA Section 313 Hazardous Chemicals (CFR 1993c)
- Resource Conservation and Recovery Act (RCRA) Hazardous Wastes (CFR 1993d)
- Environmental Protection Agency (EPA) list of 100 extremely hazardous chemicals 1990)
- EPA, 40 CFR Part 9 and 68 (FR 1994) list of regulated substances.

As part of the initial screening, facilities were assigned classifications on chemical inventories provided in the SARA list of Extremely Hazardous Substances. F classifications were based on the reportable chemical quantities within the facilit Protection Act (FR 1994) classifications of chemicals stored at the facilities, and consequences of mixing chemicals during an accident. Reviews of existing safety ana documentation and discussions with plant personnel confirmed that accidents in the would have the potential of producing bounding consequences.

#### F-5.2.2.1.2 Determination of Qualitative Likelihood of "Reasonably

Foreseeable" Accidents- The method of estimating qualitative likelihoods is the sam described in Section F-5.2.1.1.2 for radiological accidents.

#### F-5.2.2.2 EPIcode. Like RSAC-5, EPIcode (Homann 1988) uses the well-established

Gaussian Plume Model to calculate the dispersion of airborne hazardous chemicals us receptor locations as used for RSAC-5; that is, facility worker, nearest public acc boundary, and nearby communities. The EPIcode library contains information on over hazardous substances listed in ACGIH.(1988); all substances analyzed for the INEL w the library.

The continuous release models require specifying the source term as an ambien and a release rate. For term releases, the user specifies the release duration and material released.

By specifying a release quantity, release duration, and release area, the use proposes a release rate per unit spill area. EPIcode confirms that the volatility o substance can support such a release rate. If the proposed release rate exceeds the conditions at the release temperature, the EPIcode calculates a more realistic rele corresponding longer release time based on the properties of the spilled materials.

In calculating effective release height, the actual plume height may not be t height, for example, the stack height. Plume rise can occur because of the velocity emission and the temperature differential between the stack effluent and the surrou EPIcode calculates both the momentum plume rise and the buoyant plume rise and choo greater of the two results. In this application, the standard terrain calculation o used. Except as otherwise noted, the established 95 percent meteorological (stabili speed) conditions for INEL are input into EPIcode. The receptor height is always gr (0 meters) and, as in RSAC-5, the mixing layer height is always 400 meters (1,300 f deposition velocities listed in Table F-5-2 in the next section are used.

## F-5.3 Generic Input Parameters

### F-5.3.1 Accidents with Potential Release of Radioactive Material

Calculation of doses rely upon numerous input parameters. Generic input requi parameters are discussed below.

**F-5.3.1.1 Source Term. The source term is expressed as the fraction of the radioactive**

material at risk that is released into the immediate environment. The material at r given process in the facility of interest. It is the material the scenario postulat available for release, and is not necessarily the total quantity of material presen is a multiplier applied to material at risk to estimate initial source term.

For airborne releases, the overall release fraction is the product of the dam airborne and respirable fractions, and the leak path factor. The source term (Q) fo therefore developed as follows:

Q = material at risk X damage ratio X airborne release fraction X respirabl x leak path factor.

**F-5,3.1.1.1 Damage Ratio- The damage ratio is the fraction of material exposed to**

the effects of the energy/force/stress generated by the postulated event. A damage applied for accidents involving 100 percent of the material at risk.

**F-5.3.1.1.2 Airborne Release Fraction- The airborne release fraction is the fraction**

of the material that is made airborne due to the accident. Values from generic DOE used for the analyses unless more specific information is provided in source docume particular accident scenario. These generic values are summarized in Table F-5-1.

**Table F-5-1. Release fractions for various release mechanisms for accidents at the** Engineering Laboratory.

| | Release mechanisms | | | |
|---|---|---|---|---|
| Material | Failed fuel gap | Fire | Explosion | Inadvert nuclear reactio |
| Gases | | | | 1.00 |
| Noble gas | 0.10 | 1.00 | 1.00 | b |
| Krypton | 0.30 | | | |
| Halogens | 0.10 | 1.00 | 1.00 | 0.25^ |
| Iodine-129 | 0.30 | | | |
| Solids | | | | (d) |
| Volatile | 0.01 | 0.01 | (e) | |
| Nonvolatile | 0.01^f | 0.01 | 0.01 | |
| Fly ash | | 0.01 | 0.01 | |

a. Source: Elder et al.(1986).
b. - indicates no recommendation or not applicable.
C. Includes release and plateout.
d. Use Regulatory Guide values (NRC 1977a, 1979a,b).
e. 100 mg/m^3 for particulate airborne material.
f. Actually semivolatile (cesium, rubidium, ruthenium, antimony, selenium. techneti review on a case-by-case basis.

**F-5.3.1.1.3 Respirable Fraction- The respirable fraction is the fraction of the**

material with particle sizes less than 10 microns (DOE 1993) that could be retained system following inhalation. It is applied only to the source term for the inhalati

**F-5.3.1.1.4 Leak Path Factor- The leak path factor accounts for the action of**

removal mechanisms, such as containment systems, filtration, deposition, etc., to r of airborne radioactivity that is ultimately released to occupied spaces of the fac environment. A leak path factor of one is assigned for a major failure of confineme

**F-5.3.1.2 Meteorological/Dispersion Parameters. For accidents initiated within the**

INEL site, radiological doses are calculated not only for the general population, b three locations: (a) for facility workers within the originating facility area (for Chemical Processing Plant), at 100 meters (328 feet) from the source, (b) at the ne to the accident location, and (c) at the nearest INEL site boundary. A qualitative representative accidents for workers less than 100 meters (328 feet) from the sourc Slaughterbeck et al. (1995).

Except for releases through operable discharge systems such as the main stack Chemical Processing Plant, most releases of radioactive material are assumed to be The ground-level release assumption is conservative because the slower dispersion c elevated releases results in higher ground-level concentrations and, therefore, hig radiation exposures near the point of release. Credit is taken for plume rise where that due to thermal buoyancy of combustion products from a fire. Release of a plume height above ground level or with an elevated temperature could cause the plume to completely miss nearby receptors.

The assumed mixing height puts a limit on vertical dispersion of the plume. T value of the mixing height of the plume is 400 meters (1,300 feet), considered to b (Clawson et al. 1989). Both conservative and average meteorological conditions were the conservative assessment, meteorological conditions were selected that would be atmospheric dispersion of contaminants, and would not be exceeded more than 5 perce Applicable parameters are listed in Table F-5-2.

**Table F-5-2. Meteorological/dispersion parameters used in dosimetry calculations fo** Idaho National Engineering Laboratory.^a

| Parameter | Facility worker | Nearest public access | Nearest bounda |
|---|---|---|---|
| Receptor distance (m) | 100 | Specific^c | Specifi^cc |
| Wind velocity^d (m/s) | | | |
| 95 percent | 0.5 | 0.5/2.0 | 2.0 |
| 50 percent | 0.5 | 0.5/4.0 | 4.0 |
| Release elevation^e (m) | 0 | 0 | 0 |
| Wind stability class | | | |
| 95 percent | F | F | F |
| 50 percent | Not applicable | Not applicable | D^f |
| Dry deposition velocity^g (m/s) | | | |
| Solids | 0.001 | 0.001 | 0.001 |
| Halogens | 0.01 | 0.01 | 0.01 |
| Noble gases | 0 | 0 | 0 |
| Cesium | 0.001 | 0.001 | 0.001 |
| Ruthenium | 0.001 | 0.001 | 0.001 |
| Release duration^c | Specific | Specific | Specific |
| Release coefficient^e | Linear | Linear | Linear |
| Diffusion coefficients^e | Markee | Markee | Markee |

a. To convert meters to feet, multiply by 3.28.

b. Nearest site boundary values also used in population dose calculations.
c. Specific to accident scenario.
d. 0.5 meters per second for less than 2 kilometers from source; 2.0 meters per se kilometers with 95% meteorological conditions and 4.0 meters per second for 50% me For cases with plume rise, fumigation is employed.
e. Applies to most accident scenarios; deviations identified in specific accident
f. 50% meteorology is used only for the population dose calculations.
g. Applies to materials (element and physical state) included in specific source t Dry deposition, as modeled in RSAC-5, is assumed so no washout factor is specified depletion by dry deposition means that ground surfaces are contaminated during plum particles fall to ground surfaces by gravitational settling. Dry deposition is cons ground surface and biological uptake pathways because radionuclides are made availa It is slightly nonconservative for inhalation and immersion pathways due to the fra activity within the plume.

To model the atmospheric transport of released radioactive materials from the site-specific meteorological data were reviewed to determine the prevailing meteoro Accidents were evaluated for both average and conservative meteorological condition that represent the upper bound on consequences, stable meteorological conditions th minimal dispersion are assumed.

Workers within the facility area and individuals at the nearest public access boundary are assumed directly downwind from the accident location. For population d direction is constrained to the directions with the highest consequences for the ge

**F-5.3.1.3 Biological Parameters. Inhalation and ingestion pathway parameters are**

discussed below.

**F-5.3.1.3.1 Inhalation Pathway Parameters- Inhalation parameters are the same for**

all radiological scenarios. Breathing rates are assumed to be 3.33 x 10^-4 cubic me (worker average) for exposures at controlled areas like the Idaho Chemical Processi area {DOE Order 5480.11 (DOE 1992b)] and 2.66 x 10^-4 cubic meters per second (memb public average) for uncontrolled areas like public highways inside the INEL site an INEL site boundary.

RSAC-5 provides options for specifying pulmonary clearance classes for each i inventory, or for using code-selected default clearance classes. Clearance classes basis of conservatism, unless otherwise supported by available data on the chemical For INEL facility accidents, the RSAC-5 default selections are used except for the weekly for plutonium and yearly for strontium.

Another conservatism in RSAC-5 involves tritium as a radioactivity source, th terms for H-3 (tritium) are assumed to be 100 percent tritiated water (HTO).

**F-5.3.1.3.2 Ingestion Pathway Parameters- Constants used for calculation of**

internal dose from ingestion of agricultural products such as leafy vegetables, sto and milk are default parameters in the RSAC-5 code. They are based on the most curr guidance from the NRC and DOE (NRC 1977b, Moore et al. 1979, DOE 1988). The fractio food consumed locally that is grown locally is assumed to be 10 percent, and this a implemented by multiplying the calculated ingestion dose by 0.1. Consumption rates population are lower than the maximum individual values from the above references. on Rupp (1980). Concentration ratios and transfer coefficients are based on the dat (1984).

**F-5.3.1.4 Dose Estimates for Individuals. Underlying assumptions for exposure times,**

for purposes of dose estimates are discussed below. The following assumptions apply within the facility area:

- Workers are exposed unprotected to the plume for a limited time (a maxim minutes). An alarm and/or a "Take Cover Alert" is assumed to sound short accident initiation. Workers, as they are trained to do, would immediate inside the nearest building or, particularly in case of an earthquake, e crosswind from the release location.
- After the accident is over and the airborne release is terminated, worke to buses in a nearby parking lot. During transit from buildings to the b exposed to radioactivity deposited on the ground surface for a limited t of 15 minutes).
- Workers are exposed to radioactivity via the inhalation, air immersion, surface pathways only. Ingestion of food plants or animals grown onsite expected for facility workers.

The following assumptions apply to the maximally exposed individual at the n access:

- The nearest public access to the location of an accident is usually a pu example, for the Idaho Chemical Processing Plant, U.S. Highway 20/26 nea Experimental Breeder Reactor I National Historic Monument is approximate kilometers (3.7 miles) from the Chemical Processing Plant area]. This lo the INEL site boundaries and is patrolled by the INEL Security force. In accident with potential impacts outside the complex boundary, public acc highway was assumed to be controlled by INEL Security and State Highway conservatively assumed that a motorist could be on such a highway for up before being evacuated by INEL Security personnel.
- A member of the public on such a public highway directly downwind of an location would be exposed to radioactivity via the inhalation, air immer surface pathways only. Consumption of food plants or animals grown onsit expected for a member of the public temporarily on INEL site. For the in air immersion pathways, exposure time to the plume would be for the enti duration up to a maximum of two hours. Exposure time to radioactivity de ground surface would be a maximum of two hours.

The following assumptions apply to the maximally exposed individual at the ne boundary:

- A hypothetical member of the public resides at the INEL nearest site bou example, for Idaho Chemical Processing Plant, approximately 14 kilometer miles). This individual grows crops and raises animals for personal food The wind is assumed to blow directly toward this person and this person' accident occurs, and this person is assumed to receive no warning of the
- This hypothetical member of the public at the nearest site boundary dire the accident would be exposed to radioactivity via the inhalation, air i ingestion, and ground surface pathways. For the inhalation and air immer exposure time to the plume would be for the entire release duration. Cro land are exposed for the entire duration of plume passage.
- Food contaminated by the accidental release of radioactivity is assumed of the hypothetical individual's diet during the ensuing year. This perc considered consistent with normal practices that would reduce contaminat sprinkler irrigation and washing of vegetables. It does not take credit measures, such as enforced limits on consumption unless exposures reach protective action guidelines are exceeded.
- Exposure time to radioactivity deposited on the ground surface would be 70 percent of the year following the accident, because the individual co expected to spend, on the average, at least 30 percent of each day indoo from ground surface radioactivity.

**F-5.3.1.5 Population Dose Estimates. The RSAC-5 option for calculating population**

doses (in person-rem) involves determining a total effective dose equivalent (TEDE) average individual at several locations within an 80-kilometer (50-mile) radius and TEDE by the number of persons for whom it applies. The TEDE calculation is similar maximum exposed individual at the nearest site boundary, with some limitations and

- For the population option, RSAC-5 limits the radionuclide inventory to 1 scenarios with more than 100 nuclides, such as those for inadvertent nuc reactions, a screening step is performed. Only those nuclides that produ CEDE greater than one millirem for any one of the four pathways at any o

locations are included.

- In the ingestion pathway, the consumption rates are reduced as described F-5.3.1.3.2.
- The adjustment for respirable fraction in the inhalation pathway is done

The method for calculating population dose effectively assumes that the plume constant velocity (under both 95 percent and 50 percent meteorological conditions) out to 80 kilometers (50 miles) over the sector with the maximum population. This m conservative because changes in actual wind directions and speeds that vary with ti from the accident would cause greater diffusion of the plume and result in lower do

**F-5.3.1.6 Health Effects. Health effects expected from the estimated doses are discussed in**

the following sections. The risk factors used for calculation of these health effec ICRP Publication 60 (ICRP 1991), NCRP Report No. 80 (NCRP 1985), and NUREG/CR-4214 (Abrahamson et al. 1990) and are presented in Table F-5-3.

**Table F-5-3. Risk estimators for health effects from exposure to ionizing radiation** the Idaho National Engineering Laboratory.

| | | Risk factor (probability per rem) | |
|---|---|---|---|
| Effect | Nuclide | Facility worker | General populat |
| Fatal cancer (all organs) | All | 4.0 x 10^-4 | 5.0 x 10^-4 |
| Fatal, nonfatal, and severe genetic effects (all organs) | All | 5.6 x 10^-4 | 7.3 x 10^-4 |
| Cancer and severe genetic effects (thyroid) | Iodine-131 | 1.05 x 10^-5 | 1.05 x 10^-5 |
| | Iodine-132 | 3.15 x 10^-5 | 3.15 x 10^-5 |
| Lifetime risk of hypothyroidism | Iodine-131 | 1.7 x 10^-5 | 1.7 x 10^-5 |
| | Iodine-132 | 1.7 x 10^-5 | 1.7 x 10^-5 |

## F-5.3.2 Accidents with Potential Chemical Exposures

Input parameters for the analyses and the potential health effects of acciden chemical exposures are discussed below.

**F-5.3.2.1 Input Parameters. Factors such as receptor locations, terrain, meteorological**

conditions, release conditions, and characteristics of the chemical inventory are r parameters for hand calculations or computer codes to determine human exposure from releases of hazardous chemicals. This section discusses these input parameters, not conservatisms, and describes the computer models used to perform exposure estimates parameters used in the accident analyses are given in Table F-5-4.

**Table F-5-4. Release and dispersion parameters used for calculating hazardous chemi** concentrations resulting from accident scenarios at the Idaho National Engineering

| Meteorological/Dispersion parameter | Facility worker | Co-located facilities and nearest public access | Nearest s boundary |
|---|---|---|---|
| Receptor distance (m) | 100 | Specific^b | Specifi |
| Wind velocity (m/s) | 0.5^c,d | 0.5/2.0^c,d,e | 2.0^c, |
| Release elevation^c (m) | 0 | 0 | 0 |
| Wind stability class^c,d | F | F | F |
| Deposition velocity ^f (m/s) | | | |

| | | | |
|---|---|---|---|
| Solids | 0.01 | 0.01 | 0.01 |
| Gases/vapors/liquids | 0.001 | 0.001 | 0.001 |
| Unspecified | 0.001 | 0.001 | 0.001 |
| Release duration^b | Specific | Specific | Specifi |
| Release area^g | Point | Point | Point |

a. To convert from meters to feet, multiply by 3.28.
b. Specific to accident scenario.
c. Applies to most accident scenarios; deviations identified in specific accident d
d. Worst-case meteorological conditions are calculated for some scenarios by option
e. 0.5 meters per second for less than or equal to 2 kilometers from source; 2.0 me greater than 2 kilometers.
f. Applies to materials (element and physical state) included in specific source te
g. Unless area-release calculational option is used.

---

**F-5.3.2.2 Health Effects. Hazardous constituents dispersed during an accident could induce**

adverse health effects among exposed individuals. This possible impact is assessed airborne concentrations of each substance at specified downwind receptor locations exposure guidelines for chemical toxicity.

Where available, Emergency Response Planning Guideline (ERPG) values are used comparison. ERPG values are estimates of airborne concentration thresholds above wh reasonably anticipate observing adverse effects (Rusch 1993). ERPG values are speci substance, and are derived for each of three general severity levels:

- Exposure to concentrations greater than ERPG-1 values result in an unacc likelihood that one would experience mild transient adverse health effec of a clearly defined objectionable odor.
- Exposure to concentrations greater than ERPG-2 values result in an unacc likelihood that one would experience or develop irreversible or other se effects, or symptoms that could impair one's ability to take protective
- Exposure to concentrations greater than ERPG-3 values result in an unacc likelihood that one would experience or develop life-threatening health

Where ERPG values have not been derived for a toxic substance (Weitzman 1992) chemical toxicity values are substituted, as follows:

- For ERPG-1, threshold limit value/time-weighted average (TLV-TWA) values 1988) are substituted: The TWA is the time-weighted average concentratio 8-hour workday and a 40-hour workweek, to which nearly all workers may b exposed, day after day, without adverse effect.
- For ERPG-2, level-of-concern values (equal to 0.1 of the immediately dan health value-see below) are substituted: level-of-concern value is defin concentration of a hazardous substance in air, above which there may be irreversible health effects or death as a result of a single exposure fo period of time (EPA/FEMA/DOT 1987).
- For ERPG-3, immediately dangerous to life or health (IDLH) values are su IDLH is defined as the maximum concentration from which a person could e 30 minutes without a respirator and without experiencing any escape impa irreversible side effects (NIOSH 1990).

Possible health effects associated with exceeding an ERPG-2 or -3 are specifi substance of concern and must be characterized in that context. ERPG values are bas hour exposure of a member of the general population. In this EIS, ERPG values are a time-averaged exposures of one hour or less in duration. This approach provides an element of conservatism in the evaluation of accidents with releases that are signi hour.

## F-5.4 Accident Screening Methodology

### F-5.4.1 Screening and Selection Process

There are many types of postulated events that may lead to accidental release

and/or hazardous material of which only some have the potential to cause consequenc facility or immediate local area. These events could generate consequences to the e workers, and the public at the nearest site boundaries. The screening and selection events with potential to generate consequences to the public at the nearest site bo This screening may not identify maximum consequences to the worker within the facil meters (328 feet) of the accident location. These consequences are addressed qualit analysis of accident consequences in terms of worker injuries, deaths, or exposures perspective.

### F-5.4.2 Screening of Locations, Spent Nuclear Fuel, Waste and Activity Types

Sufficient quantities of each material type to cause a potential impact if r accordance with DOE-STD-1027-92, "Hazard Categorization and Accident Analysis Techn Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports" (DOE 1994) for Category 2 hazard. Results by waste stream or material type for the nine major area Volume 2, Section 5.14.

### F-5.4.3 Screening of Accident Initiating Event Types

Each INEL facility area was screened for initiating events with the potential consequences to the worker, environment, or public at the nearest site boundary.

### F-5.4.4 Estimation of Accident Event Release Frequency Ranges

Most types of accident events considered in this screening have never occurre They are defined as rare events in that the frequency with which these events are e very small. The estimation of the frequency of occurrence is based on analytical an of the occurrence of conditions and contributing events leading to an accident. Fre defined in terms of annual frequency of occurrence.

Annual frequency range estimates are derived from three sources: (a) existing documentation, (b) other accident safety analysis documentation with similar freque information, or (c) best engineering judgment if no other reference or similar info

### F-5.4.5 Summary of Accident Event Selection and Categorization

The selected accident events are categorized in Table F-5-5 according to the frequency of occurrence range of the event. Table F-5-5 also summarizes these accid frequency of occurrence, source term, dose at the nearest site boundary, and dose t

## F-5.5 References

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Office of Environmental Management
Idaho Operations Office

# APPENDIX B Idaho National Engineering Laboratory Spent Nuclear Fuel Management Program

Department of Energy Programmatic
Spent Nuclear Fuel Management
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# 1. INTRODUCTION

The U.S. Department of Energy (DOE) has prepared the Department of Energy Progr Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environment Restoration and Waste Management Programs Environmental Impact Statement (SNF and I

to assist its management in making two decisions. The first decision, which is prc determine the management program for DOE spent nuclear fuel. The second decision i direction of environmental restoration, waste management, and spent nuclear fuel ma activities at the Idaho National Engineering Laboratory.

Volume 1 of the EIS, which supports the programmatic decision, considers the ef nuclear fuel management on the quality of the human and natural environment for pla through 2035. DOE has derived the information and analysis results in Volume 1 frc specific appendixes. Volume 2 of the EIS, which supports the INEL-specific decisic environmental impacts for various environmental restoration, waste management, and fuel management alternatives for planning years 1995 through 2005.

This Appendix B to Volume 1 considers the impacts on the INEL environment of th implementation of various DOE-wide spent nuclear fuel management alternatives. The Propulsion Program, which is a joint Navy/DOE program, is responsible for spent nav examination at the INEL. For this appendix, naval fuel that has been examined at t Facility and turned over to DOE for storage is termed naval-type fuel. This appenc management of DOE spent nuclear fuel including naval-type fuel. Naval spent nuclea examination is addressed in Appendix D; Section 5.16 of this appendix includes rele environmental consequences from Appendix D.

In addition to this introduction, Appendix B contains the following chapters:

- Chapter 2 - Background: Describes INEL spent nuclear fuel facilities, the framework for spent nuclear fuel management at the INEL, and the INEL spent management program.
- Chapter 3 - Spent Nuclear Fuel Management Alternatives: Describes the DOE- nuclear fuel management alternatives as the INEL would implement them, and summary comparison of potential environmental consequences for each alterna described in Chapter 5.
- Chapter 4 - Affected Environment: Describes the INEL site and the surrounc environment that DOE spent nuclear fuel management actions could affect.
- Chapter 5 - Environmental Consequences: Provides the results of environmen consequence analyses for each spent nuclear fuel management alternative.
- Chapter 6 - References

Volume 1 contains a list of acronyms and abbreviations and a glossary that is a appendix.

# 2. BACKGROUND

This chapter contains an overview of the Idaho National Engineering Laboratory and historic events related to spent nuclear fuel, a description of the regulatory actions evaluated in this document, and an overview of the current spent nuclear fu program at the INEL.

## 2.1 Overview

The following sections provide a general overview of the INEL including its his activities, and mission as they relate to spent nuclear fuel management and future

### 2.1.1 History of Spent Nuclear Fuel Activities

The U.S. Atomic Energy Commission, a predecessor of the U.S. Department of Ener established the INEL, formerly the National Reactor Testing Station, to build, test types of nuclear reactors, support plants, and associated equipment. Since its est (see Table 2-1), DOE and its predecessor agencies have built 52 reactors at the INE DOE programs at the site have included test irradiation services, uranium recovery enriched spent fuels, calcination of liquid radioactive waste, light-water-cooled r and research, operation of research reactors, environmental restoration, and storag solid transuranic wastes. In support of the DOE reactor research program and as pa nuclear fuel reprocessing program, the INEL has received spent nuclear fuel from mc sources, including naval reactors, university reactors, commercial reactors, and DC as well as fuels fabricated in the United States and irradiated in foreign reactors

The Experimental Breeder Reactor-I, now a National Historic Landmark, maintains

in the history of nuclear power in the United States. In December 1951, this react usable electricity from a nuclear reactor. The Experimental Breeder Reactor-I alsc nuclear reactor could actually produce more fuel than it consumes.

Of special significance to spent nuclear fuel is the history of the Idaho Chemi Plant. From 1953 to 1992, this plant recovered usable uranium from spent nuclear f States government reactors. The plant operated for 39 years as a full-scale produc

**Table 2-1.** INEL spent nuclear fuel history.

| Year | Event |
|---|---|
| 1949 | National Reactor Testing Station established |
| 1951 | Site reactor first to generate electricity from nuclear fission |
| 1953 | ICPPa began operation |
| 1953 | Test of first submarine nuclear reactor |
| 1957 | Expended Core Facility constructed |
| 1965 | DOE contract with Public Service Company of Colorado (Fort St. Vrain) |
| 1974 | Site became Idaho National Engineering Laboratory |
| 1980 | DOE contracted to receive Public Service Company of Colorado (Fort St. Vrain) spent nuclear fuel |
| 1992 | Decision to discontinue reprocessing of spent nuclear fuel at ICPPa announced |
| 1992 | DOE creates Office of Spent Fuel Management |
| 1993 | Court order of June 28, 1993 issued |

a. ICPP = Idaho Chemical Processing Plant.

April 1992, DOE decided to phase out reprocessing for material recovery, resulting the reprocessing operation.

Spent naval nuclear fuel handling at the Naval Reactors Facility originated in construction of the Expended Core Facility. The original building contained a wate cells, which are connected to the water pit by transfer tunnels. The Expended Core spent nuclear fuel from operating naval ships and from prototype naval reactors. T support research and development for naval fuel quality improvement. Over the year additions and improvements at the Naval Reactors Facility site, including the const operation of three prototype reactors and facilities for training naval nuclear pow The Naval Nuclear Propulsion Program is placing the prototype reactors, which have of their useful lives, in layup. All training is expected to end before DOE issues Decision for this Environmental Impact Statement (EIS). Expended Core Facility act continuing. Appendix D describes the Naval Reactors Facility in more detail.

In 1965 the United States entered into a contract with Public Service Company c which the United States agreed to lease special nuclear material to Public Service Colorado for fuel at the Fort St. Vrain Nuclear Power Plant. In 1980, the United S Service Company of Colorado modified the 1965 contract, requiring DOE to accept ret Vrain spent nuclear fuel at the INEL. From 1980 to 1986, Public Service Company of approximately 120 shipments of Fort St. Vrain spent nuclear fuel to the INEL.

In 1974 the National Reactor Testing Station became the Idaho National Engineer The INEL mission broadened to include research and engineering for nonnuclear progr environmental restoration and waste management activities.

In the early 1980s, pursuant to the West Valley Demonstration Project Act (42 U a court order, DOE agreed to accept 125 special case commercial reactor spent nucle located at the state-owned Western New York Nuclear Service Center. DOE began a pr demonstrate the viability of a transportable spent nuclear fuel storage cask, with shipping the fuel to the INEL. Based on this, New York State Energy Research and D Authority, which has jurisdiction over the center, has allowed continued storage un U.S. Nuclear Regulatory Commission Certificates of Compliance, which have been issu remains at West Valley awaiting the Record of Decision for this EIS.

In addition to the naval and INEL-generated fuel on the site, some special-case fuel, such as fuel from university reactors, has been shipped directly to the Idahc Plant for storage. Damaged fuel from the 1979 Three Mile Island accident was shipp Test Area North for examination and storage as part of a research mission.

In 1990, DOE issued an Environmental Assessment and Finding of No Significant I Public Service Company of Colorado shipments of Fort St. Vrain spent nuclear fuel t State of Idaho challenged the adequacy of the Environmental Assessment and, in June United States District Court for the District of Idaho found for the State and orde this EIS. A DOE appeal of the order resulted in a December 1993 amendment that gov schedule and obligation for preparing the EIS.

## 2.1.2 Current Activities at Spent Nuclear Fuel-Related Facilities

Six major facility areas at the INEL (Figure 2-1) store spent nuclear fuel: Ar Laboratory - West, Idaho Chemical Processing Plant, Naval Reactors Facility, Power
Figure 2-1. Major facility areas located at the Idaho National Engineering Labor
configurations. The total amount of spent nuclear fuel at the INEL accounts for ab weight of heavy metal) of the spent nuclear fuel in the DOE complex (DOE 1993).

Table 2-2 lists the primary INEL spent nuclear fuel storage facilities, the typ and the storage configurations. Figure 2-2 indicates the relative proportion of fu The number and variety of wet and dry storage configurations currently in use at th the result of the different purposes for the facilities (e.g., at-reactor storage, development, reprocessing, and fuel research and development). The condition of th fuel in storage is generally good with the notable exception of the fuel in the Und Facility (CPP-603). The following paragraphs briefly describe each primary facilit spent nuclear fuel.

The Argonne National Laboratory - West generates spent nuclear fuel as a result development activities related to advanced reactor design. DOE has brought small q nuclear fuel from other reactors to this facility to support these activities. Rea National Laboratory - West are the Experimental Breeder Reactor II, the Transient R Facility, the Zero Power Physics Reactor, and the Neutron Radiography Reactor. Sto include both wet (including molten sodium) and dry configurations.

The Idaho Chemical Processing Plant historically received spent nuclear fuel fr and offsite reactors for reprocessing (i.e., the recovery of uranium for reuse). H to phase out reprocessing activities in 1992. The new mission for this facility ar storage, plus research and development of technologies in support of the dispositic fuel. The Idaho Chemical Processing Plant stores virtually all types of spent nucl production reactor fuel [i.e., fuel from Hanford Site and Savannah River Site (SRS) reactors]. It stores nonproduction aluminum-based spent nuclear fuel. This facili dry storage configurations.

The Naval Reactors Facility includes the Expended Core Facility, which receives naval spent nuclear fuel to support fuel development and performance analyses. In Expended Core Facility removes structural support material from fuel assemblies bef the fuel portion to the Idaho Chemical Processing Plant for interim storage.

**Table 2-2.** Major INEL spent nuclear fuel storage facilities.

| Facility(a) | Storage Type(b) | Fuel Type(c) 1 | 2 | 3 | 4 | 5 | 6a |
|---|---|---|---|---|---|---|---|
| Argonne National Laboratory - West | | | | | | | |
| Experimental Breeder Reactor II | Liquid sodium | | | | | | - |
| Hot Fuel Examination Facility | Dry | | | | | | - |
| Neutron Radiography Reactor | Wet | | | | | | - |
| Radioactive Scrap and Waste Facility | Dry | | | | | | - |
| Transient Reactor Test Facility | Dry | | | | | | |
| Idaho Chemical Processing Plant | | | | | | | |
| Underwater Fuel Storage Facilityd | Wet | - | - | | | | - |
| Irradiated Fuel Storage Facility | Dry | | | | - | | |
| Fuel Storage Area/Fluorinel Dissolution Process Cell | Wet | - | - | | | | - |
| Underground Storage Facility | Dry | | | | - | | |
| Naval Reactors Facility | | | | | | | |
| Expended Core Facility | Wet | - | | | | - | |
| Expended Core Facility Rail Siding | Dry | - | | | | | |
| Power Burst Facility | | | | | | | |
| Power Burst Facility Storage Canal | Wet | | | | | | - |
| Test Reactor Area | | | | | | | |
| Materials Test Reactor Canal | Wet | | | | | - | |
| Advanced Reactivity Measurement Facility | Wet | | - | | | | |
| Coupled Fast Reactivity Measurement Facility | Wet | | - | | | | |
| Advanced Test Reactor Canal | Wet | | - | | | | |

| | | |
|---|---|---|
| Test Area North | | |
| Test Area North Pool | Wet | - |
| Test Area North Pad | Dry | - |

a. This table lists the major spent fuel storage facilities. Other facilities (e.g contain small quantities of spent nuclear fuel.
b. Wet storage involves water-filled pools. Dry storage involves a variety of conf buildings).
c. The spent fuel types are as follows:
 1. Naval-type fuel
 2. Savannah River Site production fuels and other aluminum-clad fuels
 3. Hanford Site production fuels
 4. Graphite fuels
 5. Special case commercial fuels
 6a. Experimental reactors - stainless steel-clad fuels
 6b. Experimental reactors - zirconium-clad fuels
 6c. Experimental reactors - other fuel configurations
d. Spent nuclear fuel storage at this facility will cease by December 31, 2000, as DOE and the State of Idaho.

Figure 2-2. Distribution of INEL SNF. The Power Burst Facility reactor was place of spent nuclear fuel from this facility remains in wet storage, in a storage pool condition, but it is small and uneconomical to use. DOE plans to remove the fuel f 1996.

DOE has used Test Area North for commercial reactor fuel research. The large T Hot Shop and Hot Cells have supported the Loss of Fluid Test and commercial nuclear including dry cask storage demonstration. Test Area North stores special case comm (including Three Mile Island Unit 2 core debris) and DOE experimental fuel similar nuclear fuel.

Test Reactor Area has historically operated a number of test reactors, but the Reactor and its associated Critical Facility are the only reactors now operating. fuel at this area is associated with the Test Reactor Area reactors, which utilized fuels. In addition, DOE stores small amounts of special case commercial, foreign, Facility spent nuclear fuel at Test Reactor Area in the Materials Test Reactor basi fuel in storage at the Test Reactor Area is in water-filled pools (DOE 1993).

### 2.1.3 Spent Nuclear Fuel Mission

The INEL spent nuclear fuel mission is to manage DOE-owned spent fuel cost-effe a way that protects the safety of INEL workers, the public, and the environment. A laboratory for the DOE Spent Nuclear Fuel Program, the INEL provides support to the Fuel Management and coordinates the development of an integrated program for DOE.

The main focus of near-term activities is the accurate quantification and chara DOE-owned spent nuclear fuel, identification of spent nuclear fuel management facil conditions, identification of safe interim storage for existing and new spent nucle identification of technologies and requirements to place DOE spent nuclear fuel in Long-term activities include the development of final waste acceptance criteria req stabilization technologies for alternate fuel disposition, construction of faciliti meet waste disposal requirements, processing of the fuel to a final waste form, and the waste form for disposition.

## 2.2 Regulatory Framework for Spent Nuclear Fuel Management

This section summarizes State of Idaho laws and regulations that apply to spent management at the INEL. Volume 1, Section 7.2, provides summary information for Fe regulations, Executive Orders, and DOE Orders. Volume 2, Chapter 2, provides infor National Environmental Policy Act reviews related to site-specific decisions that h environmental impacts. Volume 2, Chapter 7, provides information on regulatory per INEL holds or for which it has applied.

The Idaho Environmental Protection and Health Act (Idaho Code, Title 39, Chapte establishes general provisions for the protection of the environment and public hea the Idaho Department of Health and Welfare and its Division of Environmental Qualit consolidating all state public health and environmental protection activities in on Act authorizes the Department to promulgate standards, rules, and regulations relat

quality, noise reduction, and solid waste disposal; and grants authority to issue r collect fees, establish compliance schedules, and review plans for the construction public water treatment and disposal facilities.

The Idaho Water Pollution Control Act (Idaho Code, Title 39, Chapter 36) author Department of Health and Welfare to protect the waters of Idaho. This law contains on the prevention of water pollution and the provision of financial assistance to m

The Idaho Department of Health and Welfare is also responsible for the enforcem implementation of the Hazardous Waste Management Act of 1983, as amended (Idaho Cod Chapter 44), which provides for the protection of health and the environment from t improper or unsafe management of hazardous wastes and for the establishment of a tr manifesting system for these wastes. This program is intended to be consistent wit stringent than, the Federal regulations established under the Resource Conservation (RCRA). At this time, Idaho has primacy over hazardous and mixed waste regulations through July 1, 1990, by the U.S. Environmental Protection Agency. The Hazardous W Management Act sets forth requirements for the development of plans that address th hazardous wastes; unauthorized treatment, storage, release, use, or disposal of the requirements for hazardous waste facilities. Under the authority of this Act, the Health and Welfare has promulgated rules and regulations on the transportation, mon and record keeping of hazardous wastes.

Several INEL facilities have air quality permits from the State, and operate in permit conditions. Permit applications are currently pending with the State for pr modified emission sources. In April 1991 DOE submitted an inventory of all potenti radioactive and criteria pollutant emission sources to the State. The inventory cc necessary for the State to issue the INEL a Permit to Operate.

The Idaho Department of Health and Welfare, Division of Environmental Quality, Bureau, conducts annual inspections of the INEL to determine if the operating porti in compliance with the Rules for the Control of Air Pollution in Idaho. The most r were in January 1994. In addition, pursuant to 40 CFR Part 61.94(H), DOE submits t annual report documenting compliance with National Emission Standards for Hazardous at the INEL.

## 2.3 Spent Nuclear Fuel Management Program at the INEL

In 1992 the Secretary of Energy directed the Assistant Secretary for Environmen and Waste Management to develop an integrated, long-term spent nuclear fuel managem In response to this request, DOE created the Office of Spent Fuel Management (EM-37 which has strategic programmatic responsibilities, has designated the INEL as the p organization for the DOE Spent Nuclear Fuel Program. In this role, the INEL provic support to the Office of Spent Fuel Management and develops site communication and the national program.

As identified in the Spent Fuel Working Group Report on Storage of the Departme Nuclear Fuel and Other Reactor Irradiated Nuclear Materials and Their Environmental Health Vulnerabilities, Volume I (DOE 1993), some of the current storage facilities inadequate for extended interim storage, and additional storage facilities or modif necessary. In February 1994, DOE issued, Plan of Action to Resolve Spent Nuclear F Vulnerabilities, Phase I (DOE 1994a), followed by a Phase II Plan in April 1994 (DC Phase III Plan in October 1994 (DOE 1994c), which identified specific corrective ac the spent nuclear fuel vulnerabilities. At the INEL, many of the corrective action completed or are currently underway. The spent nuclear fuel storage pools at Test Burst Facility, and the Underwater Fuel Storage Facility do not comply with new fa requirements. The INEL plans to move spent nuclear fuel from the CPP-603 Underwate Facility by December 31, 2000. To stabilize this fuel for storage, the INEL also p canning equipment in the Irradiated Fuel Storage Facility hot cell. This equipment operation by late 1995. To the extent of its existing capability, DOE could consol fuel at the Power Burst Facility, the Idaho Chemical Processing Plant, and the Test Idaho Chemical Processing Plant as a result of implementing the management alternat Chapter 3. These activities and other planned actions for which National Environme review will be completed before the Record of Decision of this EIS were analyzed un Action Alternative (see Chapter 3).

Each of the specific INEL spent nuclear fuel Plan of Action projects could resu worker exposures, and other potential environmental impacts. The potential environ that could result from each project or corrective action item were not analyzed inc collectively enveloped by the spent nuclear fuel management activities reported anc

alternative. Successful completion of the corrective actions would significantly r environmental, safety, and health risks associated with spent fuel storage at INEL.

The INEL has provided support in the development of dry at-reactor storage of s commercial spent nuclear fuel in accordance with the requirements of the Nuclear Wa 1982 and its 1987 amendments. Dry-storage demonstrations and research at the INEL the granting of NRC licenses to several utilities for the construction and operatic facilities at reactor sites. Research at these facilities is demonstrating the tec economics of adding dry storage capacity in metal or concrete spent fuel storage ca

# 3. SPENT NUCLEAR FUEL MANAGEMENT ALTERNATIVES

Chapter 3 describes the alternatives for spent nuclear fuel management as they National Engineering Laboratory (INEL) and summarizes and compares potential envirc consequences for each alternative. Chapter 5 contains full descriptions of the con implementing the alternatives.

## 3.1 Description of Alternatives

DOE has identified five spent nuclear fuel management alternatives:

Alternative 1 - No Action
Alternative 2 - Decentralization (2a, 2b, and 2c)
Alternative 3 - 1992/1993 Planning Basis
Alternative 4 - Regionalization (4a and 4b)
Alternative 5 - Centralization (5a and 5b)

Table 3-1 summarizes the actions that would result from the implementation of t at the INEL. For each alternative, this table summarizes the proposed transportati storage, research and development, and naval-type fuel examination activities. For and 5, it identifies a number of options.

The analysis of each alternative considers, as appropriate, existing and projec fuel inventories, existing spent nuclear fuel wet and dry storage facilities, the c facilities and associated stabilization facilities to achieve interim management ob relocation of the spent nuclear fuel as appropriate to proposed interim storage fac

Table 2-2 lists existing spent nuclear fuel storage facilities with associated fuel. Table 3-2 lists the potential facilities and projects required for specific based the potential environmental consequences for each alternative on the existing facilities and projects listed in Tables 2-2 and 3-2, respectively.

Table 3-1. Summary of spent nuclear fuel management alternatives at the Idaho Nat
Table 3-1. (Page 2) Table 3-1. (Page 3) Table 3-2. Potential spent nuclear fu

The alternatives involving the interim storage of naval spent nuclear fuel at s INEL include a transition period, which would start on June 1, 1995, and continue f 3 years. During this period, approximately 80 shipments of naval spent nuclear fue Expended Core Facility for examination and subsequent shipment to the Idaho Chemica Plant for storage. After this transition period, DOE would phase out the Expended that the worker total at the facility would decline to about 10 by 2001. Appendix transition period.

### 3.1.1 Alternative 1: No Action

Table 3-1 lists the basic actions expected under this alternative. This altern restricted to the minimum actions necessary for the continued safe and secure manag nuclear fuel. Table 3-3 lists the existing inventory of spent nuclear fuel at the is not a status quo condition in terms of spent nuclear fuel receipts (unlike Alter operations would continue in accordance with the 1992/1993 planning basis). Rather maintain spent nuclear fuel close to defueling or current storage locations with mi upgrades or replacements.

DOE would continue the operation of the following existing spent nuclear fuel-r the Fuel Storage Area/Fluorinel Dissolution Process Cell; CPP-603 Underwater Fuel S (until 2000); Irradiated Fuel Storage Facility; Underground Storage Facility; Power storage canal; Advanced Test Reactor canal; Advanced Reactivity Measurement Facilit

Reactivity Measurement Facility; Materials Test Reactor canal; Test Area North Pool Argonne National Laboratory - West Hot Fuel Examination Facility, Radioactive Scrap Facility, Transient Reactor Test Facility, Zero Power Physics Reactor, and Neutron Reactor pool. Table 2-2 lists the type(s) of storage and spent nuclear fuels assoc

**3.1.1.1 Transportation. Under this alternative, the INEL would neither receive nor ship spent**

nuclear fuel except for naval spent fuel during a transition period. DOE would con Advanced Test Reactor canal spent nuclear fuel to the Idaho Chemical Processing Pla DOE could transfer other spent nuclear fuel at the INEL site (e.g., Test Reactor Ar Pad, Power Burst Facility storage canal, Experimental Breeder Reactor-II, and Naval

**Table 3-3.** Spent nuclear fuel inventory for each alternative by 2035 (metric tons

| Fuel Type | 1. No Action(d) | 2. Decentralization | 3. 1992/1993 Planning Basis | 4a. Regionalization by Fuel Type | 4 F k ( |
|---|---|---|---|---|---|
| Naval-type | 10.23 | N/Cf | +55.00 | +55.00 | + |
| Aluminum-clad | 2.91 | 11.02 | +12.09 | -2.91 | + |
| Hanford | None | None | None | None | + |
| Graphite | 11.60 | N/C | +16.00 | +16.01 | + |
| Special case commercial | 122.88 | +0.03 | +26.69 | +33.63 | + |
| Stainless-steel-clad | 77.43 | +1.08 | +1.19 | +19.08 | + |
| Zircaloy-clad | 49.09 | +0.67 | +0.670 | +28.90 | + |
| Other | 0.01 | +0.82 | +0.82 | +1.69 | + |
| Net increase (+)/ decrease (-) | - | +13.62 | +112.47 | +151.41 | + |
| TOTAL | 274.14 | 287.76 | 386.61 | 425.55 | 2 |

a. Source: Wichmann (1995).
b. To convert metric tons to tons, multiply by 1.10. Heavy metals are uranium, plu
c. The values may not sum exactly due to rounding.
d. The No-Action Alternative represents the present inventory and projections and s determining the net increase or decrease for each type of spent nuclear fuel for
e. Regionalization 4b(2), Regionalization by Geography (Elsewhere), assumes all spe the INEL go to the Nevada Test Site or Hanford Site. Inventories for 4b(2) woul Alternative 5a.
f. N/C = No change from the No-Action Alternative.

Propulsion Program prototype reactors at the Naval Reactors Facility) to the Idaho Processing Plant to the extent of its storage capability.

**3.1.1.2 Stabilization. Due to the deteriorated condition of some of the fuel in the CPP-603**

Underwater Fuel Storage Facility, additional canning and characterization capabilit necessary to stabilize this fuel for safe transport and subsequent storage. DOE ha installation and operation of new fuel canning and characterization equipment in th Storage Facility, which could provide these capabilities, by late 1995. (The insta equipment would be a minor upgrade and would have a smaller extent than similar act under Alternatives 3, 4, and 5.) DOE could perform other required stabilization of at the INEL in either the Remote Analytical Laboratory or the Fluorinel Dissolution

**3.1.1.3 Storage. DOE has identified the CPP-603 Underwater Fuel Storage Facility as one of**

five complex-wide spent nuclear fuel storage facilities that exhibit the greatest v to selected criteria and, therefore, has selected this facility for priority attent of the August 9, 1993, agreement between the Secretaries of the Department of Energ Department of the Navy and the Governor of Idaho to phase out storage operations in

CPP-603 facility, one goal of this and the other alternatives would be to remove sp underwater storage in the North and Middle Basins of the CPP-603 facility by the en from the South Basin of this facility by the end of 2000 (DOE 1993a). DOE would re material to the Fuel Storage Area at the Idaho Chemical Processing Plant.

At the Argonne National Laboratory-West, the spent nuclear fuel stored at the H Examination Facility and the Radioactive Scrap and Waste Facility, primarily Experi Reactor-II fuel and blanket elements, would remain in dry storage until its potenti Fuel Cycle Facility. At the Experimental Breeder Reactor-II site, DOE would use dr exception of the Neutron Radiography Reactor pool fuel. The Test Area North Pool F project would continue, resulting in the relocation of Test Area North spent pool c storage at the Idaho Chemical Processing Plant by 1998. The dry cask storage requi is not related to the Dry Fuels Storage Facility.

DOE would start no new projects to increase spent nuclear fuel storage capacity sufficient storage capacity to meet No-Action storage needs. The planning of spent projects such as the Dry Fuels Storage Facility and Additional Increased Rack Capac Storage Area would stop.

**3.1.1.4 Research and Development. There would be only limited spent nuclear fuel**

research and development. Existing spent nuclear fuel management research and deve would continue. Existing facilities such as the Process Improvement Facility, the Laboratory, and the Pilot Plant Facility would support continuing research and deve

**3.1.1.5 Naval-Type Fuel Examination. After a transition period, DOE would cease**

shipments of naval spent nuclear fuel to the INEL and would phase out the Expended DOE would make onsite shipments of the "library fuel" (a representative sampling of types maintained for reference purposes) and the spent nuclear fuel that originated at the Naval Reactors Facility to the Idaho Chemical Processing Plant.

## 3.1.2 Alternative 2: Decentralization

Under this alternative, DOE could transport fuel for safety or research and dev activities. In addition, DOE could undertake actions for safety it deemed desirabl essential, and could perform spent nuclear fuel treatment and research and developm Table 3-3, the anticipated spent nuclear fuel inventory for this alternative would the inventory for Alternative 1, with the increase consisting primarily of aluminum steel-clad spent nuclear fuel from university and foreign research and experimental

**3.1.2.1 Transportation. This alternative assumes that the INEL would accept primarily**

limited shipments of spent nuclear fuel from offsite sources into the Fuel Storage university reactors) after the Record of Decision for this EIS (1995). Onsite tran the Fuel Storage Area to the Storage Facility or the Irradiated Fuel Storage Facili consolidate the spent nuclear fuel in the Advanced Test Reactor and in the Material Power Burst Facility canals at the Idaho Chemical Processing Plant for canning, cha storage.

As in the No-Action Alternative, there would be a transition period during whic Nuclear Propulsion Program would ship naval spent nuclear fuels to the Expended Cor examination and subsequent shipment to the Idaho Chemical Processing Plant for stor Section 3.1.2.5 describes the transportation of naval spent fuels that would occur period.

**3.1.2.2 Stabilization. DOE would use the canning and characterization equipment identified in**

Section 3.1.1.2 to stabilize spent nuclear fuel removed from the CPP-603 Underwater Facility for interim underwater storage.

**3.1.2.3 Storage. As in Alternative 1, DOE would transfer the spent nuclear fuel in the**

CPP-603 Underwater Fuel Storage Facility to the Fuel Storage Area by 2000. DOE wou use the Underground Storage Facility and the Irradiated Fuel Storage Facility for e fuel inventory and transfers of other spent nuclear fuel based on safety analyses. or increase fuel storage capacity at the INEL as required.

The Test Area North Pool Fuel Transfer project would result in the relocation c Test Area North spent nuclear fuel into dry storage at a pad at the Idaho Chemical

**3.1.2.4 Research and Development. The development of technology for the disposition of**

spent nuclear fuel would continue. Research and development activities would inclu pilot plant testing, continued repository performance assessments and waste accepta development, and the characterization of spent nuclear fuel. Shipments of samples nuclear fuel assemblies to offsite DOE facilities would be necessary.

**3.1.2.5 Naval-Type Fuel Examination. DOE would consider three options for naval reactor**

spent nuclear fuel receipt and shipment. Under options 2a and 2b, DOE would stop s spent nuclear fuel to the INEL and would shut down the Expended Core Facility. Opt enable the continued receipt of naval-type fuel for examination at the Expended Cor return to the originating shipyards for storage in transport casks. Chapter 3 of A describes these options. As with Alternative 1, each option would require approxir transition period. During this period, DOE would transport spent nuclear fuel in s the Expended Core Facility, unload the containers, and use them to support addition defueling.

## 3.1.3 Alternative 3: 1992/1993 Planning Basis

This alternative is consistent with DOE plans at the INEL before the injunction nuclear fuel shipment to the INEL; it assumes a 40-year planning horizon for the cc transportation, receipt, stabilization, and storage of spent nuclear fuel. As with would continue the maintenance and operation of existing spent nuclear fuel-relatec some consolidation of INEL facilities could occur. DOE would send newly generated fuel to either the INEL or the Savannah River Site. DOE would assess the construct facilities to accommodate current and projected spent nuclear fuel management requi

The amount of spent nuclear fuel at the INEL under this alternative would be gr either Alternative 1 or 2 (see Table 3-3) because this alternative assumes that the manage, before stabilization and disposal, its present inventory (see Alternative 1 receipts of DOE spent nuclear fuel, including the following:

- Naval-type spent nuclear fuel
- Approximately half of the aluminum-clad spent nuclear fuel from university research and experimental reactors
- All Training Reactor Isotopics General Atomics (TRIGA) spent nuclear fuels Hanford Site and approximately half of that from foreign, DOE, and universi
- Fort St. Vrain spent nuclear fuel from Public Service of Colorado
- Special case commercial pressurized water reactor and boiling water reactor fuel from the DOE facility in West Valley, New York
- Miscellaneous spent nuclear fuel types from such DOE sites as Los Alamos, N and Oak Ridge, Tennessee, and from university reactors and other locations

**3.1.3.1 Transportation. DOE would consolidate the spent nuclear fuel in the Test Reactor**

Area (Advanced Test Reactor canal, Materials Test Reactor canal, and Coupled Fast F Measurements Facility and Advanced Reactivity Measurement Facility canal) and the F Facility at the Idaho Chemical Processing Plant for canning and dry storage.

The INEL would receive and temporarily store new spent nuclear fuels in the Fue Transfers could occur from the Fuel Storage Area to the Underground Storage Facilit Fuel Storage Facility or, when available, the dry storage vaults at the proposed Dr Facility.

At present, DOE is transferring spent nuclear fuel from the Advanced Test React Idaho Chemical Processing Plant. DOE would maintain this canal for the storage anc its recyclable fuel assemblies until the reactor no longer had a mission. The Expe Reactor-II spent nuclear fuel in storage would remain at Argonne National Laborator Alternative 2, the Test Area North Pool Fuel Transfer project would result in the r contents of the Test Area North spent nuclear fuel pool to dry storage at a pad at Processing Plant.

**3.1.3.2 Stabilization. DOE would complete a new Canning and Characterization Facility with**

appropriate inspection, stabilization, and packaging equipment to stabilize new rec fuel and to prepare fuel currently in underwater storage for dry storage. This fac integral part of the Dry Fuels Storage Facility that DOE would complete under this the Dry Fuels Storage Facility is in service, DOE would use the canning and charact equipment described under Alternative 1 to stabilize spent nuclear fuel removed frc Underwater Fuel Storage Facility for interim underwater storage.

**3.1.3.3 Storage. As with Alternative 2, DOE would upgrade or increase dry fuel storage**

capacity at the INEL as required. DOE would complete the Fuel Storage Area increas Capacity project in 1997. Coupled with stringent fuel management and, if necessary storage of some aluminum fuel in stainless steel racks, this project would allow th to accept all of the project spent nuclear fuel receipts until the Additional Incre project would be completed in 2001. The Additional Increased Rack Capacity project Fuel Storage Area to accept the projected spent nuclear fuel receipts until the Dry Facility project would become available in 2005. The INEL would receive the Fort S nuclear fuel in the Irradiated Fuel Storage Facility on a space-available basis or in the Dry Fuels Storage Facility. Modifications to the Irradiated Fuel Storage Fa equipment would be necessary to accept the new Fort St. Vrain shipping casks.

DOE would continue to use the Underground Storage Facility and the Irradiated F Facility for current inventory and for transfers of other fuel inventories based on Based on these safety analyses, upgrades would be limited to those required for fac improvements and for making transfers safely.

**3.1.3.4 Research and Development. Spent nuclear fuel research and development would**

continue as planned, with the construction of a Technology Development Facility. T Electrometallurgical Process Demonstration Project at Argonne National Laboratory - Facility would continue. In addition, Argonne National Laboratory would implement Blanket Processing project under this alternative. The Dry Fuels Storage Facility demonstrate technology for the dry storage of selected DOE highly enriched uranium

**3.1.3.5 Naval-Type Fuel Examination. The practice of transporting spent nuclear fuel from**

naval reactors to the Expended Core Facility at the INEL would resume. After an ex would transfer such fuel to the Idaho Chemical Processing Plant for interim storage disposition. Under this alternative, the Naval Nuclear Propulsion Program would cc Expended Core Facility Dry Cell Construction project.

## 3.1.4 Alternative 4: Regionalization

This alternative assumes that DOE would base the spent nuclear fuels shipped be and the receipt of fuels from other locations primarily on either geography or fuel offers two options for the redistribution of existing and new spent nuclear fuel:

- Option 4a assumes that DOE would base the spent nuclear fuels shipped betwe and the receipt of fuels from other locations at the INEL, Hanford Site, or

River Site primarily on fuel type.

- Option 4b assumes that DOE would base the spent nuclear fuels shipped betwe and the receipt of fuels on geography. There would be a single western sit Hanford Site, INEL or Nevada Test Site. Option 4b(1) in which the INEL is regional site is essentially the same as Alternative 5b. Option 4b(2) in w SNF to another western regional site is the same as Alternative 5a.

**3.1.4.1 Transportation. Under option 4a, the INEL would receive all Zircaloy- and**

stainless-steel-clad spent nuclear fuel. This redistribution would optimize DOE sp management.

The spent nuclear fuel inventory involved under option 4a would be greater than Alternative 1, 2, or 3 because this alternative assumes that the INEL would manage inventory plus the following additional spent nuclear fuels (see Table 3-3) prior t disposal:

- Naval-type spent nuclear fuel
- All spent nuclear fuel except aluminum-clad fuel and Hanford spent nuclear
- All Training Reactor Isotopics General Atomics spent nuclear fuels from the
- Fort St. Vrain spent nuclear fuel from Public Service of Colorado
- Special case commercial pressurized water reactor and boiling water reactor fuel from the DOE facility in West Valley, New York

Under option 4b(1), DOE would regionalize all western DOE SNF at the INEL. DOE transport all spent nuclear fuel at other western sites to the INEL. Because the f alternative would be within 15 percent of that for Alternative 5b, analyses for thi assume that environmental impacts would be the same as those for as Alternative 5b INEL.

Under option 4b(2), DOE would regionalize all western DOE SNF at either the Nev or Hanford Site. DOE would transport spent nuclear fuel at the INEL to the selecte such, this option would be the same as Alternative 5a - Centralization at Other DOE

**3.1.4.2 Stabilization. DOE would stabilize the spent nuclear fuels it would retain at the INEL**

as planned for Alternative 3, with the construction of such new facilities as a can characterization facility and the Dry Fuels Storage Facility. Options 4a and 4b(1) facility for the receipt and storage of spent nuclear fuel, while option 4b(2) woul capabilities for shipping spent nuclear fuel. For spent nuclear fuel that the INEL regional sites, the receiving site would perform any stabilization beyond that requ transportation.

**3.1.4.3 Storage. Under option 4a, DOE would increase dry storage capacity and undertake**

facility upgrades similar to those described for Alternative 3, with replacements a appropriate. Under option 4b(1), DOE would increase dry storage capacity and under upgrades similar to those described for Alternative 5b, with replacements and addit Option 4b(2) would not require increased storage capacity and, therefore, there wou upgrades.

**3.1.4.4 Research and Development. As with Alternative 3, this alternative would include**

the continuation of activities related to the treatment of spent nuclear fuel, incl development (e.g., Electrometallurgical Process Demonstration Project), and the con Dry Fuels Storage Facility. DOE would initiate pilot programs as needed to support on spent nuclear fuel management and disposition. DOE would use historic data on s to provide the bounding case for a determination of the impacts associated with pot

activities.

**3.1.4.5 Naval-Type Fuel Examination. Under options 4a and 4b(1), the transportation of**

spent nuclear fuel from naval reactors to the Expended Core Facility at the INEL wc with Alternative 1, under option 4b(2) DOE would phase out shipments of naval-type to the INEL and would phase out the Expended Core Facility.

## 3.1.5 Alternative 5: Centralization

Under this alternative, DOE would send all current and future spent nuclear fue both DOE and the Naval Nuclear Propulsion Program to one DOE site for interim stora disposition.

The two options under Alternative 5 encompass the extreme ranges of spent nucle inventories that DOE could store at the INEL (i.e., all or none of the inventory). DOE would ship the INEL spent nuclear fuel inventory off the site to the Hanford Si River Site, the Nevada Test Site, or the Oak Ridge Reservation. Under option 5b, I existing spent nuclear fuel to the INEL.

This alternative would bound the maximum number of spent nuclear fuel-related a could reasonably undertake at any site. DOE would have to build new facilities at accommodate the increased inventories. Shipments of spent nuclear fuel to the site centralized destination would continue as an interim action pending the constructic storage and examination facilities at the selected site. DOE would then transfer a the selected site, and the other sites would close their spent nuclear fuel facilit ship spent nuclear fuel from the originating site, it would characterize and can al necessary.

The locations from which spent nuclear fuel would originate, in addition to the Savannah River Site, would include Argonne National Laboratory - East, Babcock and Brookhaven National Laboratory, General Atomics, Los Alamos National Laboratory, Oa National Laboratory, Sandia National Laboratories, West Valley, and Fort St. Vrain. would also include fuel that might be returned to the United States following irrac

This alternative would include activities related to the treatment of spent nuc research and development and pilot programs to support future decisions on its disp would use historic data on spent nuclear fuel to provide a foundation case for dete associated with potential pilot program activities.

**3.1.5.1 Alternative 5a - Centralization at Other DOE Sites.**

**3.1.5.1.1 Transportation - This option assumes that the INEL would consolidate and**

prepare all existing and projected onsite spent nuclear fuel for shipment to anothe Hanford Site, the Savannah River Site, the Nevada Test Site, or Oak Ridge.

**3.1.5.1.2 Stabilization - The DOE would construct a canning and characterization facility**

at the Idaho Chemical Processing Plant to accept the different types of INEL spent various shipping casks and storage containers, and to stabilize these fuel types be the selected DOE facility.

**3.1.5.1.3 Storage - As in Alternative 1, DOE would complete the CPP-603 Underwater**

Fuel Storage Facility pool inventory transfer to existing dry storage facilities by DOE would not
build the Dry Fuels Storage Facility. DOE would then close all spent nuclear fuel- the INEL with the exception of those in direct support of operating reactors, such Reactor canal or the Argonne National Laboratory-West Hot Fuel Examination Facility Facility. This closure would require the establishment of a major surveillance and operation until DOE determined the disposition of these facilities. The timeframe depend on the following factors:

- The time necessary to stabilize the spent nuclear fuel in the CPP-603 Under

Storage Facility

- The time necessary for the selected DOE site to prepare facilities qualifie nuclear fuel
- The time necessary for the procurement and licensing of shipping containers compatible with the selected receiving DOE site

The spent nuclear fuel inventory that DOE would export off the INEL site for Al the same quantity listed for Alternative 1 (see Table 3-3).

**3.1.5.1.4 Research and Development - Under this option there would be a phaseout of**

all research and development activities, although the Electrometallurgical Process Project would continue at the Argonne National Laboratory - West Fuel Cycle Facilit stabilize only spent nuclear fuel currently on the site).

**3.1.5.1.5 Naval-Type Fuel Examination - As with Alternative 1, DOE would phase out**

shipments of naval-type spent nuclear fuel to the INEL and would phase out the Expe Facility.

**3.1.5.2 Alternative 5b - Centralization at the INEL.**

**3.1.5.2.1 Transportation - This option assumes that the INEL would receive all DOE and**

naval-type spent nuclear fuel (see Table 3-3).

**3.1.5.2.2 Stabilization - The Hanford Site, the Savannah River Site, and other DOE**

facilities would stabilize as necessary, spent nuclear fuel for safe transportation Processing Plant.
The Hanford Site, the Savannah River Site, and other DOE facilities would procure an undetermined number of additional casks and install cask handling equipment as n would complete an expanded Dry Fuels Storage Facility at the INEL, which would incl Canning and Characterization Facility similar to that described for Alternative 3. if needed, repackage the spent nuclear fuel into compatible canisters for dry stora facility projects would be the same as those described for Alternative 3. In addit stabilizing for safe storage all complex-wide spent nuclear fuel, as necessary, in Idaho Chemical Processing Plant. Upgrades and new facilities would be necessary tc term fuel stabilization for ultimate disposition; this would address criticality (u uncontrolled nuclear fission) concerns about the disposal of spent nuclear fuel in repository.

**3.1.5.2.3 Storage - Projects and activities for storage of spent nuclear fuel would be similar**

to those described for Alternative 3, except that accelerated schedules for the Inc and Additional Increased Rack Capacity projects would be necessary to accommodate t fuel receipts.
In addition, the schedule for the Dry Fuel Storage Facility project would have to k accelerated and its scope expanded. For example, the Increased Rack Capacity proje completed in late 1996, the Additional Increased Rack Capacity project may have to late 1998, and the Expanded Dry Fuels Storage Facility project may have to be compl the Expanded Dry Fuels Storage Facility would become available even earlier, it cou need for the Additional Increased Rack Capacity project.

**3.1.5.2.4 Research and Development - DOE would conduct maximum spent nuclear**

fuel research and development under this option.

As with Alternative 4, the Electrometallurgical Process Demonstration Project would continue at the Argonne National Laboratory - W

**3.1.5.2.5 Naval-Type Fuel Examination - Similar to Alternative 3, the practice of**

transporting spent nuclear fuel from naval reactors to the Expended Core Facility a resume.

## 3.2 Comparison of Alternatives

Chapter 5 analyzes the environmental consequences of the alternatives. Tables summarize and compare the potential impacts associated with each alternative from t Chapter 5 for construction, normal operations, and accidents, respectively.

A review of the impacts of the alternatives, as presented in Chapter 5, indicat would be minimal or negligible in most areas. Further, most areas with measurable have no appreciable differences among alternatives.

In general, the levels of potential impacts associated with Alternatives 1 thrc would be similar because the amounts of spent nuclear fuel that DOE would manage at these alternatives would be on the same order of magnitude (e.g., 300 to 450 MTHM) would extend throughout the full 40-year management period. The lowest level of ov impact at the INEL would occur under Alternative 4b(2) - Regionalization by Geograp and Alternative 5a - Centralization at Other DOE Sites because DOE would ship INEL fuel off the site well before the management period ended in 2035. Alternative 5b 4b(1), under which DOE would ship all or nearly all spent nuclear fuel to the INEL, greatest potential onsite impacts.

# 4. AFFECTED ENVIRONMENT



## 4.1 Overview

Chapter 4 describes the existing environment at the Idaho National Engineering (INEL) site and the surrounding region. It emphasizes areas that the proposed spen management alternatives could affect. The information in this chapter provides the environmental conditions against which the Department of Energy (DOE) can measure t environmental effects of the alternatives. It supports the assessment of the poten consequences that Chapter 5 discusses. DOE used the discussion of the Affected Env Volume 2 of this EIS as input for this chapter.

## 4.2 Land Use

The INEL site encompasses 570,914 acres (2,310.4 square kilometers) in Butte, E Jefferson, Bonneville, and Clark Counties, Idaho. This section describes existing and in the surrounding region, and land use plans and policies applicable to the su

### 4.2.1 Existing and Planned Land Uses at the INEL

Categories of land use at the INEL include facility operations, grazing, genera infrastructure such as roads. Facility operations include industrial and support c

with energy research and waste management activities (DOE also conducts such activi
Falls facilities). In addition, DOE uses INEL land for recreation and environmenta
with the designation of the INEL as a National Environmental Research Park.

Much of the INEL is open space that DOE has not designated for specific uses.
open space serves as a buffer zone between INEL facilities and other land uses. Fa
operations use about 2 percent of the total INEL site area (11,400 acres or 46 squa
Public access to most facility areas is restricted. Approximately 6 percent of the
32,985 acres (133.5 square kilometers), is devoted to public roads and utility rigł
the site. Recreational uses include public tours of general facility areas and the
Reactor-I (a National Historic Landmark), and controlled hunting, which is generall
0.5 mile (0.8 kilometer) inside the INEL boundary.

Cattle and sheep grazing occupies between 300,000 and 350,000 acres (1,200 and
kilometers). The U.S. Sheep Experiment Station uses a 900-acre (3.6-square-kilomet
land, at the junction of Idaho State Highways 28 and 33, for a winter feed lot for
sheep. Grazing is not allowed within 2 miles (3.2 kilometers) of any nuclear facil
possibility of milk contamination by long-lived radionuclides, dairy cattle are not
The Department of the Interior's Bureau of Land Management grants and administers r
grazing permits. Figure 4.2-1 shows selected land uses at the INEL and in the surr
Figure 4.2-1 Selected land uses at the INEL and in the surrounding region. The I
568.3 square kilometers in the eastern and southern portions of the INEL site) and
Resource Area (430,499 acres or 1,742 square kilometers in the central and western
Bureau of Land Management administers both of these areas. Under Resource Manageme
Bureau manages portions of these Resource Areas for grazing and wildlife habitat.
exploration or development is allowed on INEL land.

DOE land use plans and policies applicable to the INEL include the INEL Institu
Fiscal Year 1994 - 1999 (DOE-ID 1993c) and the INEL Technical Site Information Repc
1993a). The Institutional Plan provides a general overview of INEL facilities, out
program directions and major construction projects, and identifies specific technic
capital equipment needs. The Technical Site Information Report presents a 20-year
development activities at the site. Under the scope of these planning documents, e
waste management activities would continue in existing facility areas and, in some
into currently undeveloped site areas. These documents also describe environmental
management, and spent nuclear fuel activities. Projected land use scenarios for th
include the outgrowth of current functional areas and the possible development of w
ponds in existing grazing areas.

No onsite land use restrictions due to Native American treaty rights would exis
alternatives described in this EIS. The INEL does not lie within any of the land b
by the Fort Bridger Treaty, and the entire INEL site is land occupied by the U.S. D
Energy. Therefore, the provisions in the Fort Bridger Treaty that allows the Shosh
Indians to hunt on unoccupied lands of the United States do not apply to the INEL s

### 4.2.2 Existing and Planned Land Use in Surrounding Areas

The Federal government, the State of Idaho, and private parties own the lands surrc
site. Land uses on Federally owned land consist of grazing, wildlife management, r
and energy production, and recreational uses. State-owned lands are used for grazi
management, and recreational purposes. Privately owned lands are used primarily fc
production, and range land.

Small communities and towns near the INEL boundaries include Mud Lake to the ea
Butte City, and Howe to the west; and Atomic City to the south. The larger communi
Falls, Rexburg, Blackfoot, and Pocatello and Chubbock are to the east and southeast
The Fort Hall Indian Reservation is to the southeast of the INEL. Recreation and t
the region around the INEL include the Craters of the Moon National Monument, Hell'
Wilderness Study Area, Black Canyon Wilderness Study Area, Camas National Wildlife
Market Lake State Wildlife Management Area, North Lake State Wildlife Management Ar
Yellowstone National Park, Grand Teton National Park, Jackson Hole Recreation Compl
and Challis National Forests, and the Snake River.

Lands surrounding the INEL site are subject to Federal and state planning laws
Federal rules and regulations that require public involvement in their implementati
for and use of Federal lands and their resources. Land use planning in the State c
from the Local Planning Act of 1975 (State of Idaho Code 1975). Because the State
land use planning agency, the Idaho legislature requires each county to adopt its c
and zoning guidelines. County plans that are applicable to lands bordering the INE

Clark County Planning and Zoning Ordinance and Interim Land Use Plan (Clark County Bonneville County Comprehensive Plan (Bonneville County 1976); Bingham County Zonin and Planning Handbook (Bingham County 1986); Jefferson County Comprehensive Plan (J County 1988); and Butte County Comprehensive Plan (Butte County 1992). Land use pl INEL facilities within the Idaho Falls city limits is subject to Idaho Falls planni restrictions (City of Idaho Falls 1989, 1992).

All county plans and policies accept development adjacent to previously develop minimize the need to extend infrastructure improvements and to avoid urban sprawl. INEL is remote from most developed areas, INEL lands and adjacent areas are not lik residential and commercial development; no new development is planned near the INEL However, DOE expects recreational and agricultural uses to increase in the surround response to greater demand for recreational areas and the conversion of range land

## 4.3 Socioeconomics

This section presents a brief overview of current socioeconomic conditions with influence where approximately 97 percent of the INEL workforce lived in 1991 (DOE-I INEL region of influence is a seven-county area comprised of Bingham, Bonneville, E Jefferson, Bannock, and Madison Counties. The region of influence also includes th Reservation and Trust Lands (home of the Shoshone-Bannock Tribes) in Bannock, Bingh and Power Counties.

### 4.3.1 Employment

Historically, the regional economy has relied predominantly on natural resource extraction. Today, farming, ranching, and mining remain important components of th economy. Idaho Falls is the retail and service center for the region of influence, evolved into an important processing and distribution center and site of higher edu

**4.3.1.1 Region. The labor force in the region of influence increased from 92,159 in 1980 to**

104,654 in 1991, an average annual growth rate of approximately 1.2 percent. In 19 influence accounted for approximately 18 percent of the total state labor force of (ISDE 1992). As listed in Table 4.3-1, the projected labor force in the region of 108,667 by 1995.

Unemployment rates varied considerably among the counties of the region of infl ranging from 2.6 percent in Clark County to 6.3 percent in Bannock and Bingham Coun 1980 the average annual unemployment rate for the region has ranged from 5.3 percen 8.3 percent in 1983. In 1991 the average annual unemployment rate for the region c 5.5 percent compared to the statewide average of 6.2 percent (ISDE 1992).

Employment in the region of influence increased from 86,261 in 1980 to 98,898 i average annual growth rate of approximately 1.3 percent. As listed in Table 4.3-1, projected to increase to 101,450 by 1995.

**Table 4.3-1.** Projected labor force, employment, and population for the INEL region 1995-2004.

| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|---|
| Labor Force | 108,667 | 109,607 | 110,547 | 111,487 | 112,427 | 113,367 | 114,308 |
| Employment | 101,450 | 102,328 | 103,205 | 104,083 | 104,960 | 105,838 | 106,716 |
| Population | 247,990 | 251,518 | 255,096 | 258,726 | 262,406 | 266,140 | 268,667 |

Source: ISDE (1992); SAIC (1994); ISDE (1991); ISDE (1986).

**4.3.1.2 Idaho National Engineering Laboratory. INEL plays a substantial role in the**

regional economy. During Fiscal Year 1990, INEL directly employed approximately 11,100 personnel, accounting for almost 12 percent of total regional employment. T population directly supported by INEL employment was approximately 38,000 persons, of the total regional population. The major employers at INEL are DOE-ID, DOE-ID c Argonne National Laboratory-West, and the Naval Reactors Facility (see Figure 4.3-1 total direct INEL employment was approximately 11,600 jobs (DOE-ID 1994). Projecti January 1995 indicate that the total number of jobs at INEL will decrease to approx Fiscal Year 1995 and to approximately 7,250 in Fiscal Year 2004 (Tellez 1995). Pro

in INEL employment are primarily related to contractor consolidation, which account of the projected losses between Fiscal Year 1994 and Fiscal Year 2004, and to reduc Naval Reactors Facility, which accounts for 33 percent of the projected job losses. at DOE-ID resulted in the consolidation of several contracts under one contract. T eliminated redundant administrative activities previously performed by each indivic offered early retirement or other options to impacted INEL contractor employees.

### 4.3.2 Population and Housing

**4.3.2.1 Population. From 1960 to 1990, population growth in the region of influence**

mirrored statewide growth. During this period, the region's population increased a rate of approximately 1.3 percent, while the growth rate for the State was 1.4 perc and 1990, population growth in the region of influence approximately equaled that c average growth rate of 0.6 percent per year. The region of influence had a 1990 pc 219,713, which comprised 22 percent of the total State population of 1,006,749. Ba and employment trends, the population in the region of influence will reach approxi 248,000 persons by 1995 (Table 4.3-1).

Figure 4.3-1. Historic and projected employment at the Idaho National Engineerin

In 1990, the most populous counties were Bannock and Bonneville, which together over 60 percent of the seven-county total (Figure 4.3-2). Butte and Clark were the the counties in the region of influence. The largest cities in the region of influ Idaho Falls, with 1990 populations of approximately 46,000 and 44,000, respectively Fort Hall Indian Reservation and Trust Lands contained 5,113 residents, most of whc resided in Bingham County.

**4.3.2.2 Housing. Bonneville and Bannock Counties (which respectively include the cities of**

Idaho Falls and Pocatello) provided 67 percent of the 73,230 year-round housing uni influence in 1990 (see Table 4.3-2). Of this number, approximately 70 percent were units, 17 percent were multifamily units, and 13 percent were mobile homes. Most c units (75 percent) were in Bonneville and Bannock Counties. About 29 percent of th housing units in the region were rental units and 71 percent were homeowner units (

The median value of owner-occupied housing units ranged from $37,300 in Clark C $68,700 in Madison County, and median monthly rents ranged from $243 in Butte Count Bonneville County. In 1990, there were 1,510 occupied housing units on the Fort Ha Reservation and Trust Lands (USBC 1992) and a vacancy rate of 14 percent.

### 4.3.3 Community Services

This assessment considers the following selected community services in the regi public schools, law enforcement, fire protection, hospital services, and solid wast Table 4.3-3 summarizes pertinent characteristics of these services for the region c

Seventeen public school districts and three nonpublic schools provide education **about 58,000 children in the region of influence.** Of these students, about 6,500 w INEL-related employees. During the 1990-1991 academic year, most public school dis average of $3,000 to $4,000 per student annually. Higher education in the region i University of Idaho, Idaho State University, Brigham Young University, Ricks Colleg Eastern Idaho Technical College.

Seven county sheriff's offices, 12 city police departments, and the Idaho State enforcement services in the region. There was a total of 479 sworn officers and 10

Figure 4.3-2. Historic and projected total population for the counties of the re

**Table 4.3-2.** Number of housing units, vacancy rates, median house value, and media by county and region of influence.

| County | Homeowner housing units Number of units | Vacancy rates | Median value ($) | Rental units Number of units | Va |
|---|---|---|---|---|---|
| Bannock | 16,447 | 2.4 | 53,300 | 7,467 | 10 |
| Bingham | 9,010 | 2.0 | 50,700 | 2,955 | 9. |
| Bonneville | 17,707 | 1.9 | 63,700 | 7,375 | 6. |

| | | | | | |
|---|---|---|---|---|---|
| Butte | 780 | 4.6 | 41,400 | 302 | 16 |
| Clark | 177 | 1.7 | 37,300 | 114 | 9. |
| Jefferson | 4,000 | 2.0 | 54,300 | 992 | 4. |
| Madison | 3,522 | 1.3 | 68,700 | 2,392 | 2. |
| Region of influence | 51,674 | 2.1 | - | 21,556 | 4. |

a. Source: USBC (1992).

enforcement personnel in 1991, more than 59 percent of whom served Bannock and Bonn Counties.

Eighteen fire districts in the region of influence operate 30 fire stations sta approximately 300 volunteer firefighters. Bingham, Bonneville, Butte, Clark, and J which surround the INEL, have developed emergency plans to be implemented in the ev radiological or hazardous materials emergency. Each emergency plan identifies faci extremely hazardous substances and defines transportation routes for these substanc plans also include procedures for notification and response, listings of emergency facilities, evacuation routes, and training programs.

Eight hospitals serve the region of influence with more than 900 licensed beds nearly 128,000 patient-days per year. Occupancy rates range from 22.0 to 61.7 perc (IDHW 1990). County governments and the Blackfoot, Dubois, Idaho Falls, and Pocate departments provide regional ambulance services. A private ambulance company serve Butte County. Four quick-response units, two medical helicopters, and two clinics emergency medical services also serve the region of influence (Hardinger 1990; U.S. 1992).

**Table 4.3-3.** Summary of public services available in the region of influence.

| Public Service | County Bannock | Bingham | Bonneville | But |
|---|---|---|---|---|
| Schools | | | | |
| Number of public school districts | 2 | 5 | 3 | 1 |
| Total enrollment | 15,455 | 11,311 | 17,896 | 765 |
| Number of INEL-related students (excluding military) | 485 | 1,532 | 4,040 | 301 |
| Health Care Delivery | | | | |
| Number of hospitals | 3 | 2 | 1 | 1 |
| Number of licensed beds | 309 | 238 | 311 | 4 |
| Law Enforcement | | | | |
| Number of sworn law enforcement officers | 151 | 65 | 143 | 4 |
| Total personnel per 1000 population | 2.5 | 2.0 | 2.2 | 1.3 |
| Fire Protection | | | | |
| Number of fire stations | 9 | 7 | 6 | 2 |
| Number of firefighters | 166 | 96 | 121 | 15 |
| Number of firefighting vehicles | 37 | 25 | 24 | 3 |
| Municipal Solid Waste Disposal | | | | |
| Number of landfills meeting EPAb regulations | 1c | 3d | 1e | 2 |
| Expected lifespan in years | 30 | 3-6 | 50 | 30 |

a. Source: IDE (1991); IDHW (1990); IDLE (1991); Kouris (1992a); and Kouris (1992

b. EPA = U.S. Environmental Protection Agency.

c. Fort Hall Mine Landfill is being redesigned to meet EPA standards.

d. Aberdeen Landfill may close due to noncompliance with EPA standards.

e. A new landfill is replacing Bonneville County Landfill.

f. Madison and Clark Counties are evaluating a regional landfill for use after 199

Municipal solid waste generated in the region of influence is transported to cc 1992, twelve landfills served the region of influence. Four landfills (one each in Jefferson, and Madison Counties) will close without replacement before reaching the capacity due to noncompliance with new Environmental Protection Agency standards (C

## 4.3.4 Public Finance

In Fiscal Year 1991, total county revenues for the region of influence amountec $90 million (see Table 4.3-4). County governments receive most of their revenues f intergovernmental transfers. In 1991 the total assessed value of taxable property influence was about $4.5 billion. In addition to property tax revenues, local gove counties) also receive revenue from sales tax disbursements and revenue-sharing prc sources provide approximately 60 to 85 percent of the total revenues received by ea

**Table 4.3-4.** Total revenues and expenditures by county, Fiscal Year 1991.

| County | Total revenues ($) | Total expenditures ($) |
|---|---|---|
| Bannock | 16,232,274 | 14,216,708 |
| Bingham | 11,434,200 | 10,708,011 |
| Bonnevilleb | 50,186,650 | 51,850,100 |
| Butte | 1,417,684 | 1,397,012 |
| Clark | 1,236,849 | 1,086,379 |
| Jefferson | 4,408,236 | 4,566,074 |
| Madison | 5,249,432 | 5,662,080 |
| Seven-county region | 90,165,325 | 89,486,364 |

a. Sources: Ghan (1992); Bingham County (circa 1992); McFadden (circa 1992); Swage (1992a); Swager & Swager (1992b); Draney, Searle, and Associates (1992); Schwenc Sutton (1992).

b. Bonneville County's financial statements and total revenue data include special schools, cities, cemeteries, fire districts, ambulance districts, and other spec other county budgets. The majority of intergovernmental revenue is used to func

Although DOE as a Federal agency is exempt from paying state or local taxes, IN and contractors are not. In 1992, INEL employees paid an estimated $60 million in withholding tax and $24 million in state withholding tax.

In 1991 the major categories of county government expenditures were general gov services, 27 percent; road maintenance, 18 percent; public safety, 16 percent; heal programs, 16 percent; sanitation and public works, 9 percent; debt service, 3 perce 2 percent; and other expenditures, 9 percent.

## 4.4 Cultural Resources

This section discusses cultural resources at the INEL, including prehistoric an archeological sites and historic sites and structures, and traditional resources th religious importance to local Native Americans. It also discusses paleontological INEL site.

### 4.4.1 Archeological Sites and Historic Structures

As summarized in the INEL Draft Management Plan for Cultural Resources (Miller INEL contains a rich and varied inventory of cultural resources. This includes fos provide an important paleontological context for the region and the many prehistori sites that are preserved within it. These latter sites, including campsites, lithi hunting blinds, among others, are also an important part of the INEL inventory beca information about the activities of aboriginal hunting and gathering groups who inh approximately 12,000 years. In addition, archeological sites, pictographs, caves, features of the INEL landscape are also important to contemporary Native American g historic, religious, and traditional reasons. Historic sites, including the abandc Powell/Pioneer, a northern spur of the Oregon Trail known as Goodale's Cutoff, many homesteads, irrigation canals, sheep and cattle camps, and stage and wagon trails, the area during the late 1800s and early 1900s. Finally, the many scientific and t inside the INEL boundaries have preserved important information on the historic dev nuclear science in America.

To date, more than 100 cultural resource surveys have been conducted over apprc 4 percent of the area on the INEL site. These surveys, most of which have occurrec facility areas, have identified 1,506 archeological resources, including 688 prehis sites, 753 prehistoric isolates, and 27 historic isolates (Miller 1992; Gilbert anc numbers do not include architectural properties associated with the creation and or Until formal significance evaluations (archeological testing and historic records s completed, all cultural sites in this inventory are considered to be potentially el the National Register of Historic Places. However, all the isolates have been cat to meet eligibility requirements (Yohe 1993).

Due to the relatively high density of prehistoric sites on the INEL and the nee resources during Federal undertakings, DOE has sponsored a preliminary study, which development of a predictive model, to identify areas where densities of sites are h potential impacts to significant archeological resources, as well as costs of compl correspondingly (Ringe 1993). This information provides guidance for INEL project

selection of appropriate areas for new construction. However, it does not take the that are required by the National Historic Preservation Act before ground-disturbin (NHPA 1966 as amended).

The predictive model, constructed using a multivariate statistical technique on variables associated with areas with and without sites, indicates that prehistoric appear to be concentrated in association with certain definable physical features c context, very high densities of resources are likely to occur along the Big Lost Ri atop buttes, and within craters and caves. The Lemhi Mountains, the Lake Terreton mile- (2,800-meter-) wide zone along the edge of local lava fields probably contain density of sites. Within the extensive flows of basaltic lava and along the low fc Mountains, site density is classified as moderate, and the lowest density of prehis probably occurs in the floodplain of the Big Lost River and the alluvial fans emerg Creek Valley, in the sinks, and in the recent Cerro Grande lava flow. However, a c or medium density does not eliminate the possibility that significant resources exi Although the predictive model has not been tested, it is useful as a planning guide most likely to contain archeological resources based on past surveys.

Although there has been no systematic inventory of historically significant fac with the creation and operation of the INEL, a preliminary study indicated that all require evaluation (Braun et al. 1993). The Experimental Breeder Reactor-I is a Na Landmark listed in the National Register of Historic Places. To date, however, few properties have been formally evaluated for eligibility to the National Register. Agreement between DOE, the Idaho State Historic Preservation Office, and the Nation Council on Historic Preservation establish that certain structures at Test Area Nor Auxiliary Reactor Area (DOE 1993a) are eligible for nomination, and outline specifi preserving the historic value of the areas in conformance with the requirements of American Building Survey and the Historic American Engineering Record. Other facil INEL site are likely to require similar efforts if DOE schedules them for major moc demolition, or abandonment.

### 4.4.2 Native American Cultural Resources

Because Native American people believe the land is sacred, the entire INEL rese important to them. Cultural resources, to the Shoshone-Bannock peoples, include al traditional lifeways and usage of all natural resources. This includes not only pr sites, which are important in a religious or cultural heritage context, but also fe landscape, air, plant, water, or animal resources that might have special significa may be affected by changes in the visual environment (construction, ground disturba introduction of a foreign element into the setting), dust particles, or by contamin the INEL is included within a large territory once inhabited by and still of import Shoshone-Bannock Tribes. Plant resources used by the Shoshone-Bannock Tribes that or near the INEL site are listed in Table 4.4-1. Areas significant to the tribes w buttes, wetlands, sinks, grasslands, juniper woodlands, Birch Creek, and the Big Lc

Five Federal laws prompt consultation between Federal agencies and Indian Tribe Environmental Policy Act (NEPA 1969), the National Historic Preservation Act (NHPA amended), the American Indian Religious Freedom Act (AIRFA 1978), the Archeological Protection Act (ARPA 1979), and the Native American Graves Protection and Repatriat (NAGPRA 1990). In accordance with these directives and in consideration of its Nat Policy (DOE 1990a and DOE 1992a), DOE is developing procedures at the INEL for cons coordination with the Shoshone-Bannock Tribes of the Fort Hall Reservation. DOE ha additional interaction and exchange of information with the Shoshone-Bannock Tribes outlined this relationship in a formal Working Agreement with these tribes (DOE 199 the Cultural Resources Management Plan for the INEL (Miller 1992) and the curation permanent storage of archaeological materials will be completed by June 1996. The Resources Management Plan will define procedures for involving the tribes during th of project development and the curation agreement will provide for the repatriation accordance with NAGPRA.

### 4.4.3 Paleontological Resources

There are 31 known fossil localities at the INEL site. Available information s region has relatively abundant and varied paleontological resources. Preliminary a

**Table 4.4-1.** Plants used by the Shoshone-Bannock tribes that are located on or nea

| Plant Family | Type of Use | Location |
|---|---|---|
| Desert Parsley | medicine, food | scattered over site |
| Milkweed | food, tools | roadsides |
| Sagebrush | medicine, tools | throughout the site |
| Balsamroot | food, medicine | around buttes |
| Thistle | food | scattered throughout site |
| Gumweed | medicine | disturbed areas |
| Sunflower | medicine, food | roadside |
| Dandelion | food, medicine | throughout site |
| Beggar's Ticks | food | disturbed areas throughout site |
| Tansymustard | food, medicine | disturbed areas |
| Cactus | food | throughout the site |
| Honeysuckle | food, tools | Big Southern Butte |
| Goosefoot | food | throughout site |
| Russian Thistle | food | disturbed areas throughout site |
| Dogwood | food, medicine, tools | Webb Springs, Birch Creek |
| Juniper | medicine, food, tools | throughout site |
| Gooseberry | food | scattered throughout site |
| Mentha arvensis | medicine | Big Lost River |
| Wild onion | food, medicine, dye | throughout site |
| Caloehortus spp. | food | buttes |
| Fireweed | food | throughout site |
| Pine | food, tools, medicine | Big Southern Butte |
| Douglas Fir | medicine | Big Southern Butte |
| Plantain | medicine, food | throughout site |
| Wildrye | food, tools | throughout site |
| Indian Ricegrass | food | throughout site |
| Bluegrass | food, medicine | throughout site |
| Serviceberry | food, tools, medicine | buttes |
| Chokeberry | food, medicine, tools, fuel | buttes |
| Wood's Rose | food, smoking, medicine, ritual | Big Lost River, Big Southern Butte |
| Red Raspberry | food, medicine | Big Southern Butte |
| Willow | medicine | throughout site in moist areas |
| Coyote Tobacco | smoking, medicine | Big Lost River, Webb Springs |
| Cattail | food, tools | sinks, outflow from facilities |

Source: Andersen et al. (1995).

these materials are most likely to occur in association with archeological sites; i in deposits of the Big Lost River, Little Lost River, and Birch Creek; in deposits playas; in some wind and sand deposits; and in sedimentary interbeds or lava tubes flows (Miller 1992).

## 4.5 Aesthetic and Scenic Resources

### 4.5.1 Visual Character of the INEL Site

The Bitterroot, Lemhi, and Lost River mountain ranges border the INEL site on t west. Persons can see volcanic buttes near the southern boundary of the INEL from the site and from the Fort Hall Reservation. Most of the INEL site consists of ope covered predominantly by large sagebrush and grasslands (see Section 4.9). Pasture farmland border much of the INEL site (see Section 4.2).

Although the INEL has a master plan, it has not established specific visual res The nine facility areas on the INEL site are generally of low density, look like cc industrial complexes, and are spread across the site. Structures in the facility a from 10 feet to approximately 100 feet (3 to 30 meters). About 90 miles (145 kilon public highway run through the INEL site (see Section 4.11). Although many INEL fa visible from these highways, most facilities are located more than 0.5 mile (0.8 ki roads.

### 4.5.2 Scenic Areas

The Craters of the Moon National Monument is about 15 miles (24 kilometers) sou INEL site's western boundary. The Monument is located in a designated Wilderness A must maintain Class I (very high) air quality standards or minimal degradation, as Clean Air Act (CAA 1990; CFR 1990; CFR 1991b). Under Section 169a of the Clean Air quality includes visibility and scenic view considerations.

Lands adjacent to the INEL under Bureau of Land Management jurisdiction are Vis Management Class II areas (BLM 1984; BLM 1986), which urge preservation and retenti existing character of the landscape. Lands inside the INEL boundaries are Class II most lenient classes in terms of modification. The Bureau of Land Management is cc Black Canyon Wilderness Study Area, which is adjacent to the INEL, for a Wilderness designation (BLM 1986); if approved, this would result in an upgrade from Visual Re Management Class II to a Class I.

Features of the natural landscape have special significance to the Shoshone-Ban visual environment of the INEL site is within the visual range of Fort Hall Reserva

## 4.6 Geology

This section describes the geology of the INEL and the surrounding area. Secti characterizes the general geology, while section 4.6.2 describes the natural resour Sections 4.6.3 and 4.6.4 describe seismic and volcanic hazards, respectively.

### 4.6.1 General Geology

The site is on the Eastern Snake River Plain (Figure 4.6-1). The Plain forms a trending, crescent-shaped trough with low relief composed primarily of surface basa formed 1.2 million to 2,100 years ago. The Plain features thin, discontinuous, and deposits of wind-blown loess and sand; water-borne alluvial fan, lacustrine, and fl sediments; and rhyolitic domes formed 1,200,000 to 300,000 years ago (Kuntz et al. (Figure 4.6-2). Mountains and valleys of the Basin and Range Province, which trend northwest and consist of folded and faulted rocks that are more than 70 million yea Plain on the north and south. The Yellowstone Plateau bounds the Plain on the nort episode of Basin and Range faulting began 20 to 30 million years ago and continues recently associated with the October 28, 1983, Borah Peak earthquake [moment magnit magnitude 7.3 on the Richter scale with a resulting peak ground acceleration of 0.0 INEL (Jackson 1985)], which occurred along the Lost River fault, approximately 100 (62 miles) from site facilities and the 1959 Hebgen Lake Earthquake, moment magnitu approximately 150 kilometers (93 miles) from the INEL (Figure 4.6-1).

The northeast-trending volcanic terrain of the Plain has a markedly different g tectonic pattern than the folded and faulted terrain of the northwest-trending Basi Basin and Range faults have not been observed on or across the Plain. Four northwe volcanic rift zones, attributed to basaltic eruptions that occurred 4 million to 2, across the Plain at the INEL (Bowman 1995; Hackett and Smith 1992; Kuntz et al. 199

The seismic characteristics of the Eastern Snake River Plain and the adjacent E Province are also different. Earthquakes and active faulting are associated with t tectonic activity. The Plain has historically experienced few and small earthquake Pelton et al. 1990; WCC 1992; Jackson et al. 1993).

**Figure 4.6-1. Location of INEL in context of regional geologic features. Figure 4.6-2. Lithologic logs of deep drill holes in the INEL area. 4.6.2 Natural Resources**

In 1979 the INEL drilled a geothermal exploration well to 3,159 meters (10,365 Researchers measured a temperature of 142yC (288yF) but identified no commercial qu geothermal fluids (IDWR 1980). Mineral resources include several quarries or pits boundary that supply sand, gravel, pumice, silt, clay, and aggregate for road const maintenance, new facility construction and maintenance, waste burial activities, an landscaping cinders. During excavations, DOE might study the gravel pits to charac surficial geology of the site. Outside the site boundary, mineral resources incluc pumice, phosphate, and base and precious metals (Strowd et al. 1981; Mitchell et al geologic history of the Plain makes the potential for petroleum production at the I

### 4.6.3 Seismic Hazards

The distribution of earthquakes at and near the INEL from 1884 to 1989 clearly Plain has a remarkably low rate of seismicity, whereas the surrounding Basin and Ra high rate (Figure 4.6-3, WCC 1992). The mechanism for faulting and generation of e Basin and Range is attributed to northeast-southwest directed crustal extension.

Several investigators have suggested hypotheses for the low rate of seismic act Plain compared to the activity in both the Centennial Tectonic Belt and the Intermc Belt:

- Smith and Sbar (1974) and Brott et al. (1981) suggest that high crustal tem the Plain and adjacent region inside the seismic parabola (Figure 4.6-1) re deformation (aseismic creep), in contrast to the brittle deformation (rock in the Basin and Range.
- Anders et al. (1989) suggest that the Plain and the adjacent region inside parabola (Figure 4.6-1) have increased integrated lithospheric strength. T the presence of mid-crustal basic intrusive rock strengthens the crust so t to fracture (see also Smith and Arabasz 1991).

Figure 4.6-3. Earthquakes with magnitudes greater than 2.5 from 1884 to 1989. -

and associated seismicity by altering the local tectonic stress field. As volcanic rift zones, they push apart the surrounding rocks and decrease dif thereby preventing earthquakes from occurring.

- Anders and Sleep (1992) propose that the introduction of mantle-derived mag midcrust beneath the Plain has decreased faulting and earthquakes by loweri deformation.

The markedly different tectonic and seismic histories of the Plain and Basin an reflect the dissimilar deformational processes acting in each region. Both regions same extensional stress field (Weaver et al. 1979; Zoback and Zoback 1989; Pierce a Jackson et al. 1993); however, crustal deformation occurs through dike injection in through large-scale normal faulting in the Basin and Range (Rodgers et al. 1990; Pa Thompson 1991; Hackett and Smith 1992).

Major seismic hazards include the effects from ground shaking and surface defor tilting). Other potential seismic hazards (e.g., avalanches, landslides, mudslides and soil liquefaction) are not likely to occur at the INEL because the local geolog conducive to them. Based on the seismic history and the geologic conditions, earth moment magnitude 5.5 (and associated strong ground shaking and surface fault ruptur to occur in the Plain. However, moderate to strong ground shaking from earthquakes Range can affect the INEL. Researchers use patterns of seismicity and locations of assess potential sources of future earthquakes and to estimate levels of ground mot The sources and maximum magnitudes of earthquakes that could produce the maximum le motions at all INEL facilities include the following (WCC 1990; WCC 1992):

- A moment magnitude 7.0 earthquake at the southern end of the Lemhi fault al and Fallert Springs segments
- A moment magnitude 7.0 earthquake at the southern end of the Lost River fau Arco segment
- A moment magnitude 5.5 earthquake associated with dike injection in either Lava Ridge-Hell's Half Acre Volcanic Rift Zone and the Axial Volcanic Zone
- A "random" moment magnitude 5.5 earthquake occurring in the Eastern Snake R

Figure 4.6-4 shows a facility-specific example of the relationship of the peak on the INEL to the annual frequency of occurrence of seismic events on various seis region, including the four events described above (WCFS 1993). The curves refer sp site of the Idaho Chemical Processing Plant in the south-central INEL and might not other INEL areas. Ground motion contributions from seismic sources not shown on Fi (i.e., Intermountain seismic belt and Yellowstone Region) are significantly smaller distant locations or lower estimated maximum magnitudes. The INEL Natural Phenomen determines INEL seismic design-basis events based on studies such as those performe Clyde Consultants (1990) and Woodward Clyde Federal Services (1993).

A maximum horizontal ground surface acceleration of 0.24g at the Idaho National Laboratory is estimated to result from an earthquake that could occur once every 2, 1994). The seismic hazard information presented in this EIS is for general seismic comparisons across DOE sites. Potential seismic hazards for existing and new facil evaluated on a facility-specific basis, consistent with DOE orders, standards, and procedures. Section 5.15 describes the potential impacts of postulated seismic eve

### 4.6.4 Volcanic Hazards

Volcanic hazards at the INEL can come from sources inside or outside Plain boun hazards include the effects of lava flows, ground deformation (fissures, uplift, su earthquakes (associated with magmatic processes as distinct from earthquakes associ tectonics), and ash flows or airborne ash deposits (Bowman 1995). Most of the basa activity occurred from 4 million to 2,100 years ago in the INEL area. The most rec volcanic eruption occurred 2,100 years ago at the Craters of the Moon, 25 kilometer southwest of the INEL (Kuntz et al. 1992). The rhyolite domes along the Axial Volc between 1.2 million and 300,000 years ago and have a recurrence interval of about 2 Therefore, the probability of future dome formation affecting INEL facilities is ve

Figure 4.6-4. Contribution of the seismic sources to the mean peak acceleration

Catastrophic Yellowstone eruptions have occurred three times in the past 2 mill INEL is more than 160 kilometers (70 miles) from the Yellowstone Caldera rim and hi winds would not disperse Yellowstone ash in the direction of INEL. Due to the infr distance, and unfavorable dispersal, pyroclastic flows or ash fallout from future Y should not impact the INEL.

Basaltic lava flows and eruptions from fissures or vents might occur. Based on analysis of the volcanic history in the Big Southern Butte area (Volcanism Working conditional probability that basaltic volcanism would affect a south-central INEL l 2.5 y 10-5 per year (once per 40,000 years or longer), where the risk associated wi Zone volcanism is greatest. The estimated probability of volcanic impact on INEL f north, where both silicic and basaltic volcanism have been older and less frequent, year (once every million years or longer). The statistics of 116 measured INEL-are and areas were used to define the two lava flow hazard zones (Figure 4.6-5). The h particular site within or near a volcanic zone is much lower, typically by an order more, and must be assessed on a site-specific basis (Bowman 1995).

## Figure 4.6-5. Map of the INEL showing locations of volcanic rift zones and lava flow hazard zones. 4.7 Air Quality

This section describes the air resources of the INEL site and the surrounding a discussion includes the climatology and meteorology of the region, descriptions of radiological air contaminant emissions, and a characterization of existing and proj pollutants. The analysis includes both existing facilities and those that were exp analysis was performed) to be operational before June 1, 1995. Additional detail a information on the material presented in this section is presented in Appendix F, S Volume 2.

### 4.7.1 Climatology and Meteorology

The Eastern Snake River Plain climate exhibits low relative humidity, wide dail swings, and large variations in annual precipitation. Average seasonal temperature INEL site range from -7.3yC (18.8yF) in winter to 18.2yC (64.8yF) in summer, with a temperature of about 5.6yC (42yF). Temperature extremes range from a summertime ma 39.4yC (103yF) to a wintertime minimum of -45yC (-49yF). The annual average relati 50 percent, with monthly average maximum values ranging from 59 percent in July to February and December, and with monthly average minimum values ranging from 16 perc and July to 47 percent in January (Clawson et al. 1989).

Annual precipitation is light, averaging 221.2 millimeters (8.71 inches), with of zero to 127 millimeters (5 inches). The maximum 24-hour precipitation rate is 4 (1.8 inches). The greatest short-term precipitation rates are attributable primari which occur approximately two or three days per month during the summer. The avera snowfall is 701 millimeters (27.6 inches), with a maximum of 1,516 millimeters (59. minimum of 173 millimeters (6.8 inches) (Clawson et al. 1989).

The INEL site is in the belt of prevailing westerlies; however, the mountain ra Eastern Snake River Plain normally channel these winds into a southwest wind. Most experience the predominant southwest-northeast wind flow of the Eastern Snake River subtle terrain features near some locations cause considerable variations from this annual average wind speed measured at the 6.1-meter (20-foot) level at the Central

Weather Station is 3.4 meters per second (7.5 miles per hour). Monthly average val 2.3 meters per second (5.1 miles per hour) in December to 4.2 meters per second (9. in April and May (Clawson et al. 1989). The highest hourly average near-ground win measured onsite is 22.8 meters per second (51 miles per hour) from the west-southwe maximum instantaneous gust of 34.9 meters per second (78 miles per hour) (Clawson e Figure 4.7-1 presents the frequency of wind speed and wind direction at three metec monitoring sites on the INEL site from 1988 to 1992. The wind directions presentec the direction from which the wind blows. The three wind-roses demonstrate the effe predominant wind directions and wind speed. The winds at the Test Area North monit predominantly from the north-northwest, whereas the winds from the other stations a from the southwest.

Air pollutant dispersion is a result of the processes of transport and diffusic contaminants in the atmosphere. Transport is the movement of a pollutant in the wi diffusion refers to the process whereby turbulent eddies dilute a pollutant plume. gradient of the atmosphere (i.e., the change in temperature with altitude) can rest vertical diffusion of pollutants. Lapse rate conditions, which tend to enhance ver slightly less than 50 percent of the time. Conversely, thermal stratification or i which inhibit vertical diffusion, occur slightly more than 50 percent of the time. the pollutants can freely diffuse is the mixing depth, while the layer of air from mixing depth is the mixed layer. Estimates of the monthly average depth of the mix from 400 meters (1,312 feet) in December to 3,000 meters (9,843 feet) in July. Wit mostly clear skies, nocturnal inversions begin forming after sunset and dissipate a after sunrise. These inversions are often ground-based, meaning the atmospheric te with height from the ground (Clawson et al. 1989).

Other than thunderstorms, severe weather is uncommon. Five funnel clouds (torn touching the ground) and no tornadoes were reported on the site between 1950 and 19 the region is good because of the low moisture content of the air and minimal sourc reducing pollutants. From Craters of the Moon National Monument, the seasonal visu 130 to 155 kilometers (81 to 97 miles) (Notar 1993).

## 4.7.2 Air Quality

**4.7.2.1 Nonradiological Air Quality. The INEL is in the Eastern Idaho Intrastate Air**

Quality Control Region (AQCR 61). Neither the INEL nor any of the surrounding coun

Figure 4.7-1. Depiction of annual average wind direction and speed at INEL meteor

designated as a nonattainment area (CFR 1992b) for the National Ambient Air Quality (CFR 1991b). Ambient air quality data monitored in the vicinity of the INEL indica in compliance with applicable air quality standards (DOE 1991a).

The Clean Air Act (CAA 1990) contains requirements to prevent the deterioration in areas designated to be in attainment with the ambient air quality standards. Th administered through a program that limits the increase in specific air pollutants existed in what has been termed a baseline (or starting) year, which is 1977. The maximum allowable ambient pollutant concentration increases or increments. They sp limits for pollutant level increases for the nation as a whole (Class II areas) anc stringent increment limits (as well as ceilings) for designated national resources, forests, parks, and monuments (Class I areas). Three areas in the INEL vicinity ar Significant Deterioration Class I ambient air quality areas: Craters of the Moon W approximately 53 kilometers (33 miles) to the west-southwest; Yellowstone National approximately 143 kilometers (89 miles) to the northeast; and Grand Teton National approximately 145 kilometers (90 miles) to the east-northeast.

DOE evaluates proposed new and modified sources of emissions at INEL to determi emissions increase of all pollutants. The INEL is considered a major source, becau emissions of specific regulated air contaminants exceed 227 metric tons (250 tons) Therefore, a Prevention of Significant Deterioration analysis must be performed for emission increases of specified regulated pollutants. Levels of significance for n range from very small quantities (less than 1 pound) for beryllium up to 91 metric year for carbon monoxide. Their significance is dependent on the toxicity of the s radionuclides, significance means any increase in emissions that would result in an millirem per year or greater.

Ambient air quality standards for Idaho are the same as the National Ambient Ai Standards but include total suspended particulates and fluorides. The Idaho Depart Welfare (IDHW) also has ambient concentration limits for hazardous and toxic air pc

Table 4.7-1 lists emission rates of criteria and hazardous and toxic air pollutants
The types and amounts of nonradiological emissions from INEL facilities and act
**similar to those from other industrial complexes that are the same sizes as the INE**
sources such as boilers and emergency generators emit both criteria and toxic pollu

**Table 4.7-1.** Baseline annual average and maximum hourly emission rates of nonradic pollutants at the INEL.

| Pollutant | Annual average (kg/yr)b,c | Maximum hourly (kg/hr |
|---|---|---|
| Criteria pollutants | | |
| Carbon monoxide (CO) | 301,000 | 177 |
| Lead (Pb) | 11 | 0.085 |
| Nitrogen dioxide (NO2) | 744,000 | 545 |
| Particulate matter (PM10)d | 302,000 | 230 |
| Sulfur dioxide (SO2) | 202,000 | 136 |
| Hazardous/toxic air pollutantse | | |
| Acetaldehyde | 31 | 0.39 |
| Ammonia | 1,600 | 3.4 |
| Arsenic | 4.2 | 9.0 y 10-4 |
| Benzene | 370 | 16 |
| 1,3-Butadiene | 220 | 0.8 |
| Carbon tetrachloride | 28 | 0.08 |
| Chloroform | 1.9 | 5.5 y 10-3 |
| Chromium - trivalent | 3.1 | 2.5 y 10-3 |
| Chromium - hexavalent | 0.4 | 6.2 y 10-4 |
| Cyclopentane | 350 | 0.58 |
| Dichloromethane | 620 | 0.29 |
| Formaldehyde | 960 | 8.9 |
| Hydrazine | 8.3 | 9.5 y 10-4 |
| Hydrochloric acid | 1,500 | 0.34 |
| Mercury | 200 | 0.023 |
| Napthalene | 16 | 2.2 |
| Nickel | 270 | 0.057 |
| Nitric acid | 1,500 | 1.7 |
| Phosphorous | 56 | 0.024 |
| Potassium hydroxide | 990 | 0.24 |
| Propionaldehyde | 62 | 0.24 |
| Styrene | 4.7 | 0.74 |
| Tetrachlorethylene | 980 | 0.11 |
| Toluene | 580 | 56 |
| Trichloroethylene | 4.7 | 0.013 |
| Trimethylbenzene | 87 | 12 |

a. Source: Volume 2, Table 4.7-2.
b. To convert kilograms to pounds, multiply by 2.2.
c. Annual average values include actual emissions plus projected increases from fac become opertional after the baseline year.
d. It is conservatively assumed that all particulate matter is PM10 (less than 10 m
e. Hazardous/toxic air pollutants that are listed in State of Idaho regulations and that exceed screening criteria.

sources include chemical processing operations, transportation, waste management ac research laboratories.

Table 4.7-2 compares the INEL contribution to air quality to applicable standar This assessment modelled the INEL air emissions inventory for 1990 using the method by the U.S. Environmental Protection Agency to predict the maximum ground-level con would occur at or beyond the site boundary for each regulated pollutant (EPA 1993b) Source Complex-2 model primarily assessed criteria pollutants, and the SCREEN model air pollutants. The SCREEN model incorporates meteorological data that tend to ove and is useful for identifying cases that require additional, more refined assessmen concentrations listed in Table 4.7-2 are the sums of the following factors: the cc from potential impacts from current operations and the concentrations resulting frc or operation of planned upgrades or modifications before the implementation of the described in Section 5.7. Background concentrations have not been included because on background levels in the INEL environs are not available for most pollutants and levels are low and are more than offset by the use of the maximum (as opposed to ac The baseline concentrations represent the maximum calculated concentration occurrin locations (site boundary, public roads, and Craters of the Moon Wilderness Area).

the baseline concentrations to applicable Federal and state criteria pollutant and pollutant guidelines and regulations shows that air quality at INEL is in complianc guidelines and regulations. The 24-hour total suspended particulate background con as 40 micrograms per cubic meter, which is the same as the annual geometric mean va sources include chemical processing operations, transportation, waste management ac research laboratories.

**4.7.2.2 Radiological Air Quality. The major source of radiation exposure in the Eastern**

Snake River Plain is from natural background radiation sources such as cosmic rays; naturally present in soil, rocks, and the human body; and airborne radionuclides of as radon). Sources of radioactivity related to INEL operations include research an spent nuclear fuel testing and stabilization, irradiated material and fuel examinat treatment and storage, and depleted uranium armor production.

Radioactive emissions from INEL facilities include the noble gases (argon, kryp and iodine; particulate fission products such as rubidium, strontium, and cesium; r

**Table 4.7-2.** Comparison of baseline ambient air concentrations with most stringent regulations and guidelines at the INEL.

| Pollutant | Averaging time | Most stringent regulation or guideline (-g/m3)a,b,c | Maximum baseline concentrat (-g/m3) |
|---|---|---|---|
| Criteria pollutants | | | |
| Carbon monoxide (CO) | 8-hour | 10,000 | 280 |
| | 1-hour | 40,000 | 610 |
| Lead (Pb) | Calendar Quarter | 1.5 | 0.001 |
| Nitrogen dioxide (NO2) | Annual | 100 | 4 |
| Particulate matter (PM10) | Annual | 50 | 5 |
| | 24-hour | 150 | 80 |
| Sulfur dioxide (SO2) | Annual | 80 | 6 |
| | 24-hour | 365 | 140 |
| | 3-hour | 1,300 | 580 |
| Hazardous/toxic air pollutants | | | |
| Acetaldehyde | Annual | 4.5 y 10-1 | 1.1 y 10-2 |
| Ammonia | Annual | 1.8 y 102 | 6.0 y 100 |
| Arsenic | Annual | 2.3 y 10-4 | 9.0 y 10-5 |
| Benzene | Annual | 1.2 y 10-1 | 2.9 y 10-2 |
| Butadiene | Annual | 3.6 y 10-3 | 1.0 y 10-3 |
| Carbon Tetrachloride | Annual | 6.7 y 10-2 | 6.0 y 10-3 |
| Chloroform | Annual | 4.3 y 10-2 | 4.0 y 10-4 |
| Chromium - hexavalent | Annual | 8.3 y 10-5 | 6.0 y 10-5 |
| Chromium - trivalent | Annual | 5.0 y 100 | 3.6 y 10-2 |
| Cylclopentane | Annual | 1.7 y 104 | 2.7 y 10-0 |
| Formaldehyde | Annual | 7.7 y 10-2 | 1.2 y 10-2 |
| Hydrazine | Annual | 3.4 y 10-4 | 1.0 y 10-6 |
| Hydrochloric acid | Annual | 7.5 y 100 | 9.8 y 10-1 |
| Mercury | Annual | 1.0 y 100 | 4.2 y 10-2 |
| Methylene Chloride | Annual | 2.4 y 10-1 | 6.0 y 10-3 |
| Napthalene | Annual | 5.0 y 102 | 1.8 y 101 |
| Nickel | Annual | 4.2 y 10-3 | 2.7 y 10-3 |
| Nitric Acid | Annual | 5.0 y 101 | 6.4 y 10-1 |

**Table 4.7-2.** (continued).

| Pollutant | Averaging time | Most stringent regulation or guideline (-g/m3)a,b,c | Maximum baseline concentrat (-g/m3) |
|---|---|---|---|
| Perchloroethylene | Annual | 2.1 y 100 | 1.1 y 10-1 |
| Phosphorous | Annual | 1.0 y 100 | 3.0 y 10-1 |
| Potassium hydroxide | Annual | 2.0 y 101 | 2.0 y 10-1 |
| Proprionaldehyde | Annual | 4.3 y 100 | 3.0 y 10-1 |
| Styrene | Annual | 1.0 y 103 | 1.3 y 100 |
| Toluene | Annual | 3.8 y 103 | 3.7 y 102 |

| | | | |
|---|---|---|---|
| Trichloroethylene | Annual | 7.7 y 10-2 | 9.7 y 10-4 |
| Trimethylbenzene | Annual | 1.2 y 103 | 1.0 y 102 |

a. CFR (1991b).
b. IDHW (1994); the ambient standards for the criteria pollutants are the same as t
c. Standards cited for hazardous/toxic air pollutants are for all new sources const since May 1, 1994, under State of Idaho Regulations for the Control of Air Pollu Idaho (IDHW 1994).

Source: Volume 2, Section 4.7.

by neutron activation such as tritium (hydrogen-3), carbon-14, and cobalt-60; and v (less than 6 y 10-4 curies per year) of heavy elements such as uranium, thorium, pl decay products. Historically, the radionuclide with the highest emission rate is t krypton-85, which is released primarily by the chemical reprocessing of spent nucle Chemical Processing Plant. Fuel reprocessing also releases small amounts (less tha year) of iodine-129, which is of concern because of its long half-life (16 million properties (iodine isotopes tend to accumulate in the human thyroid). Reactor oper gas isotopes with short half-lives, including argon-41 and isotopes of xenon (prima -135, and -138). Other activities at the INEL, including waste management operatic low levels of airborne radionuclide emissions (less than 1 y 10-4 curie per year). summarizes airborne radionuclide emissions from INEL facility areas, plus estimatec projects expected, at the time of the analysis was performed, to become operational 1995.

Radioactivity released to the atmosphere can result in human exposure through a pathways, including inhalation, external exposure, and ingestion. DOE conducts phy

**Table 4.7-3.** Summary of airborne radionuclide emissions from INEL facility areas (

| Facility | Tritium/ carbon-14 | Iodines | Noble gases | Mixed fission an activation productsb |
|---|---|---|---|---|
| Argonne National Laboratory-West | 1.0 y 102 | -d | 1.3 y 104 | 8.1 y 10-4 |
| Central Facilities Area | 2.6 y 100 | 5.0 y 10-7 | - | 1.9 y 10-5 |
| Idaho Chemical Processing Plant | 4.3 y 101 | 6.4 y 10-2 | 1.0 y 104 | 3.6 y 10-2 |
| Naval Reactors Facility | 1.9 y 10-1 | 6.3 y 10-6 | 5.7 y 10-1 | 5.6 y 10-5 |
| Power Burst Facility/Waste Experimental Reduction Facility | 4.9 y 101 | - | - | 1.3 y 100 |
| Radioactive Waste Management Complex | - | - | - | 2.6 y 10-5 |
| Test Area North | 1.2 y 10-1 | - | - | 5.6 y 10-6 |
| Test Reactor Area | 1.6 y 102 | 1.6 y 10-2 | 3.3 y 103 | 3.0 y 100 |
| INEL total | 2.1 y 103 | 1.1 y 10-1 | 1.2 y 105 | 5.6 y 100 |

a. With the exception of the Idaho Chemical Processing Plant, emissions estimates a operations. Idaho Chemical Processing Plant emissions are based on 1993 emissic upward to reflect operation of the New Waste Calcining Facility at maximum permi Anticipated projects in the baseline include the Waste Experimental Reduction Fa and sizing operations but not incineration), Argonne National Laboratory-West Fu and Portable Water Treatment Unit, as described in Appendix F of Volume 2.
b. Mixed fission and activation products that are primarily particulate in nature ( cobalt-60, strontium-90, and cesium-137).
c. U/Th/TRU = Radioisotopes of uranium, thorium, or transuranic elements such as pl americium, and neptunium.
d. A dash (-) indicates that the emissions for this group are negligibly small or z

Source: Volume 2, Table 4.7-1.

measurements (ambient air monitoring) and uses calculation techniques (atmospheric modeling) to assess existing levels of radiation (both cosmic and manmade) in and r assess doses to workers and the surrounding population.

The offsite population can receive a radiation dose as a result of radiological attributable to existing INEL operations. DOE assesses such a dose for a maximally individual and for the population as a whole. The maximally exposed individual is person whose habits and proximity to the site are such that the person would receiv projected to result from sitewide radioactive emissions. The calculated annual dos

as a result of current and anticipated sitewide emissions is 0.05 millirem (Section This value is a small fraction of both the National Emission Standards for Hazardou dose limit of 10 millirem per year (CFR 1992a) and the dose received from natural k sources of 351 millirem per year (Section 4.7 to Volume 2). Figure 4.7-2 compares

The collective annual dose to the surrounding population, determined using 1990 Bureau data for the total population residing within an 80-kilometer (50-mile) radi on the site, is about 0.3 person-rem (Section 4.7 to Volume 2). This value is smal the annual dose received by the same population from background sources, which is n 40,000 person-rem (Section 4.7 to Volume 2).

Workers at each major INEL facility can receive radiation exposures. DOE has k assessment of the dose to these workers on contributions from sources at each facil expected to become operational before June 1, 1995. The results of this assessment maximum dose received by a worker at any onsite area is about 4.3 millirem per year Volume 2), well below the National Emissions Standard for Hazardous Air Pollutants 10 millirem per year. The standard applies to the highest exposed member of the pu applicable to workers. However, it is the most restrictive limit for airborne rele useful comparison. This dose value of 4.3 millirem per year includes the maximum p operation of the Portable Water Treatment Unit at the Power Burst Facility Area. F operation would be temporary (1 to 2 years) and is not representative of a permanen baseline. If this facility were not included, the baseline dose to the worker woul 0.2 millirem per year.

Figure 4.7-2. Comparison of dose to maximally exposed individual (MEI) to the Na

## 4.8 Water Resources

This section describes existing regional and site hydrologic conditions and dis of surface and subsurface water and water use and rights. The subsurface water sect the vadose zone (or unsaturated zone and perched water bodies) located between the the water table.

### 4.8.1 Surface Water

Other than surface-water bodies formed from accumulated runoff during snowmelt precipitation and manmade infiltration and evaporation ponds, there is little surfa The following sections discuss regional drainage conditions, local runoff, floodpla surface-water quality. Figure 4,8-1 supports discussions in this section.

**4.8.1.1 Regional Drainage. The INEL is in the Pioneer Basin, a closed drainage basin that**

includes three main surface-water bodies--the Big and Little Lost Rivers and Birch water bodies drain mountain watersheds directly west and north of the site. However surface-water flow is diverted for irrigation before it reaches site boundaries (Ba resulting in little or no flow for several years inside the site boundaries (Pittma

The Big Lost River drains approximately 3,755 square kilometers (1,450 square n before reaching the site. Approximately 48 kilometers (30 miles) upstream of Arco, Dam controls and regulates the flow of the river, which continues southeast past th and Arco and onto the Eastern Snake River Plain. The river channel then crosses the boundary of the site, where the INEL Diversion Dam controls surface-water flow. Dur runoff events, the dam diverts surface water to a series of natural depressions, de areas. The Big Lost River continues northeasterly across the site to an area of nat basins (playas or sinks) near Test Area North. In dry years, surface water does not western boundary of the site, and because the INEL is located in a closed drainage water never flows off the site.

Birch Creek drains an area of approximately 1,943 square kilometers (750 square summer, upstream of the site, surface water from Birch Creek is diverted to provide

Figure 4.8-1. Selected facilities and predicted inundation map for probable maxin

to produce hydropower. In the winter, water flow crosses the northwest corner of th manmade channel 6.4 kilometers (4 miles) north of Test Area North, where it then in channel gravels.

The Little Lost River drains an area of approximately 1,826 square kilometers ( miles). Strearnflow is diverted for irrigation north of Howe, Idaho. Surface water

River has not reached the site in recent years; however, during high stream flow ye reach the site and infiltrate into the subsurface (E(3&G 1984).

**4.8.1.2 Local Runoff. Surface water generated from local precipitation will flow into**

topographic depressions (lower elevations than the surrounding terrain) on the site either evaporates or infiltrates into the ground, increasing subsurface saturation subsurface migration (Wilhelmson et al. 1993).

Localized flooding can occur at the site when the ground is frozen and melting with heavy spring rains. Test Area North was flooded in 1969 (Koslow and Van Haafte 1969 extensive flooding caused by snowmelt occurred in the lower Birch Creek Valley Studies have shown that both the 25- and 100-year, 24-hour rainfall/snowmelt storm flooding within the Radioactive Waste Management Complex (Dames & Moore 1992). The system, including dikes and erosion prevention features designed to mitigate potent flooding, are being upgraded.

**4.8.1.3 Floodplains. Intermittent surface-water flow and the INEL Diversion Dam (built in**

1958 and enlarged in 1984) have effectively prevented flooding from the Big Lost Ri However, onsite flooding from the river could occur if high water in the Mackay Dam River were coupled with a darn failure. Koslow and Van Haaften (1986) examined the of structural failure of the Mackay Dam due to a seismic event, coupled with a prob flood (the largest flood assumed possible in an area), This scenario predicts flood the INEL Diversion Dam and spreading at the Idaho Chemical Processing Plant, Naval Facility, and the Test Area North Loss-of-Fluid Test Facility (Figure 4.8-1). In th combined Mackay Dam failure and a 100-year flood (flood that occurs on an average c 100 years), flooding along the Big Lost River would also occur, with low velocities on the INEL (Koslow and Van Haaften 1986). The area inundated under the Mackay Dam scenarios probably would use more than the 100- or 500-year floodplains for the Big INEL. A 100-year floodplain study for the INEL is in progress.

**4.8.1.4 Surface-Water Ouality, Water quality in the Big and Little Lost Rivers and Birch**

Creek is similar and has not varied a great deal over the period of record. Measure chemical, and radioactive parameters have not exceeded applicable drinking water qu Chemical composition is determined primarily by the mineral composition of the rock mountain ranges northwest of the site and by the chemical composition of irrigation with the surface water (Robertson et al. 1974; Bennett 1990).

Site activities do not directly affect the quality of surface water outside the s discharges from site facilities are to manmade seepage and evaporation basins or st wells. Effluents are not discharged to natural surface waters. In addition, surface directly off the site (Hoff et al. 1990). However, water from the Big Lost River, a from evaporation basins and stormwater injection wells, does infiltrate the Snake R (Robertson et al. 1974; Wood and Low 1988; Bennett 1990). These areas are inspected and sampled as stipulated in the INEL Stormwater Pollution Prevention Program (DOE-

## 4.8.2 Subsurface Water

Subsurface water at the site occurs in the Snake River Plain Aquifer and the va section describes regional and local hydrogeologic conditions, vadose zone hydrolog and subsurface-water quality. Generally, the term "groundwater" refers to usable qu that enter freely into wells under confined and unconfined conditions within an aqu

**4.8.2. 1 Regional Hydrogeology. The INEL overlies the Snake River Plain Aquifer, the**

largest aquifer in Idaho (Figure 4.8-2). This aquifer underlies the Eastern Snake R covers an area of approximately 24,900 square kilometers (9,611 square miles). Grou aquifer generally flows south and southwestward across the Snake River Plain. The e storage in the aquifer is 2.5 x 1012 cubic meters (2 billion acre-feet, which is ab volume of water contained in Lake Erie) (Robertson et al. 1974). A typical irrigati

much as 13.9 x 106 cubic meters (3.7 x 10(9) gallons) per year of water if pumped e (Garabedian 1989). The Snake River Plain Aquifer is among the most productive aquif nation.

The drainage basin recharging the Snake River Plain Aquifer covers an area of a 90,643 square kilometers (35,000 square miles). The aquifer is recharged by infiltr

Figure 4.8-2. Location of the INEL, Snake River Plain, and generalized groundwate

water, seepage from stream channels and canals, underflow from tributary stream val into the watershed, and direct infiltration from precipitation (Garabedian 1989). M in surface water-irrigated areas and along the northeastern margins of the plain. G discharges primarily from the aquifer through springs that flow into the Snake Rive pumping for irrigation. Major springs and seepages that flow from the aquifer are l American Falls Reservoir (southwest of Pocatello) and the Thousand Springs area bet Dam and King Hill (near Twin Falls).

**4.8.2.2 Local Hydrogeology. The INEL site covers 2,305 square kilometers (890 square**

miles) of the north-central portion of the Snake River Plain Aquifer. Depth to grou land surface at the site ranges from approximately 61 meters (200 feet) in the nort (900 feet) in the south (Pittman et al. 1988) (see Figure 4.8-3). Groundwater flow the south-southwest, and the upper surface is primarily unconfined (not overlain by or bedrock). However, the aquifer behaves as if it were partially confined because geologic conditions. The occurrence and movement of groundwater in the aquifer depe geologic setting and the recharge and discharge of water within that setting. Most consists primarily of numerous relatively thin, basaltic lava flows with interbedde extending to depths of 1,067 meters (3,500 feet) below the land surface (Irving 199 groundwater migrates horizontally through fractured, basaltic interflow zones (brok zones) that occur at various depths. Water also migrates vertically along joints an edges of interflow zones (Garabedian 1986). Sedimentary interbeds restrict the vert groundwater. The variability in how the aquifer stores and transmits water increase aquifer investigations and modeling.

The rate at which water moves through the ground depends on the hydraulic gradi elevation and pressure with distance in a given direction) of the aquifer, the effe (percentage of void spaces), and hydraulic conductivity (capacity of a porous media of the soil and bedrock. Because aquifer porosity and hydraulic conductivity decrea most of the water in the aquifer moves through the upper 61 to 152 meters (200 to 5 basalts. Estimated flow rates within the aquifer range from 1.5 to 6.1 meters (5 tc (Barraclough et al. 1981).

The aquifer's ability to transmit water (transmissivity), and its ability to st are important physical properties of the aquifer. In general, the hydraulic charact enable the easy transmission of water, particularly in the upper portions.

Figure 4.8-3. Hydrostratigraphy scross the INEL and water table surface.

Recharge north. Most of the inflow to the aquifer results from the underflow of groundwater alluvial-filled valleys adjacent to the Eastern Snake River Plain and adjacent surf (i.e., Big and Little Lost Rivers and Birch Creek). In addition, recharge at the si amount of precipitation, particularly snowfall, for a given year (Barraclough et al

**4.8.2.3 Vadose Zone Hydrology The vadose (unsaturated) zone extends from the land**

surface down to the water table. Within the vadose zone, water and air occupy openi geologic materials. Subsurface water in the vadose zone is referred to as vadose wa this complex zone consists of surface sediments (primarily clay and silt, with some and many relatively thin basaltic lava flows, with some sedimentary interbeds. Thic occur in the northern part of the site, which thin to the south where basalt is exp

The vadose zone protects the groundwater by filtering many contaminants through buffering dissolved chemical wastes, and slowing the transport of contaminated liqu The vadose zone also protects the aquifer by storing large volumes of liquid or dis released to the environment through spills or migration from disposal pits or ponds decay processes to occur.

Travel times for water through the vadose zone are important for an understandi contaminant movement. The flow rates in the vadose zone depend directly on the exte the percentage of sediments versus basalt, and the moisture content of vadose zone increases under wetter conditions and slows under dryer conditions.

**4.8.2.4 Perched Water. Locally, saturated conditions that exist above the water table are**

called perched water. Perched water occurs when water migrates vertically and later surface until it reaches an impermeable layer (Irving 1993). As perched water sprea sometimes for hundreds of meters, it moves over the edges of the impermeable layer downward. Several perched water bodies can form between the land surface and the wa

In general, perched water bodies slow the downward migration of fluids that inf vadose zone from the surface because the downward flow is not continuous. The occur perched water at the site is related to the presence of disposal ponds or other sur which studies have detected at the Idaho Chemical Processing Plant, Test Reactor Ar North. For example, a 1986 field study at the Idaho Chemical Processing Plant showe water occurs in three areas at possibly three depth zones, ranging from approximate (30 feet) to 98 meters (322 feet) below the ground surface and extending laterally 1 ,097 meters (3,600 feet). In general, the chemical concentrations, shape, and siz have fluctuated over time in response to the volume of water discharged to the infi (Irving 1993).

**4.8.2.5 Subsurface Water Quality. Natural water chemistry and contaminants originating at**

the site affect subsurface water quality. The INEL Groundwater Protection Managemen conducts monitoring programs. This program collects samples from surface water, per aquifer wells to identify contaminants and contaminant migration to and within the

**4.8.2,5.1 Natural Water Chemistry - Several factors determine the natural groundwater**

chemistry of the Snake River Plain Aquifer beneath the site. These factors include reactions that occur as water interacts with minerals in the aquifer and the chemic (1) groundwater originating outside the site; (2) precipitation falling directly on (3) streams, rivers, and runoff infiltrating the aquifer (Wood and Low 1986, 1988). the groundwater is different, depending on the source areas. For example, groundwat northwest contains calcium, magnesium, and bicarbonate leached from sedimentary roc groundwater from the east contains sodium, fluorine, and silicate resulting from cc rocks (Robertson et al. 1974).

Although the natural chemical composition of groundwater beneath the site does Environmental Protection Agency drinking water standards for any component, the nat affects the mobility of contaminants introduced into the subsurface from INEL activ dissolved contaminants adsorb (or attach) to the surface of rocks and minerals in t thereby retarding the movement of contaminants in the aquifer and inhibiting furthe contamination. However, many naturally occurring chemicals compete with contaminant adsorption sites on the rocks and minerals or react with contaminants to reduce the and mineral surfaces.

**4.8.2.5.2 Groundwater Quality - Previous waste discharges to unlined ponds and deep**

wells have introduced radionuclides, nonradioactive metals, inorganic salts, and or the subsurface.

Table 4.8-1 summarizes the highest detected concentrations of contaminants observed in the aquifer between 1987 and 1992, concentrations near the site boundary, Envirc **Agency maximum contaminant levels, and DOE Derived Concentration Guides.** The follow

Table 4.8-1. Highest dtected contaminant concentrations in groundwater at the Ida

paragraphs discuss each category of contaminants and comparisons of observed concen maximum contaminant levels.

Radionuclides - In general, radionuclide concentrations in the Snake River Plain the site have decreased since the mid-1980s because of changes in disposal practice decay, adsorption of radionuclides to rocks and minerals, and dilution by natural s groundwater entering the aquifer (Pittman et al. 1988; Orr and Cecil 1991; Bargelt Radionuclides released and observed in the soil and groundwater include tritium, st iodine-129, cobalt-60, cesium-137, plutonium-238, plutonium-239/240, and americium- Associates 1994). Most of these radionuclides have been observed at the Idaho Chemi Plant and Test Reactor Area facility areas. However, radionuclides have also been c

Test Area North disposal well.

Concentrations of radionuclides in the aquifer have decreased over time. This dec to reduced discharges, adsorption, radioactive decay, and improved waste management of 1992, concentrations of iodine-129, cobalt-60, tritium, strontiurn-90, and cesiu the EPA maximum contaminant levels for radionuclides in drinking water in localizeć INEL boundary. Currently, there are no individual maximum contaminant levels for pl plutonium-239, plutonium-240, and americium-24 1. However, these radionuclides have detected above the established limits for gross radioactivity or the proposed adjus activity maximum contaminant level for drinking water (Golder Associates 1994; Mann Orr and Cecil 1991).

Extremely low concentrations of iodine- 129 and tritium have migrated outside sit 1992, iodine- 129 concentrations were well below the maximum contaminant levels in approximately 6 and 13 kilometers (4 and 8 miles) south of the site boundary (Mann concentrations were much below maximum contaminant levels just south of the site bc By 1988 the tritium plume encompassed by the 500 picocurie per liter contour was ba boundary, and its size has continued to decrease (Pittman et al. 1988; Otr and Ceci 1991). Cobalt-60, strontium-90, cesium-i 3?, plutonium-238, plutonium-240!241, and have not been detected outside the site boundaries.

Nonradioactive Metals - The INEL has released sodium, chromium, lead, and mercu site and into the subsurface through unlined ponds and deep wells. Of these metals, sodium in the greatest quantity from waste treatment processes; however, sodium is not have an established maximum contaminant level. In 1988 chromium concentrations maximum contaminant level were measured near the Test Reactor Area. Lead and mercur occurred at concentrations below the maximum contaminant level near the Idaho Chemi Plant (Orr and Cecil 1991).

Inorganic Salts - Human activities at the site have released chloride, sulfate, the subsurface. Although chloride and sulfate releases have occurred, only nitrate maximum contaminant levels (near the Idaho Chemical Processing Plant in 1981). Disp to the injection well and infiltration ponds at the Idaho Chemical Processing Plant elevated nitrate levels in the central portion of the site. By 1988 the levels of n below the maximum contaminant level. Irrigation in the Mud Lake area might be causi contaminants to enter the northeastern portion of the site in concentrations compar nearby irrigated areas (Orr et al. 1991; Robertson et al. 1974; Edwards et al. 1990

Organic Compounds - Concentrations of volatile organic compounds have been dete the aquifer beneath the site. However, many of these compounds were detected at amc detection limit (0.002 milligram per liter), or two parts per billion, which is the which a specific analytical method can detect a contaminant. However, concentration following compounds exceeding the maximum contaminant levels have occurred in and n Area North disposal well: carbon tetrachloride, chloroform, 1,2-cis-dichloroethylen 1,1 -dichloroethylene, 1 ,2-trans-dichloroethylene, trichloroethylene, tetrachloroe chloride (Leenheer and Bagby 1982; Mann and Knobel 1987; Mann 1990; Liszewski and M

**4.8.2.5.3 Perched Water Quality - Wastewater discharges from INEL operations have**

infiltrated into the vadose zone and created most of the perched water beneath the Studies have
detected elevated concentrations of the following contaminants in samples: tritium, cobalt-60, chromium, and sulfate concentrations in deep perched water near the Test strontium-90 in perched water near the Idaho Chemical Processing Plant and at Test (Irving 1993; Schafer-Perini 1993). DOE has not yet measured potential concentratic contaminants in all INEL perched water bodies. In general, the chemical concentrati size of these bodies have fluctuated over time in response to the volume of water ċ infiltration ponds.

## 4.8.3 Water Use and Rights

The INEL does not withdraw or use surface water for site operations, nor does i effluents to natural surface water. However, the three surface-water bodies at or n Little Lost Rivers and Birch Creek) have the following designated uses: agricultura cold-water biota, salmonid spawning, and primary and secondary contact recreation. waters in the Big Lost River and Birch Creek have been designated for domestic wate special resource waters.

Groundwater use on the Snake River Plain includes irrigation, food processing a

and domestic, rural, public, and livestock supply. Water use for the upper Snake Ri and the Snake River Plain Aquifer was 16.4 billion cubic meters (4.3 trillion gallc which was more than 50 percent of the water used in Idaho and approximately 7 perce agricultural withdrawals in the nation. Most of the water withdrawn from the Easter Plain [1.8 billion cubic meters (0.47 trillion gallons) per year] is for agricultur source of all water used at the INEL. Site activities withdraw water at an average cubic meters (1.9 billion gallons) per year (DOE-ID 1993e). However, the baseline a rate dropped to 6.5 million cubic meters (1.7 billion gallons) in 1995. The average is equal to approximately 0.4 percent of the water consumed from the Eastern Snake Aquifer, or 53 percent of the maximum annual yield of a typical irrigation well. Of water pumped from the aquifer, a substantial portion is discharged to the surface c eventually returned to it (DOE-ID 1993d,e).

A sole-source aquifer, as designated by the Safe Drinking Water Act (SDWA 1974) supplies 50 percent of the drinking water consumed in the area overlying the aquife aquifer areas have no alternative source or combination of sources that could physi economically supply all those who obtain their drinking water from the aquifer. Bec supplies 100 percent of the drinking water consumed within the Eastern Snake River Northwest 1988) and an alternative drinking water source or combination of sources the Environmental Protection Agency designated the Snake River Plain Aquifer a sole in 1991 (FR 1991b).

DOE holds a Federal Reserved Water Right for the INEL, which permits a water capacity of 2.3 cubic meters (80 cubic feet) per second and a maximum water consump 43 million cubic meters (11.4 billion gallons) per year for drinking, process water cooling. Because it is a Federal Water Right, the site's priority on water rights ć establishment of the INEL.

## 4.9 Ecological Resources

This section describes the biotic resources - flora, fauna, threatened and enda and wetlands - on the INEL site, which are typical of the Great Basin and Columbia Because the proposed actions are most likely to affect areas near existing major fa emphasizes the biotic resources in those areas. However, because the proposed acti other resources outside such areas (e.g., more mobile species like pronghorn, Antil it also describes biotic resources for the entire INEL site.

### 4.9.1 Flora

Vegetation on the INEL site is primarily of the shrub-steppe type and is a smal 45,000 square kilometers (111.2 million acres) of this vegetation type in the Inter 15 vegetation associations on the INEL site range from primarily shadscale-steppe v altitudes through sagebrush- and grass-dominated communities to juniper woodlands a of the nearby mountains and buttes (Rope et al. 1993; Kramber et al. 1992; Anderson associations can be grouped into six basic types: juniper woodland, grassland, shr consists of "sagebrush-steppe" and "salt desert shrubs"), lava, bareground-disturbe vegetation. Shrub-steppe vegetation, which is dominated by big sagebrush (Artemisi saltbush (Atriplex spp.), and rabbitbrush (Chrysothamnus spp.) covers more than 90 INEL. Grasses include cheatgrass (Bromus tectorum), Indian ricegrass (Oryzopsis hy wheatgrasses, (Agropyron spp.), and squirreltail (Sitanion hysterix). Herbaceous p (Phlox spp.), wild onion (Allium spp.), milkvetch (Astragalus spp.), Russian thistl various mustards. Work being conducted by Idaho State University will provide addi information on INEL plant communities and the status of sensitive plant species.

Facility and human-disturbed (grazing not included) areas cover only about 2 pe INEL. Introduced annuals, including Russian thistle and cheatgrass, frequently dom areas. These species usually are less desirable to wildlife as food and cover, anć desirable perennial native species. These disturbed areas serve as a seed source, potential for the establishment of Russian thistle and cheatgrass in surrounding le Vegetation inside facility boundaries is generally disturbed or landscaped. Specie INEL is comparable to that of like-sized areas with similar terrain in other parts West. Plant diversity is typically lower in disturbed and modified areas.

### 4.9.2 Fauna

The INEL site supports animal communities characteristic of shrub-steppe vegeta habitats. More than 270 vertebrate species occur, including 46 mammal, 204 bird, 1 amphibian, and 9 fish species (Arthur et al. 1984; Reynolds et al. 1986). Common s genera include mice (Reithrodontomys spp. and Peromyscus spp.), chipmunks (Tamias s jackrabbits (Lepus spp.), and cottontails (Sylvilagus spp.).

Songbirds and passerines commonly observed at the INEL include the American rok migratorius), horned lark (Eremophila alpestris), black-billed magpie (Pica pica), (Oreoscoptes montanus), Brewer's sparrow (Spizella breweri), sage sparrow (S. belli meadowlark (Sturnella neglecta), while resident upland gamebirds include the sage g (Centrocercus urophasianus), chukar (Alectoris chukar), and grey partridge (Perdix migratory bird species, which use the INEL for part of the year, include a variety [e.g., mallard (Anas platyrhynchos), northern pintail (Anas acuta), and Canada goos canadensis)] and raptors [e.g., Swainson's hawk (Buteo swainsoni), rough-legged haw and American kestrel (Falco sparverius)].

The most abundant big-game species that occurs on the INEL is the pronghorn, bu (Odocoileus hermonius), moose (Alces alces), and elk (Cervus elaphus) are present i as transients. Other large mammals observed on the INEL include the coyote (Canis common across the site, and the badger (Taxidea taxus) and bobcat (Felis rufus), bc present across the site but are much less abundant. Fish, including kokanee salmon nerka), rainbow trout (Oncorhynchos mykiss), and mountain whitefish (Prosopium will on the INEL only when the Big Lost River flows onto the site (as a result of heavy in the mountains to the northwest); they are not full-time residents.

A number of researchers have studied effects of radiation exposure from contami INEL on small mammals and birds, and have concluded that subtle sublethal effects ( growth rates and life expectancies) can occur in individual animals as a result of However, they can attribute no population or community-level impacts to such exposu Markham 1978; Evenson 1981; Arthur et al. 1986; Millard et. al 1990).

The monitoring of radionuclide levels outside the boundaries of the various INE off the INEL site has detected radionuclide concentrations above background levels and animals (Markham 1974; Craig et al. 1979; Markham et al. 1982; Morris 1993), bu data suggest that populations of exposed animals (e.g., mice and rabbits) as well a on these exposed animals (e.g., eagles and hawks) are not at risk.

### 4.9.3 Threatened, Endangered, and Sensitive Species

State and Federal regulatory agency lists (Lobdell 1992, 1995), the Idaho Depar Game Conservation Data Center list, and information from site surveys provided the identify Federal- and state-protected, candidate, and sensitive species that potent INEL. This information identified two Federal endangered (bald eagle, and peregrin Federal Category 2 candidate (white-faced ibis, northern goshawk, ferruginous hawk, long-eared myotis, small-footed myotis, pygmy rabbit, Townsend's western big-eared pointheaded grasshopper) species as animals that potentially occur on the INEL site Five animal species listed by the state as Species of Special Concern occur on the observations of the Federal- or state-listed animal species have occurred near any where proposed actions would occur. This analysis did not identify any Federal- or species as potentially occurring on the INEL site. Eight plant species identified agencies and the Idaho Native Plant Society as sensitive, rare, or unique occur on and Henderson 1984).

### 4.9.4 Wetlands

The U.S. Fish and Wildlife Service National Wetlands Inventory has identified m areas inside the boundaries of the INEL that might possess some wetlands characteri conducted in the fall of 1992 indicate that these possible wetlands cover about 1.4 kilometers or 8,206 acres) of the INEL site (Hampton et al. 1993). Approximately 7 possible wetlands areas occur near the Big Lost River and its spreading areas and p Birch Creek Playa, and in an area north of and in the general vicinity of Argonne N Laboratory-West. Limited riparian (riverbank) communities with mature trees along River (Reynolds 1993) reflect the intermittent flow in the river (1986 and 1993 wer with flow reported on the site). The remainder of the possible wetlands are scatte INEL site. In 1994, INEL began evaluating these potential wetlands to determine if

Corps of Engineers definition of jurisdictional wetlands (COE 1987). Approximately near facilities and are mostly manmade (e.g., industrial waste and sewage treatment pits, and gravel pits).

**Table 4.9-1.** Threatened and endangered species, special species of concern, and se

| | Name | Statusa |
|---|---|---|
| BIRDS | Northern goshawk (Accipiter gentilis) | C2, SSC, FS, E |
| | Burrowing owl (Athene cunicularia) | C2, BLM |
| | Ferruginous hawk (Buteo regalis) | C2, SSC, BLM |
| | Swainson's hawk (Buteo swainsoni) | BLM |
| | Great egret (Casmerodius albus) | SSC |
| | Merlin (Falco columbarius) | SSC, BLM |
| | Peregrine falcon (Falco peregrinus) | E |
| | Gyrfalcon (Falco rusticolus) | BLM |
| | Common loon (Gavia immer) | SSC, FS |
| | Bald eagle (Haliaeetus leucocephalus) | E |
| | Long-billed curlew (Numenius americanus) | SPS, BLM |
| | American white pelican (Pelecanus erythrorhynchos) | SSC |
| | White-faced ibis (Plegadis chihi) | C2 |
| MAMMALS | Merriam's shrew (Sorex merriami) | SPS |
| | Pygmy rabbit (Brachylagus (Sylvilagus) idahoensis) | C2, BLM, SSC |
| | California myotis (Myotis californicus) | SSC |
| | Fringed myotis (Myotis thysanodes) | SSC |
| | Western pipistrelle (Pipistrellus hesperus) | SSC, BLM |
| | Townsend's western big-eared bat (Plecotus townsendii) | C2, SSC, FS, E |
| | Long-eared myotis (Myotis evotis) | C2 |
| | Small-footed myotis (Myotis subulatus) | CS |
| PLANTS | Lemhi milkvetch (Astragalus aquilonius) | BLM, FS, INPS |
| | Painted milkvetch (Astragalus ceramicus var. apus) | 3c, INPS-M |
| | Winged-seed evening primrose (Camissonia pterosperma) | BLM, INPS-S |
| | Nipple cactus (Coryphantha missouriensis) | INPS-M |
| | Spreading gilia (Ipomopsis (Gilia) polycladon) | BLM, INPS-2 |
| | King's bladderpod (Lesquerella kingii var. cobrensis) | INPS-M |
| | Tree-like oxytheca (Oxytheca dendroidea) | INPS-S |
| | Sepal-tooth dodder (Cuscuta denticulata) | INPS-1 |
| INSECTS | Idaho pointheaded grasshopper (Acrolophitus pulchellus) | C2, BLM |

a. Key:

C2 = Federal Category 2 species. BLM = Bureau of Land Man
3c = No longer considered for Federal listing. FS = U.S. Forest Servic
E = Federal and state endangered species. INEL = Idaho National Eng
SSC= State species of special concern. SPS = State protected sp

## 4.10 Noise

The major noise sources at the INEL occur primarily in developed operational ar sources include facilities; equipment and machines (e.g., cooling towers, transform boilers, steam vents, paging systems, construction equipment, and materials-handlin aircraft; and bus, car, truck, and railroad traffic. At the INEL boundary, which i 3 kilometers (2 miles) from any facility, noise from most sources is barely disting background noise levels. Some disturbance of wildlife activities could occur at th noise from operational and construction activities. The State of Idaho and the cou INEL is located have not established any regulations that specify acceptable commun with the exception of prohibitions on nuisance noise.

Existing INEL-related noises of public significance are from the transportation materials to and from the site and in-town facilities via buses, trucks, private ve freight trains. During the normal workweek, most of the 4,000 to 5,000 employees w site (as opposed to those working in Idaho Falls) travel daily by buses from surrou (see Section 4.3). In addition, 300 to 500 private vehicles travel to the INEL sit communities each day (see Section 4.11). Noise measurements along U.S. Highway 20 15 meters (50 feet) from the roadway indicate that the sound level from traffic ran decibels, A-weighted (dBA) (Abbott et al. 1990), and that the primary source is bus While few people reside within 15 meters (50 feet) of the roadway, the results indi traffic noise might be objectionable to members of the public residing near princip bus routes. The acoustic environment along the INEL site boundary in rural areas a

away from traffic noise is typical of a rural location, with the day-night sound le range of 35 to 50 dBA (EPA 1974).

Public exposure to aircraft noise is due in part to INEL-related activities. A travel of INEL personnel via commercial air transport is a significant fraction of out of regional airports. Onsite INEL security patrol and surveillance flights do individuals off the site because of the INEL's remoteness. For INEL helicopter fli or terminate in Idaho Falls, members of the public are exposed to the unique noises aircraft. Because the number of flights per day is limited and most flights occur hours, public exposure to aircraft nuisance noise is not great.

Normally only one train per day serves the INEL, via the Scoville spur. Noise rail transport include those from diesel engines, wheel-track contact, and whistle crossings. Even with only one or two exposures to these sources per day, individua railroad tracks might find the noises mildly objectionable.

## 4.11 Traffic and Transportation

Roads are the primary access to and from the INEL site. Commercial shipments ar via truck and plane, some bulk materials are transported via rail, and waste is tra rail. This section discusses the existing traffic volumes, transportation routes, t and waste and materials transportation, including baseline radiological exposures f materials transportation. This section summarizes the information in Lehto (1993).

### 4.11.1 Roadways

#### 4.11.1.1 Infrastructure Regional and Site Systems. Figure 4.11 - 1 shows the existing

regional highway system. Two interstate highways serve the regional area. Interstat north-south route that connects several cities along the Snake River, is approximat (25 miles) east of the INEL site. 1-86 intersects 1-15 approximately 64 kilometers the INEL site, and provides a primary linkage from I-li to points west. 1-15 and US primary access routes to the Shoshone-Bannock reservation. US 20 and US 26 are the routes to the southern portion of the INEL site. Idaho State Routes 22, 28, and 33 northern portion of the INEL; State Route 33 provides access to the northern INEL s **Table 4.11-1 lists the baseline (1991) traffic for several of these access routes.** these segments is currently designated "free flow," which is defined as "operation virtually unaffected by the presence of other vehicles."

The INEL has developed an onsite road system of approximately 140 kilometers (8 paved surface, including about 29 kilometers (18 miles) of service roads that are c Most of the roads are adequate for the current level of normal transportation activ some increased traffic volume. DOE plans to reconstruct several deteriorating INEL 1950s that have been and will continue to be used to transport heavier-than-normal

#### 4.11.1.2 Infrastructure Idaho Falls. Approximately 4,000 DOE and contractor personnel

administer and support INEL work at offices in Idaho Falls. DOE shuttle vans provic transport between in-town facilities. One of the busiest intersections is Science C Fremont Avenue, which serves Willow Creek Building, Engineering Research Office Bui
Figure 4.11-1. Transportation routes in the vicinity of the INEL. (not available in
Table 4.11-1. Baseline traffic for selected highway segments. Electronic Techno
weekday hours, but it is designed for the current traffic.

#### 4.11.1.3 Transit Modes. Four major modes of transit use the regional highways, community

streets, and INEL site roads to transport people and commodities: DOE buses and shu motor pool vehicles, commercial trucks, and personal vehicles. Table 4.11-2 summari miles for INEL-related traffic.

Table 4.11-2. Baseline annual vehicle miles traveled for Idaho National Engineeri

### 4.11.2 Railroads

Figure 4.11-1 shows the Union Pacific Railroad lines in southeastern Idaho. Ida railroad freight service from Butte, Montana, to the north, and from Pocatello and the south, The Union Pacific Railroad's Blackfoot-to-Arco branch, which crosses the of the INEL, provides rail service to the site for the shipment of spent nuclear fu bulk commodities, and radioactive materials. This branch connects with a DOE-owned Scoville Siding, then links with developed INEL areas. Table 4.11-3 lists rail ship Years 1988 through 1992.

Table 4.11-3. Loaded rail shipments to and from the Idaho National Engineering La

### 4.11.3 Airports and Air Traffic

Commercial airlines provide Idaho Falls with jet aircraft passenger and cargo s commuter service to both the Idaho Falls and Pocatello airports. In addition, local available in Idaho Falls, and private aircraft use the major airport and many other Total landings at the Idaho Falls airport for 1991 and 1992 were 5,367 and 5,598, r Idaho Falls and Pocatello airports collectively record nearly 7,500 landings annual

Non-DOE air traffic over the INEL site is limited to altitudes greater than 305 (1,000 feet) over buildings and populated areas, and non-DOE aircraft are not permi The primary air traffic at the INEL site is DOE helicopters, which are used for sec purposes. These helicopters have specific operations stations and duties.

### 4.11.4 Accidents

From 1987 through 1992, the average motor vehicle accident rate was 0.94 accident kilometers (1.5 accidents per million miles) for INEL vehicles, which compares with of 1.5 accidents per million kilometers (2.4 accidents per million miles) for all I and 8 accidents per million kilometers (12.8 accidents per million miles) nationwic vehicles (Lehto 1993). There are no recorded rail or air accidents associated with date, no fatal air traffic accidents have involved flights through either the Idahc airports.

### 4.11.5 Transportation of Waste, Materials, and Spent Nuclear Fuel

Hazardous, radioactive, industrial commercial, and recyclable wastes are transp site. Federal and State regulations and requirements govern the transportation of h radioactive materials (Lehto 1993). Hazardous materials include commercial chemical hazardous wastes that are nonradioactive; they are regulated and controlled based c toxicity. Onsite spent nuclear fuel comes from Argonne National Laboratory - West, Reactors Facility, and the Advanced Test Reactor; it is transported by truck to var and research and development facilities.

This assessment used six years of data (1987 through 1992) to establish a baseli doses from incident-free, onsite total nonnaval spent nuclear fuel transportation a **Table 4.11-4 lists the results in terms of cumulative doses (1995-2035) and health** do not include onsite naval shipments, which are assessed in Attachment A to Appenc Volume 1 of this ElS. The baseline includes no offsite shipments, which are address Appendixes D and I.

Table 4.11-4. Cumulative dose and cancer fatalities from incident-free onsite shi

## 4.12 Occupational and Public Health and Safety

### 4.12.1 Radiological Health and Safety

DOE Order 5480.11, "Radiation Protection for Occupational Workers" (DOE 1992b), radiation dose that INEL workers can receive to 5 rem per year; administrative cont worker dose to 2 rem per year, except under unusual circumstances. In addition, DC a comprehensive program, known as ALARA (As Low As Reasonably Achievable), to ensur reduction of occupational doses to the extent practicable.

The largest fraction of the occupational dose received by INEL workers is from

radiation. Internal radiation doses constitute a small fraction of the occupationa could receive annual external radiation exposures with measured doses greater than thermoluminescent dosimeter that they must wear at all times during work on the sit recorded doses for 1987 to 1991 as a baseline for routine site operations for this period, the INEL monitored about 6,000 workers annually for radiation exposure. Ab those individuals received measurable radiation doses. Monitoring reports indicate 1991, 20 individuals (most of whom were maintenance and construction workers employ M-K Ferguson at the Idaho Chemical Processing Plant) received annual doses larger t (4 individuals in 1987, 1 in 1989, and 15 in 1990).

From 1987 to 1991, the average occupational dose to individuals who had receive doses was 0.156 rem per year, resulting in an average collective dose (the number c workers receiving measurable doses was about 32 percent or 1,920) of about 300 pers resulting number of expected excess latent cancer fatalities would be less than 1 f operation.

This analysis based the doses to the maximally exposed individual and offsite p baseline radioactive concentrations associated with normal operations. The baselin maximally exposed individual is 5.6 y 10-2 millirem, which corresponds to a latent probability of 2.8 y 10-8. The baseline population dose is 7.0 y 10-2 person-rem w a latent fatal cancer incidence of less than 1 (4 y 10-5) annually and less than 1 40 years.

## 4.12.2 Nonradiological Exposure and Health Effects

DOE used the air quality data in Table 4.7-2 to evaluate health impacts associa exposure to two compound classes: criteria pollutant and toxic. This analysis has on air emissions only, and not water pathways, because none of the alternatives wou discharge of pollutants to surface waters or the subsurface. Table 4.7-2 lists 5 c 26 toxic compounds. The classification of two of the toxic compounds (benzene and carcinogens was consistent with EPA designations published in the Integrated Risk I (IRIS) data base (DOE 1991b). However, this data base does not include sufficient quantitative inhalation cancer risk assessment.

To obtain a hazard index, this analysis evaluated toxic and criteria pollutant effects by adding hazard quotients for each compound. The EPA Risk Assessment Guid Superfund (EPA 1989) describes this approach. The hazard quotient is the ratio of concentration or dose to a Reference Concentration (RfC) or Dose (RfD). For compou listed Reference Concentration or Dose values, the analysis used appropriate State The use of the noncancer hazard index assumes a level of exposure (standard) below health effects would be unlikely. The hazard index is not a statistical probabilit be interpreted as such.

This analysis based toxic and criteria pollutant compound hazard index values f exposed individual on the maximum concentrations for the compounds at the INEL site public access roads inside the INEL site boundary, and the Craters of the Moon Wild Because the hazard index for criteria pollutants is less than 1, no adverse health from routine operations for either workers or the maximally exposed individual. Be index for toxic pollutants exceeds 1, the potential for carcinogenic health risks c varying spacial and temporal distributions of the concentrations of individual air unlikely that any individual would be exposed to all the pollutants all the time. hazard indices for the toxic compounds are less than 1, adverse health effects are

## 4.12.3 Occupational Health and Safety

Total injury and illness incidence rates at the INEL varied from an annual aver 4.9 per 200,000 work hours from 1987 to 1991. During this time, total lost workday from a low of 1 per 200,000 work hours in 1988 and 1989 to a high of 2.6 per 200,00 1991. The rates appear higher for 1991 because of a 1990 change in reporting requi injuries and illnesses. INEL rates for 1987 to 1989 are below overall DOE rates (2 illness incidence and 1.4 total lost workday cases per 200,000 work hours) and Bure Statistics rates (8.5 total injury and illness incidence and 4.0 total lost workday hours). For 1990 and 1991, INEL rates are slightly above overall DOE rates, but be Labor Statistics rate.

There were 1,337 total recordable injury and illness cases at the INEL from 198 average of 8,385 employees working 79,654,000 hours. Of these cases, 114 (8.5 perc

occupational illnesses, of which 48 percent were repeated trauma disorders and 30 p classified as skin diseases or disorders. One fatality occurred at the INEL betwee when an employee was struck and killed by a forklift.

## 4.13 Idaho National Engineering Laboratory Services

This section discusses water, electricity, fuel capacities and consumption, was and security and emergency protection at INEL facilities.

### 4.13.1 Water Consumption

A system of about 30 wells, with pumps and storage tanks, provides the water su INEL site. Because of the distance between site facility areas, the water supply s facility is independent. The site uses no natural surface water. The City of Idah system, which includes about 16 wells, provides water to DOE and contractor facilit

A Water Rights Agreement between DOE and the State of Idaho regulates groundwat the INEL site. Under this agreement, INEL has claim to 2,300 liters per second (36 minute) of groundwater, not to exceed 43 billion liters (11 billion gallons) per ye has not measured the total pumping rate from the aquifer, which would depend on the pumps operating. There is a slight possibility that the site could exceed the regu very short periods, such as during recovery from an extended power outage when many run to refill depleted storage tanks.

The average INEL site water consumption from 1987 through 1991 was 7.4 billion (1.9 billion gallons) per year, based on the cumulative volumes of water withdrawn (Teel 1993). The projected baseline usage for 1995 will be about 6.5 billion liter gallons). The estimated average water consumption of Idaho Falls facilities is 300 (80 million gallons) per year.

### 4.13.2 Electricity Consumption

The Antelope substation supplies commercial electric power to the INEL site thr to the Federally owned Scoville substation. The Scoville substation supplies elect the INEL electric power distribution system (Teel 1993). The contract with Idaho P supply electric power to the INEL site provides "up to 45,000 kilowatts monthly" at (IPC/DOE 1986). Hydroelectric generators along the Snake River in southern Idaho a and Valmy coal-fired thermal electric generation plants in southwestern Wyoming and Nevada, respectively, generate the electric power supplied by Idaho Power. The Exp Reactor-II can also provide approximately 12 to 15 megavolt-amperes of capacity for power loop (Teel 1993).

The rated capacity of the INEL site power transmission loop line is 124 megavol peak demand on the system from 1990 through 1993 was about 40 megavolt-amperes, and usage was slightly less than 217,000 megawatt-hours per year (Teel 1993). This usa decrease by about 4 percent by 1995.

The INEL facilities in Idaho Falls receive electric power from the City of Idah operates four hydroelectric power generation plants on the Snake River along with s distribution facilities. The Bonneville Power Administration, which operates hydro the Columbia River system, supplies supplemental power to the City of Idaho Falls. Falls facilities used 31,500 megawatt-hours of electricity (Teel 1993).

### 4.13.3 Fuel Consumption

Fuels consumed at the INEL site include several liquid petroleum fuels, coal, a fuels are transported to the site for storage and use. Natural gas is the only rep the INEL Idaho Falls facilities; the Intermountain Gas Company provides this fuel t underground lines (Teel 1993).

The average annual fuel consumption at the INEL site from 1990 through 1993 was fuel oil, 10,578,000 liters (2,795,000 gallons); diesel fuel, 5,690,000 liters (1,5 propane gas, 568,000 liters (150,000 gallons). The INEL also uses about 8,200 metr (9,000 tons) of coal. Fuel storage is provided at each facility and inventories ar necessary. No fossil fuel shortage has ever occurred at the INEL site (Teel 1993).

### 4.13.4 Wastewater Disposal

Sanitary wastewater systems at the smaller onsite facility areas consist primar and drain fields. The larger areas, such as Central Facilities Area, Idaho Chemica and Test Reactor Area, have wastewater treatment facilities. The City of Idaho Fal treatment system serves the Idaho Falls facilities (Teel 1993).

The average annual wastewater discharge volume at the INEL site from 1989 throu 537 million liters (142 million gallons). The wastewater from DOE and contractor-c in Idaho Falls is not metered but is estimated to be 300 million liters (80 million The primary causes of the difference between water pumped and estimated wastewater evaporation from ponds and cooling towers, irrigation of landscaped areas, and disc wastewater (Teel 1993). Some industrial wastewater, such as steam condensate, is a evaporation ponds and injection wells.

### 4.13.5 Security and Emergency Protection

This section describes the fire protection and prevention, security, and emerge resources for the INEL site and the surrounding areas. This discussion includes th Department, DOE and INEL Emergency Preparedness, and DOE and INEL Security. DOE es an Emergency Management System that incorporates all applicable requirements for em planning, preparedness, and response at the INEL. Each INEL facility must prepare Plan that contains detailed contingency plans and emergency procedures.

**4.13.5.1 DOE Fire Department. The contractor-operated Fire Department staffs and operates**

three fire stations on the INEL that support the entire site. Each station has the expertise to respond to explosions, fires, spills, and medical emergencies. These north end at Test Area North, at Argonne National Laboratory-West, and at the Centr Each station has a minimum of one engine company capable of supporting any fire eme assigned area. The Fire Department has a staff of 44 firefighters and 11 support p operates with a minimum critical staff of 7 firefighters at any time. In addition firefighting services, the Fire Department provides the INEL ambulance, emergency m (EMT), and hazardous material response services. The Fire Department has mutual ai with other firefighting organizations, such as the Bureau of Land Management and th Falls, Blackfoot, and Arco. Through these agreements, the Idaho Falls Fire Departm facilities in the City of Idaho Falls.

**4.13.5.2 DOE and INEL Emergency Preparedness. Each DOE INEL contractor**

administers and staffs its own emergency preparedness program under the direction a DOE. All contractor programs for emergency control and response are compatible. T Communication Center is in the DOE Headquarters building and staffed by the INEL pr with DOE oversight; it is the communication and overall control center for support commanders in charge of an emergency response. The DOE emergency preparedness syst mutual aid agreements with all regional county and major city fire departments, pol facilities. Through the agreements, the Idaho Falls emergency preparedness organiz facilities in the City of Idaho Falls.

**4.13.5.3 DOE and INEL Security. DOE has oversight responsibility for safeguards and**

security at the INEL. The security program has three categories: security operati security, and safeguards. The security operations division provides asset protecti special nuclear material, facilities, and personnel) and technical security (comput Under this category, DOE administers the INEL protective force, which is supplied b personnel security staff processes personnel security clearances. The safeguards d responsible for the management and accountability of special nuclear materials. Th force, consisting of 200 armed guards and 350 support personnel, provides the onsit administer the programs. Each INEL contractor has a safeguards and security staff, similar manner, to manage the security associated with its facilities. Contractor

security staffs range from about 5 to 60 persons, depending on the size and complex associated facilities. Each staff works with the INEL protective forces.

## 4.14 Materials and Waste Management

This section summarizes the management of materials and wastes (high-level, tra low-level, low-level, hazardous, industrial and commercial solid wastes and hazardc INEL and Idaho Falls facilities, and presents an overview of the current status of types generated, stored, and disposed at the INEL.

The total amount of waste generated and disposed has been reduced through waste and treatment. The INEL attains waste minimization by reducing or eliminating wast recycling, and by reducing the volume, toxicity, or mobility of waste before storag addition, the site has achieved volume reduction of radioactive wastes through more surveying, waste segregation, and use of administrative and engineering controls.

The quantitative data presented in this section are from Volume 2 of this EIS, noted.

### 4.14.1 High-Level Waste

At present, about 11,900 cubic meters (4,970 cubic yards calcine solid and 2,14 liquid) of high-level waste are in storage at the INEL Idaho Chemical Processing Pl for locations of major waste management facilities). This facility blends liquid w aluminum and zirconium wastes from past spent nuclear fuel reprocessing, and sodium and processes them through calcination to produce a granular calcine solid. Becaus termination of reprocessing, the site no longer generates liquid high-level waste, high-level waste residues. Liquid high-level wastes generated by prior reprocessin solidified at the site. At present, the site generates liquid waste that is not di reprocessing. The site manages this liquid as high-level waste. The site will cal high-level waste that does not contain sodium, and as much sodium-bearing high-leve practicable by January 1, 1998, in accordance with the Amended Order Modifying Orde 1993, United States District Court for the District of Idaho, December 22, 1993. T baseline for high-level waste generation is 750 cubic meters (980 cubic yards) annu

### 4.14.2 Transuranic Waste

About 65,000 cubic meters (85,000 cubic yards) of transuranic and alpha-contami wastes are retrievably stored and 62,000 cubic meters (81,000 cubic yards) of trans (Morton and Hendrickson 1995) have been buried at the Radioactive Waste Management the INEL. At present, no facilities can dispose of transuranic waste; however, DOE to retrieve, repackage, certify, and ship stored transuranic wastes at the INEL to repository for final disposition. DOE has not determined the disposition of alpha-level waste and buried waste. Since the October 1988 ban by the State of Idaho prc of transuranic waste to the INEL, DOE has shipped only minor amounts of transuranic generated on the site to the INEL Radioactive Waste Management Complex for interim present, there are no treatment facilities for transuranic wastes at the INEL. The baseline for transuranic waste generation is 6 cubic meters (8 cubic yards) annuall

### 4.14.3 Mixed Low-Level Waste

At present, DOE accepts only mixed low-level waste generated at the INEL for tr disposal at the INEL. DOE stores mixed low-level waste generated at the INEL at in facilities until treatment systems become available or operational. A total of 1,8 (2,400 cubic yards) of mixed low-level waste interim storage capacity is available Current mixed low-level waste interim storage is approximately 1,100 cubic meters ( yards). Treatment technologies exist for much of the mixed low-level waste generat and waste minimization eliminates potential sources of mixed low-level waste before projected 1995 baseline for mixed low-level waste is 525 cubic meters (687 cubic ya (EG&G 1993).

### 4.14.4 Low-Level Waste

Through 1991, DOE disposed of 145,000 cubic meters (190,000 cubic yards) of low at the Radioactive Waste Management Complex. In 1991, the total available low-leve capacity at the complex was 37,000 cubic meters (48,000 cubic yards). DOE has curt waste treatment since 1991 while waiting for updated safety documentation and an en impact assessment for the Waste Experimental Reduction Facility. The INEL stores l awaiting treatment on asphalt or concrete pads at the Waste Experimental Reduction radioactive waste storage containers at the generating facilities. The projected 1 level waste generation is 4,270 cubic meters (5,585 cubic yards) annually (EG&G 199

### 4.14.5 Hazardous Waste

DOE collects hazardous waste generated at the INEL and stores it temporarily at Waste Storage Facility before shipping it off the site. The Hazardous Waste Storag adequate storage capacity [approximately 64 cubic meters (84 cubic yards)] to manag hazardous waste generated at the INEL. The site recycles, reuses, or reprocesses s possible, and might replace some hazardous substances with nonhazardous substances.

### 4.14.6 Industrial/Commercial Solid Waste

DOE disposes of the industrial and commercial solid waste generated at the site Landfill Complex at the Central Facilities Area. The Landfill Complex has approxin 910,000 square meters (225 acres) of land available for solid waste disposal, inclu area at Landfill III, which is currently in use. The estimated capacity of the INE will be sufficient to dispose of INEL waste for 30 to 50 years; however, capacity c excavations will be filled by 1998. DOE has proposed expanding the excavation. Vc EIS describes the landfill expansion project. The industrial and commercial solid currently in use is in a 48,000-square-meter (12-acre) gravel pit area north of Dis does not expect to store solid waste intended for disposal. Waste segregation occu facility so recyclable materials do not enter the solid waste stream. The average waste disposed at the Central Facilities Area landfill from 1988 through 1992 was a 52,000 cubic meters (68,000 cubic yards) (also the projected 1995 baseline) (EG&G 1

### 4.14.7 Hazardous Materials

The INEL 1993 chemical inventory lists 774 hazardous chemicals. The number anc weight of hazardous chemicals used on the site and at individual facilities change use. The annual Superfund Amendments and Reauthorization Act reports for the INEI include year-to-year inventories.

# 5. ENVIRONMENTAL CONSEQUENCES

## 5.1 Overview

This chapter discusses the potential environmental consequences for each spent management alternative described in Chapter 3. The U.S. Department of Energy (DOE) environmental consequence analyses of nonnaval spent nuclear fuel management from V input for this chapter; however, DOE made necessary adjustments to accommodate the between Volume 1 and Volume 2 alternatives. In addition, DOE adjusted the 10-year horizon for Volume 2 alternatives to 40 years for Volume 1.

As described in Chapter 1, this chapter analyzes only nonnaval DOE actions; how Section 5.16, "Cumulative Impacts and Impacts from Connected or Similar Actions," i from the Naval Nuclear Propulsion Program and nonnaval DOE impacts that are cumulat Appendix B restriction of analysis to nonnaval actions results in Alternative 2 (op becoming a single alternative.

Chapter 5 addresses potential impacts from construction and normal operations f

of the affected environment described in Chapter 4. In addition, it provides poten from accidents and several types of summary information. In cases where the conseq does not result in a distinction among the alternatives, this chapter describes the division by alternative to avoid needless repetition. Tables 3-4 through 3-6 in Se and compare the potential impacts associated with each alternative.

## 5.2 Land Use

Alternatives 1, 2, 4b(2), and 5a [No Action, Decentralization, Regionalization (Elsewhere), and Centralization at other DOE sites] would have the least impact on 0.8 acre (0.003 square kilometer); Alternatives 4b(1) [Regionalization by Geography 5b (Centralization at the INEL) would result in the greatest changes, impacting nea (0.12 square kilometer).

Overall environmental impacts on land use by any of the alternatives would be s DOE would build new facilities in developed areas that it has already dedicated to that previous activities have disturbed. Under all the alternatives, proposed acti consistent with the existing land use plans discussed in Section 4.2 and would be s existing developed areas on the site. None of the proposed activities would involv INEL boundaries, and no effects on surrounding land uses or local land use plans sh

No onsite land use restrictions due to Native American treaty rights would exis alternatives described in this EIS. Potential impacts on Native American and other are discussed in Section 5.4 (Cultural Resources) and in Appendix L (Environmental

## 5.3 Socioeconomics

This section describes the potential effects of the spent nuclear fuel alternat socioeconomic resources of the region of influence described in Section 4.3. Table list proposed changes in the INEL-related workforce and population. Figure 5.3-1 s proposed changes.

### 5.3.1 Methodology

This section addresses socioeconomic impacts in terms of both direct and seconc and population effects. Direct effects are changes in INEL employment that DOE exp under each alternative and include construction and operations phase impacts. Secc include indirect and induced impacts. Indirect effects are impacts to regional bus employment resulting from changes in DOE regional purchases or nonpayroll expenditu effects are impacts to regional businesses and employment that result from changes by affected INEL employees. The total economic impact to the region is the sum of secondary effects.

The bases for the estimated direct impacts in this section are project summary developed in cooperation with INEL contractors. Employment impacts represent actua INEL staffing; they do not include changes in staffing due to a reassignment of the workforce. The projected decline in baseline INEL activity is not part of any alte a comprehensive analysis of potential impacts was not included. Projected declines employment are presented in Figure 5.3-1 in order to provide the reader with a fran evaluating potential employment and population impacts. This assessment used RIMS total employment impacts with multipliers that the U.S. Bureau of Economic Analysis specifically for the INEL region of influence. A comprehensive discussion of the n provided in Appendix F-1 of Volume 2. Cumulative impacts on socioeconomic resource region are discussed in Section 5.16.

**Table 5.3-1.** Estimated changes in employment and population for Alternatives 3, 4a 1995 - 2004.

| Factor | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 200 |
|---|---|---|---|---|---|---|---|---|---|
| Direct employment | 0 | 0 | 0 | 0 | 250 | 250 | 375 | 375 | 375 |
| Secondary employment | 0 | 0 | 0 | 0 | 352 | 352 | 528 | 528 | 528 |
| Total employment change | 0 | 0 | 0 | 0 | 602 | 602 | 903 | 903 | 903 |
| Change in ROIb labor force (%) | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.5 | 0.8 | 0.8 | 0.8 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Change in ROI employment (%) | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.6 | 0.8 | 0.8 | 0.8 |
| Population change | 0 | 0 | 0 | 0 | 2,027 | 2,027 | 3,040 | 3,040 | 3,0 |
| Change in ROI population (%) | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.8 | 1.1 | 1.1 | 1.1 |

a. Sources: Johnson (1995); USBEA (1993); USBC (1992).
b. ROI = region of influence.

**Table 5.3-2.** Estimated changes in employment and population for Alternatives 4b(2) 1995 - 2004.

| Factor | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 200 |
|---|---|---|---|---|---|---|---|---|---|
| Direct employment | 50 | 50 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Secondary employment | 70 | 70 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total employment change | 120 | 120 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Change in ROIa labor force (%) | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Change in ROI employment (%) | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Population change | 405 | 405 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Change in ROI population (%) | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

a. Sources: Johnson (1995); USBEA (1993); USBC (1992).
b. ROI = region of influence.

## 5.3.2 Alternatives 1 and 2 - No Action and Decentralization

Activities associated with Alternatives 1 and 2 would not result in any addition operations jobs at the INEL; therefore, implementation of either of these alternati impact on socioeconomic resources in the region of influence.

## 5.3.3 Alternatives 3, 4a, 4b(1), and 5b - 1992/1993 Planning Basis, Regionalization by Fuel Type,

Regionalization by Geography (INEL), and Centralization at the INEL

### 5.3.3.1 Construction. As listed in Table 5.3-1, construction employment under these

alternatives would peak during the period from 2001 to 2004 with approximately 375 jobs per year. When added to the estimated 528 indirect jobs, the total employment region would be an addition of approximately 903 jobs. Employment would decline tc

Based on historic data, approximately 97 percent of the new employees who would would live in the seven-county region of influence. As listed in Table 5.3-1, if a were filled by in-migrants to the region, there would be a 0.8-percent increase in force and in regional employment during the peak years. These changes would be min have no adverse impacts on socioeconomic resources in the region. In fact, althoug implementation of any of these alternatives would result in an increase over projec levels, as shown in Figure 5.3-1, there would be an overall decline in employment f 1995 levels.

Assuming each new employee represented one household and 3.47 persons per househ would be a corresponding increase in regional population levels of 1.1 percent (app 3,000 people). Given this minor change in population, DOE expects potential impact for community resources and services such as housing, schools, police, health care, to be negligible.

### 5.3.3.2 Operations. Activities associated with Alternatives 3, 4a, 4b(1), and 5b would not

require any additional operations jobs at the INEL. Therefore, the implementation alternatives would have no impact on socioeconomic resources in the region of influ

### 5.3.4 Alternatives 4b(2) and 5a - Regionalization by Geography (Elsewhere) and Centralization at Other

DOE Sites

**5.3.4.1 Construction. As listed in Table 5.3-2, construction employment under these**

alternatives would peak during the period from 1995 to 1996 with approximately 50 a jobs per year. When added to the estimated 70 indirect jobs, the total employment region would be approximately 120 jobs. Employment after 1996 would drop to zero.
Figure 5.3-1. INEL employment by SNF alternative relative to site employment prc
Based on historic data, approximately 97 percent of the new employees who would would live in the seven-county region of influence. As listed in Table 5.3-2, if a were filled by in-migrants to the region, there would be a 0.1-percent increase in force and in regional employment levels during the peak years. These changes woulc would have no adverse impacts on socioeconomic resources in the region. In fact, a implementation of any of these alternatives would be an increase over projected emp from 1995 to 1996, as shown in Figure 5.3-1, there would be an overall decline in e projected 1995 levels.

Assuming each new employee represented one household and 3.47 persons per househ would be a corresponding increase in regional population levels of 0.2 percent (app 400 people). Given this minor change in population, DOE expects potential impacts for community resources and services such as housing, schools, police, health care, to be negligible.

**5.3.4.2 Operations. Activities associated with Alternatives 4b(2) and 5a would not result in**

any additional operations jobs at the INEL. Therefore, the implementation of eithe alternatives would have no impact on socioeconomic resources in the region of influ

## 5.4 Cultural Resources

This section summarizes the potential impacts of spent nuclear fuel management cultural resources at the INEL site.

This assessment evaluated both direct and indirect impacts due to the proposed the INEL, direct impacts to archaeological resources usually would be those associa disturbance from construction activities. Direct impacts to existing historic stru demolition, modification, deterioration, isolation from or alteration of the charac setting; or introduction of visual, audible, or atmospheric elements out of charact property's setting. In addition, indirect impacts to archaeological resources coul overall increase in activity at the INEL, which could bring a larger workforce clos sites. Direct impacts to traditional resources could occur through land disturbanc changes to the environmental settings of traditional use and sacred areas. Impacts pollution, noise, and contamination that could affect the traditional hunting and g visual or audible settings of sacred areas.

The potential for adverse impacts on cultural resources would be the least unde 2, 4b(2), and 5a, which would disturb approximately 0.8 acres (0.003 square kilomet would be minor because surveys of the area to be disturbed found no eligible cultur (Reed et al. 1986; DOE 1993a).

The potential for adverse impacts on cultural resources would be similar under 4b(1), and 5b with the greatest potential under Alternatives 4b(1) and 5b [Regional Geography (INEL) and Centralization at the INEL], which would involve the disturban acres (0.12 square kilometer). Again, impacts would be minimal because surveys of disturbed area found no eligible cultural resources (Reed et al. 1986). Under thes proposed modifications at the Idaho Chemical Processing Plant facilities could adve historically significant structures and could require consultation with the Idaho S Preservation Office (Braun et al. 1993).

The Shoshone-Bannock Tribes are also concerned with the potential impact to imp American resources from changes in the visual setting, noise, air quality, or water

activities associated with spent nuclear fuel management would take place within ex currently engaged in similar activities, DOE does not expect any impacts to importa American resources from alteration of the visual setting or noise associated with i any of the alternatives. There could be temporary, minor impacts on air quality fr associated with construction activities. Emissions of radionuclides to the air unc would be minor and would be well below applicable standards and guidelines. Under operating conditions, radioactive discharges to the soil or directly to the aquifer

DOE would minimize the potential for direct and indirect adverse impacts on tra resources from pollution, noise, and contamination through compliance with applicab Federal laws and regulations. Impact avoidance and other mitigation measures for c are described in Section 5.20.2.

## 5.5 Aesthetic and Scenic Resources

None of the alternatives for spent nuclear fuel management at the INEL would ha consequences on scenic resources or aesthetics because DOE would confine the propos developed areas. Although the construction of the proposed facilities would produc could temporarily affect visibility, the INEL would follow standard construction pr both erosion and dust generation. Facility operations under each alternative would emissions to the atmosphere that would impact visibility.

## 5.6 Geology

This section discusses the potential effects of the spent nuclear fuel manageme geologic resources at the INEL site.

Proposed INEL spent nuclear fuel management activities would only have minor lc impacts on the geology of the site for all the alternatives. Direct impacts to gec site would be associated with the disturbance or extraction of surface deposits to facilities. These impacts could include excavations into the soil and rock of the and banking, and the extraction of aggregate materials from gravel and borrow pits Table 5.6-1 lists estimated extractions of aggregate from site gravel pits for all **fuel, environmental restoration, and waste management projects.** These values serve spent nuclear fuel project usage.

A secondary impact to geological resources from construction activities would b for increased soil erosion. DOE would minimize any potential soil erosion by the u Management Practices designed to control stormwater runoff and slope stability.

**Table 5.6-1.** Estimated INEL gravel/borrow use (cubic meters). ,b

| Alternative | | Estimated Gravel/Borrow Use |
|---|---|---|
| 1. | No Action | 158,000 |
| 2. | Decentralization | 158,000 |
| 3. | 1992/1993 Planning Basis | 392,000 |
| 4a. | Regionalization by Fuel Type | 392,000 |
| 4b(1) | Regionalization by Geography (INEL) | 1,772,000 |
| 4b(2) | Regionalization by Geography (Elsewhere) | 296,000 |
| 5a. | Centralization at other DOE Sites | 296,000 |
| 5b. | Centralization at the INEL | 1,772,000 |

a. Source: EG&G (1994).

b. To convert cubic meters to cubic yards, multiply by 1.31.

## 5.7 Air Quality and Related Consequences

This section describes the potential nonradiological and radiological impacts t associated with each alternative. The term "baseline concentrations" is defined as concentrations resulting from potential emissions from current operations and those planned upgrades or modifications that DOE would construct or operate prior to any actions described in this EIS. Additional information is provided in Section 5.7 a Volume 2.

### 5.7.1 Alternative 1 - No Action

**5.7.1.1 Nonradiological Air Quality. Construction activities associated with this alternative**

would be limited to upgrading an existing facility. Potential impacts to air quali activities would include fugitive dust and exhaust emissions from support equipment the impacts from construction using the EPA Fugitive Dust Model (FDM) (Winges 1992) modeling results showed that the expected construction-related air quality impacts and highly localized.

Minimal spent nuclear fuel activities would occur under this alternative. Ther that the ambient concentrations levels from normal operations would be similar to t **Table 4.7-1 lists nonradioactive emissions from normal operations.** Tables 5.7-1 an maximum potential concentrations for the proposed alternatives; they are all below standards and guidelines. Ambient concentrations from Alternative 1 activities wil applicable standards and guidelines.

**5.7.1.2 Radiological Air Quality. No radiological impacts to the environment would result**

from construction activities.

No additional facilities that would be in operation for this alternative would emissions. Therefore, for normal operations, doses to the maximally exposed indivi population, and workers would be equivalent to baseline doses, as listed in Table 5 lists associated emission rates.

**Table 5.7-1.** Maximum impacts to nonradiological air quality from spent nuclear fue pollutants. ,b

| Pollutant | Averaging time | Applicable standard (-g/m3) | Maximum baseline concentration (-g/m3) | Baseline plus maximum alternativec (-g/m3) |
|---|---|---|---|---|
| Carbon monoxide | 1-hr | 40,000 | 610 | 610 |
| | 8-hr | 10,000 | 280 | 280 |
| Nitrogen dioxide | Annual | 100 | 4 | 4 |
| Lead | Quarterly | 1.5 | 0.001 | 0.001 |
| Particulate matter (PM10) | 24-hr | 150 | 80 | 80 |
| | Annual | 50 | 5 | 5 |
| Sulfur dioxide | 3-hr | 1,300 | 580 | 580 |
| | 24-hr | 365 | 140 | 140 |
| | Annual | 80 | 6 | 6 |

a. Source: Section 5.7 of Volume 2 of this EIS and Belanger et al. (1995).
b. Listed concentrations are the maximum of those calculated at the INEL site bounc inside the INEL site boundary, and the Craters of the Moon Wilderness Area.
c. The listed concentrations are the maximums for any of the proposed alternatives.

**Table 5.7-2.** Maximum impacts to nonradiological air quality from spent nuclear fue pollutants. ,b

| Pollutant | Averaging time | Applicable standard (-g/m3) | Maximum baseline concentration (-g/m3) | Impact from maximum alternativec (-g/m3) |
|---|---|---|---|---|
| Ammonia | Annual | 1.8y102 | 6.0y100 | 1.8y100 |
| Benzene | Annual | 1.2y10-1 | 2.9y10-2 | 2.3y10-2 |
| Formaldehyde | Annual | 7.7y10-2 | 1.2y10-2 | 4.4y10-2 |
| Methyl isobutyl ketone | Annual | 2.1y103 | (e) | 2.6y101 |
| Hydrofluoric acid | Annual | 2.5y101 | (e) | 1.8y10-2 |
| Tributylphosphate | Annual | 2.5y101 | (e) | 6.1y10- -2 |

a. Source: Section 5.7 of Volume 2 of this EIS and Raudsep (1995).
b. Listed concentrations are the maximum of those calculated at the INEL site bounc inside the INEL site boundary, and the Craters of the Moon Wilderness Area.
c. The listed concentrations are the maximums for any of the proposed alternatives, sources expected to become operational after May 1, 1994.
d. In accordance with State of Idaho regulations for toxic air pollutants, the perc based on concentrations resulting from the alternatives and from new or modifiec operational since May 1, 1994.
e. Baseline concentrations for these pollutants were not analyzed because their emi

levels.

**Table 5.7-3.** Annual dose increments by alternative in comparison to the baseline.

| Alternative | INEL worker (millirem) | Maximally exposed individual (millirem) | Populati (person- |
|---|---|---|---|
| Baseline | 4.3y100c | 5.6y10-2 | 3.4y10-1 |
| 1. No Action | 3.3y10-4 | 3.5y10-3 | 1.0y10-1 |
| 2. Decentralization | 3.3y10-4 | 3.5y10-3 | 1.0y10-1 |
| 3. 1992/1993 Planning Basisc | 3.3y10-3 | 8.0y10-3 | 1.9y10-1 |
| 4a. Regionalization by Fuel Type | 3.3y10-3 | 8.0y10-3 | 1.9y10-1 |
| 4b(1). Regionalization by Geography (INEL)d | 4.2y10-3 | 4.8y10-2 | 3.9y10-1 |
| 4b(2). Regionalization by Geography (Elsewhere) | 7.0y10-5 | 3.9y10-3 | 8.3y10-2 |
| 5a. Centralization at Other DOE Sites | 7.0y10-5 | 3.9y10-3 | 8.3y10-2 |
| 5b. Centralization at the INEL | 4.2y10-3 | 4.8y10-2 | 3.9y10-1 |

a. Source: Section 5.7 of Volume 2 of this EIS.
b. Population dose is calculated based on the projected population in 2000 or 2010
c. Baseline worker dose includes the maximum projected operation of the portable wa Power Burst Facility area. However, the operation would be temporary (1 to 2 ye representative of a permanent increase in the baseline. If this facility were n the worker would be about 0.2 millirem per year.
d. Alternative 4b(1) doses are slightly less than Alternative 5b doses.

## 5.7.2 Alternative 2 - Decentralization

### 5.7.2.1 Nonradiological Air Quality. Potential impacts to air quality from construction

activities would include fugitive dust and exhaust emissions from support equipment assessment showed that the expected construction-related air quality impacts shoulc highly localized.

Emissions resulting from normal operations under this alternative would include emissions and those resulting from the startup of the proposed facilities. Emissic with startup would be less than 1 percent of those from normal operations. Tables the maximum concentrations predicted for the proposed alternatives. Ambient concen Alternative 2 activities would be below applicable standards and guidelines.

**Table 5.7-4.** Radionuclide emissions by alternative for spent nuclear fuel projects

| Project and Location | Associated Alternative | Radionuclides and Emission H-3/ C-14 | Co-60 | Kr-85 |
|---|---|---|---|---|
| TAN Pool Fuel Transfer Project | 1, 2, 3, 4a | | | |
| a. Drying operations | 4b(1), 5b | 9.6y102 | - | - |
| b. Storage operations (Test Area North) | | 3.9y10-1 | - | - |
| Additional Increased Rack Capacity (Idaho Chemical Processing Plant) | 3, 4a, 4b(1), 5b | 2.0y10-1 | 1.2y10-8 | - |
| Dry Fuels Storage Facility (Idaho Chemical Processing Plant) | 3, 4a, 4b(1), 4b(2), 5a, 5b | 1.8y10-2 | 1.9y10-6 | - |
| Fort St. Vrain Spent Fuel Storage (Idaho Chemical Processing Plant) | 3, 4a, 4b(1), 5b | - | 5.6y10-8 | - |
| Increased Rack Capacity (Idaho Chemical Processing Plant) | 3, 4a, 4b(1), 5b | 2.0y10-1 | 1.2y10-8 | - |
| EBR-II Blanket Treatment (Argonne National Laboratory - West) | 3, 4a, 4b(1), 5b | 1.6y102 | - | 4.9y1 |
| Electrometallurgical Process Demonstration Project (Argonne National Laboratory - West) | 3, 4a, 4b(1), 4b(2), 5a, 5b | 8.4y102 | - | 1.4y1 |
| Spent Fuel Processing Facility | 4b(1), 5b | 3.1y103 | 1.9y10-6 | 5.0y1 |

a. Source: Appendix F-3 of Volume 2 of this EIS.

**5.7.2.2 Radiological Air Quality. No radiological impacts to the environment would result**

from construction activities.
Emissions resulting from normal operations under this alternative would include emissions and those resulting from the startup of the proposed facilities. Table 5 rates for the spent nuclear fuel alternatives, including Decentralization. Table 5 doses to the maximally exposed individual, the population, and workers. These valu comparison to the National Emission Standards for Hazardous Air Pollutants dose lin per year, the dose limit received from background sources of 351 millirem per year, population dose from background sources of 40,000 person-rem.

## 5.7.3 Alternative 3 - 1992/1993 Planning Basis

**5.7.3.1 Nonradiological Air Quality. Potential impacts to air quality from construction**

activities would include fugitive dust and exhaust emissions from support equipment assessment showed that expected construction-related air quality impacts should be highly localized.
Emissions resulting from normal operations under this alternative would include emissions and those resulting from the proposed facilities. Emission rates associa would be less than 1 percent of those from normal operations. Tables 5.7-1 and 5.7 maximum potential concentrations for the proposed alternatives. Ambient concentrat Alternative 3 activities would be below applicable standards and guidelines.

**5.7.3.2 Radiological Air Quality. No radiological impacts to the environment would result**

from construction activities.
Emissions resulting from normal operations under this alternative would include emissions and those resulting from the startup of the proposed facilities. Table 5 rates for the spent nuclear fuel alternatives. Table 5.7-3 lists the resulting dos exposed individual, the population, and workers. These values are small in compari Emission Standards for Hazardous Air Pollutants dose limit of 10 millirem per year, received from background sources of 351 millirem per year, and the population dose sources of 40,000 person-rem.

## 5.7.4 Alternative 4a - Regionalization by Fuel Type

**5.7.4.1 Nonradiological Air Quality. Potential impacts to air quality from construction**

activities would include fugitive dust and exhaust emissions from support equipment assessment showed that the expected construction-related air quality impacts shoulc highly localized.
Emissions resulting from normal operation under this alternative would include emissions and those resulting from the startup of the proposed facilities. Emissic with startup would be less than 1 percent of those from normal operations. Tables the maximum potential concentrations for the proposed alternatives. Ambient concen Alternative 4 activities would be below applicable standards and guidelines.

**5.7.4.2 Radiological Air Quality. No radiological impacts to the environment would result**

from construction activities.
Emissions resulting from normal operation under this alternative would include emissions and those resulting from the proposed facilities. Table 5.7-4 lists emis nuclear fuel alternatives including Regionalization. Table 5.7-3 lists the resulti maximally exposed individual, the population, and workers. These values are small the National Emission Standards for Hazardous Air Pollutants dose limit of 10 milli dose limit received from background sources of 351 millirem per year, and the popul background sources of 40,000 person-rem.

## 5.7.5 Alternative 4b(1) - Regionalization by Geography (INEL)

**5.7.5.1 Nonradiological Air Quality. Potential impacts to air quality from construction**

activities would include fugitive dust and exhaust emissions from support equipment assessment showed that the expected construction-related air quality impacts shoulc highly localized.

Emissions resulting from normal operation under this alternative would include emissions and those resulting from the startup of the proposed facilities. Emissic with startup would be less than 1 percent of those from normal operations. Tables the maximum potential concentrations from the proposed alternatives. Ambient conce Alternative 4b(1) activities would be below applicable standards and guidelines.

**5.7.5.2 Radiological Air Quality. No radiological impacts to the environment would result**

from construction activities.

Emissions resulting from normal operation under this alternative would include emissions and those resulting from the proposed facilities. Table 5.7-4 lists asso for spent nuclear fuel alternatives including Regionalization by Geography (INEL). resulting doses to the maximally exposed individual, the population, and workers. small in comparison to the National Emission Standards for Hazardous Air Pollutants millirem per year, the dose limit received from background sources of 351 millirem population dose from background sources of 40,000 person-rem.

## 5.7.6 Alternative 4b(2) - Regionalization by Geography (Elsewhere)

**5.7.6.1 Nonradiological Air Quality. Potential impacts to air quality from construction**

activities would include fugitive dust and exhaust emissions from support equipment assessment showed that the expected construction-related air quality impacts shoulc highly localized.

Emissions resulting from normal operation under this alternative would include emissions and those resulting from the startup of the proposed facilities. Emissic with startup would be less than 1 percent of those from normal operations. Tables the maximum potential concentrations from the proposed alternatives. Ambient conce Alternative 4b(2) activities would be below applicable standards and guidelines.

**5.7.6.2 Radiological Air Quality. No radiological impacts to the environment would result**

from construction activities.

Emissions resulting from normal operation under this alternative would include emissions and those resulting from the proposed facilities. Table 5.7-4 lists asso for spent nuclear fuel alternatives including Regionalization by Geography (Elsewhe lists resulting doses to the maximally exposed individual, the population, and work are small in comparison to the National Emission Standards for Hazardous Air Pollut 10 millirem per year, the dose limit received from background sources of 351 millir the population dose from background sources of 40,000 person-rem.

## 5.7.7 Alternative 5a - Centralization at Other DOE Sites

**5.7.7.1 Nonradiological Air Quality. Potential impacts to air quality from construction**

activities would include fugitive dust and exhaust emissions from support equipment assessment showed that the expected construction-related air quality impacts shoulc highly localized.

Emissions resulting from normal operation under this alternative would include emissions and those resulting from the startup of the proposed facilities. Emissic with startup would be less than 1 percent of those from normal operations. Tables

the maximum potential concentrations from the proposed alternatives. Ambient conce Alternative 5a activities would be below applicable standards and guidelines.

**5.7.7.2 Radiological Air Quality. No radiological impacts to the environment would result**

from construction activities.

Emissions resulting from normal operation under this alternative would include emissions and those resulting from the proposed facilities. Table 5.7-4 lists assc for spent nuclear fuel alternatives including Centralization at other DOE sites. T resulting doses to the maximally exposed individual, the population, and workers. small in comparison to the National Emission Standards for Hazardous Air Pollutants millirem per year, the dose limit received from background sources of 351 millirem population dose from background sources of 40,000 person-rem.

### 5.7.8 Alternative 5b - Centralization at the INEL

**5.7.8.1 Nonradiological Air Quality. Potential impacts to air quality from construction**

activities would include fugitive dust and exhaust emissions from support equipment assessment showed that the expected construction-related air quality impacts shoulc highly localized.

Emissions resulting from normal operation under this alternative would include emissions and those resulting from the proposed facilities. Emission rates associa of the proposed facilities would be less than 1 percent of those from normal operat and 5.7-2 list the maximum potential concentrations from the proposed alternatives. concentrations from Alternative 5b activities would be below applicable standards a

**5.7.8.2 Radiological Air Quality. No radiological impacts to the environment would result**

from construction activities.

Emissions resulting from normal operation under this alternative would include emissions and those resulting from startup of the proposed facilities. Table 5.7-4 emission rates for spent nuclear fuel alternatives including Centralization at the lists resulting doses to the maximally exposed individual, the population, and work are small in comparison to the National Emission Standards for Hazardous Air Pollut 10 millirem per year, the dose limit received from background sources of 351 millir the population dose from background sources of 40,000 person-rem.

## 5.8 Water Resources and Related Consequences

This section discusses potential environmental consequences to water resources spent nuclear fuel management alternatives. DOE evaluated each alternative with res impacts on water quality (both surface and subsurface water), water use, and human

Any liquid effluents from facilities proposed for the spent nuclear fuel altern tanks or lined evaporation basins. Under normal operating conditions, radioactive d soil or directly to the aquifer would not occur. Creed (1994) presents spent nuclea data for the analysis of the potential impacts resulting from a hypothetical leak c per day from secondary containment around the SNF storage pools during operations. addresses the effects that this leak could have on the quality of subsurface water Preliminary results indicate that there will be no contaminants above maximum conta the INEL boundary resulting from the postulated operational leak. Some storage pool leakage in the past. However, based on the bounding accident scenario for high-leve failure, leakage during the implementation of the selected spent nuclear fuel manag would cause negligible impacts to water resources (Bowman 1994). None of the propos for the management of spent nuclear fuel would result in any renewed discharges to Section 5.15 discusses potential releases of hazardous or radioactive liquids as a

With respect to water usage, Alternative 4b(1) [Regionalization by Geography (I Alternative Sb (Centralization at the INEL) would consume the largest volume of wat cubic meters (400 million gallons) over 40 years. The greatest water consumption ra alternatives would be 50,000 cubic meters (13 million gallons) per year (Hendricksc

incremental usage would represent approximately a 0.7 percent increase over the tot
withdrawal rate at the INEL of 7.4 million cubic meters (1.9 billion gallons) per y
consumptive use water right is 43 million cubic meters (11.4 billion gallons) per y
Alternatives 4b( I) and Sb would have negligible impact on the quantity of water in
River Plain Aquifer.

## 5.9 Ecology

DOE expects that construction impacts, which would include the loss of some wil
due to land clearing and facility development, would be greatest under Alternative
[Regionalization by Geography (INEL)] and Alternative 5b (Centralization at the INE
construction activity would take place either within the boundaries of heavily deve
adjacent to those areas, it would have minimal impact on ecological resources. How
activities could provide opportunities for the spread of exotic plant species (e.g.
Russian thistle).

There would be no construction impacts to wetlands, which would be excluded frc
development, and impacts to threatened and endangered species would be unlikely, gi
(previously-developed areas) and the maximum size [approximately 31 acres (0.125 sq
kilometers)] of the affected area. Construction activities at the INEL probably wc
of the endangered species identified in Section 4.9.3 (the bald eagle and peregrine
these birds of prey are associated with riparian areas, wetlands, and larger bodies
reservoirs) and inhabit dry upland areas only temporarily when migrating (National
Society 1987). Disturbance to other sensitive (but not Federally-listed) species i
Section 4.9.3 (e.g., the burrowing owl, northern goshawk, ferruginous hawk, Swainsc
gyrfalcon, Townsend's western big-eared bat, and pygmy rabbit) would be possible bu
the scale of the planned construction. Any impacts would be negligible and short l
as long as the construction activities.

Representative impacts from operations would include the disturbance and displa
animals (such as the pronghorn) caused by the movement and noise of personnel, equi
vehicles. Such impacts would be greatest under Alternative 4b(1) [Regionalization
(INEL)] and Alternative 5b (Centralization at INEL), which would involve a generall
operational activity; however, these impacts would be minor under all the proposed

## 5.10 Noise

As discussed in Section 4.10, noises generated on the INEL do not travel off th
that affect the general population. Therefore, INEL noise impacts for each alterna
limited to those resulting from the transportation of personnel and materials to an
would affect nearby communities, and from onsite sources that could affect wildlife

Transportation noises would be a function of the size of the workforce (e.g., a
workforce would result in increased employee traffic and corresponding increases in
truck and rail; a decreased workforce would result in decreased employee traffic an
decreases in deliveries). This analysis of traffic noise considered railroad noise
roadways that provide access to the INEL. DOE does not expect the number of freigh
in the region and through the site to change as a result of any of the alternatives
spent nuclear fuel, regardless of the alternative, would be a small fraction of the
Blackfoot-to-Arco Branch of the Union Pacific System line that crosses the INEL. T
transport employees and personnel on roads would be the principal source of communi
near the INEL.

This analysis used the day-night average sound level to assess community noise,
the EPA (EPA 1974, 1982) and the Federal Interagency Committee on Noise (FICON 1992
analysis based its estimate of the change in day-night average sound level from the
for each alternative on projected changes in employment and traffic levels. The an
considers the combination of construction and operation employment. The baseline n
comparable to that for the No-Action alternative. Section 4.10 discusses levels re
No-Action alternative. The traffic noise analysis considered U.S. Highway 20, whic
to access the INEL from Idaho Falls. Changes in noise level below 3 decibels proba
result in a change in community reaction (FICON 1992).

The new employment associated with each alternative is a small percentage of th
workforce. The maximum new employment of about 375 INEL onsite jobs would occur wi
Alternatives 3, 4a, 4b(1), and 5b during the peak construction period beginning in

Section 5.3, Socioeconomics). No new operations employment is projected for any of except Alternatives 4b(1) and 5b for which there would be 25 new jobs beginning in cumulative onsite workforce under each alternative would be greatest in 1995 and wc thereafter. The peak cumulative onsite workforce for Alternatives 4b(2) and 5a wou 1995 by less than 1 percent compared to the No-Action baseline. There would be a c increase in private vehicle and truck trips to the site. The day-night sound level (50 feet) from the roads that provide access to the INEL probably would increase by 1 decibel. The peak cumulative onsite workforce for Alternative 2 in 1995 would be for the No-Action baseline.

For any of the alternatives, truck activity would consist of a few trips per da site carrying spent nuclear fuel. This increase in truck trips would not result in in traffic noise levels along the routes to the INEL. The day-night average sound Highway 20 and other access routes probably would decrease slightly as a result of overall decrease in employment levels at the INEL. DOE expects no change in the cc reaction to noise along this route and other access routes. No mitigation efforts

## 5.11 Traffic and Transportation

### 5.11.1 Introduction

Spent nuclear fuel management activities involve the transportation of spent nu the boundaries of the INEL (onsite) and on highways and rail systems outside the bc INEL (offsite). This section summarizes the methods of analysis used to determine t consequences of onsite transportation of nonnaval spent nuclear fuel under normal c (incident-free) and of transportation accidents. The impacts include doses and heal Appendices D and I of Volume 1 address consequences of shipments to or from the INE other DOE sites and spent nuclear fuel-related locations.

### 5.11.2 Methodology

**5.11.2.1 Incident-Free Transpodation. Radiological impacts were determined for two**

groups of people during normal incident-free transportation: (1) crewmen (drivers) of the public. Members of the public are persons sharing the transport link (on-lin were determined for Onsite shipments because members of the public have access to t the roads on the INEL. Radiological impacts were calculated using the RADTRAN 4 (Ne Kanipe 1992) and RISKIND (Yuan et al. 1993) computer codes.

The magnitude of the incident-free dose depends mainly on the Transport Index c and the on-link vehicle densities. The Transport Index is defined as the dose rate (3.28 feet) from the surface of a radioactive package; it is measured in millirem p nuclear fuel was assigned a dose rate of 14 millirem per hour at 1 meter from the s This dose rate yielded a dose rate of 10 millirem per hour at 2 meters (6.56 feet) transport vehicle, which is the regulatory limit for an exclusive use vehicle (see

Radiological doses were converted to cancer fatalities using risk conversion fa 5.0 x 10~ fatal cancer per person-rem for members of the public and 4.0 x 10A fatal person-rem for workers. These risk conversion factors are from Publication 60 of th Commission on Radiological Protection (ICRP 1991).

Because the onsite transportation of spent nuclear fuel at the INEL is consider incident-free nonradiological risk (from exhaust emissions and dust resuspension) w

**5.11.2.2 Accidents. The doses of the maximum reasonably foreseeable onsite spent nuclear**

fuel transportation accident were calculated using the RISKIND computer code. Doses for generic rural and suburban population densities, assuming 6 persons per square areas and 719 persons per square kilometer for suburban areas. Areas within 80 kilc of INEL have population densities between rural and suburban but are closer to the population density. Doses were also assessed under both neutral and stable atmosphe Radiation doses calculated were used to estimate the potential for fatal cancers in population using risk factors developed by the International Commission on Radiolog (ICRP 1991).

The probability of the maximum reasonably foreseeable onsite spent nuclear fuel accident was estimated taking into account spent nuclear fuel handling procedures w Test Reactor facility as well as factors related to transportation of the spent nuc accident to occur, errors must occur in loading the wrong spent nuclear fuel into t radiation surveys of the loaded cask fail to detect abnormally high radiation level vehicle must breakdown or rollover during the short transit between the Advanced Te the Idaho Chemical Processing Plant, and operators fail to ensure that adequate coc maintained inside the cask. The estimated probability of this accident is no greate million years.

The risk of the onsite spent nuclear fuel transportation accident was estimated accident doses by the accident probability, taking into account the probability of conditions used. The resulting risk value gives a bounding estimate of the annual p cancers occurring in the local population due to onsite spent nuclear fuel transpor

## 5.11.3 Onsite Spent Nuclear Fuel Shipments

For each spent nuclear fuel management alternative, a small number of onsite DC fuel shipments would be likely each year as a result of continuing reactor operatic Test Reactor and the Experimental Breeder Reactor-li. The alternatives would not af of these two facilities, thus the shipments be'tween these facilities and the Idahc Plant, integrated over 40 years, would be the same for each spent nuclear fuel mana

Spent nuclear fuel shipments to the Idaho Chemical Processing Plant from four l INEL (including the Test Reactor Area, Argonne National Laboratory-West, Test Area Power Burst Facility) were evaluated. The number of shipments would not change with because DOE plans to ship all spent nuclear fuel to the Idaho Chemical Processing F that would ship spent nuclear fuel off the site under Regionalization [Alternatives and Centralization (Alterntives Sa and Sb) would ship it first to the Idaho Chemica for canning or other stabilization prior to shipment. DOE estimated the total proje shipments over 40 years of operation (1995-2035) from each facility from either his current inventories. DOE based the projected number of shipments for Test Reactor A Argonne National Laboratory-West to the Idaho Chemical Processing Plant on historic 1987 through 1992, and the doses reflect shipments for 1995 through 2035. The proje shipments from Test Area North would include Three Mile Island canisters, Loss of F special case commercial fuel, and non-fuel-bearing components stored in the Test Ar The projected number of shipments from the Power Burst Facility includes all spent at that facility.

Onsite shipments would include those that originated and ended on the INEL site that originate or terminate at non-INEL facilities are offsite shipments. Appendixe the consequences of naval and DOE offsite spent fuel shipments, respectively. Movem nuclear fuel inside (INEL) facility fences (e.g., from the CPP-603 Underwater Stora Fuel Storage Area) are operational transfers, not onsite shipments; therefore, this consider such shipments

## 5.11.4 Incident-Free Impacts

The occupational and general population collective doses from onsite spent nucl shipments and the resulting incidence of latent cancer fatalities were calculated. same regardless of alternative. Occupational radiation exposure would potentially b resulting in 0.0014 latent cancer fatalities. General population exposure would pot person-rem, resulting in 0.000044 latent cancer fatalities.

In addition to collective radiation exposure, the maximally exposed individual onsite SNF shipments were calculated for a driver (occupational exposure), a person shipment, and a person standing beside the road as a single shipment passes by (gen the public). The calculated dose to a driver would be 1.7 rem, assuming that person shipments over 40 years. The calculated maximally exposed individual dose to a pers single shipment covering the longest distance from Test Area North to the Idaho Che Plant would be 0.015 millirem, and to a person exposed to passing shipment at a dis (3.28 feet), the dose would be 0.0014 millirem (Maheras 1995).

Traffic impacts for the spent nuclear fuel shipments were estimated from data i (1994). The maximum number of spent nuclear fuel shipments of 691 per year would oc Alternative Sb, Centralization at the INEL. A maximum 23-percent increase in traffi would occur with this alternative, based on the estimates of the number of trips re

transport of construction equipment, material, spent nuclear fuel, other wastes, an from the INEL. Even if this average daily traffic volume were to occur for 1 hour, traffic volume would increase to 145 vehicles per hour for US 20, US 26, Routes 33 would not change the baseline level of service, which is designated as "free flow."

### 5.11.5 Accident Impacts

An onsite spent nuclear fuel transportation accident involving the inadvertent cooled fuel element from the Advanced Test Reactor to the Idaho Chemical Processing considered to be the maximum reasonably foreseeable accident. The melted spent nucl potential to relocate into a critical configuration. However, the probability of a much less than 1 x 10(-7) per year and would be considered to be not reasonably for 5.11-1 lists the calculated maximally exposed individual dose and collective dose t in the maximally impacted sector and corresponding risk of fatal cancers. The dose exposed individual is considered an occupational exposure.

As listed in Table 5.11-1, the total number of fatal cancers expected in the su affected by the transportation for neutral and stable meteorological conditions wou respectively. For the neutral case, this would represent a 0.01-percent increase fr fatal cancers that would be likely from normal incidence in the affected population case, this would represent a 0.20-percent increase from the number of fatal cancers likely from normal incidence in the affected population.

The total number of fatal cancers expected in the rural population affected by for neutral and stable meteorological conditions would be 0.75 and 6.0, respectivel

**Table 5.11-1.** Impacts from maximum reasonably foreseeable spent nuclear fuel trans and suburban population densities).

| Population density categoryb | Meteorologyc | Accident frequencyd (events/yr) | Dose to MEIe (rem) | Offsite population dose (person-rem) | Risk fatal per y |
|---|---|---|---|---|---|
| Rural | Neutral | 1.0y10-6 | 7.6y101 | 1.5y103 | 7.5y1 (7.5y |
| Rural | Stable | 1.0y10-7 | 2.5y102 | 1.2y104 | 6.0y1 (6.0y |
| Suburban | Neutral | 1.0y10-6 | 7.6y101 | 2.1y104 | 1.1y1 (1.1y |
| Suburban | Stable | 1.0y10-7 | 2.5y102 | 1.7y105 | 8.5y1 (8.5y |

a. Source: Enyeart (1994).
b. Results are for generic rural and suburban population densities. The generic ru persons per square kilometer; the generic suburban population density has an ave comparison, the sector with the highest population density within 80 kilometers Plant and Test Reactor Area at the INEL with an average population density of 53
c. Neutral meteorology is characterized by Stability Class D, 4 meters-per-second w time. Stable meteorology is characterized by Stability Class F, 1 meter-per-sec the time.
d. Accident frequency includes both the event frequency and the frequency of the me approximately one-tenth the frequency of neutral meteorology.
e. Maximally exposed individual located at the point of maximum exposure to the air 1,280 feet) downwind, depending on meteorology. For onsite accidents the maxima worker.
f. Fatal cancer risk = dose times accident frequency times (ICRP 60 risk factor for cancer per rem for public, 4.0 y 10-4 fatal cancer per rem for workers. For dos doubled. Numbers in parentheses indicate the total number of fatal cancers in t exposed individual dose is considered an occupational exposure.

case, this would represent a 0.09-percent increase from the number of fatal cancers likely from normal incidences in the affected population. For the stable case, this 1.7-percent increase from the number of fatal cancers that would he likely from nor the affected population.

The estimated maximum nonradiological occupational and general population traff over 40 years due to any of the spent nuclear fuel management alternatives would be 2.5 x 10(-3), respectively. These estimated fatalities were based on fatality risk shipments (Cashwell et. al 1986).

transport of construction equipment, material, spent nuclear fuel, other wastes, an from the INEL. Even if this average daily traffic volume were to occur for 1 hour, traffic volume would increase to 145 vehicles per hour for US 20, US 26, Routes 33 would not change the baseline level of service, which is designated as "free flow."

## 5.11.5 Accident Impacts

An onsite spent nuclear fuel transportation accident involving the inadvertent cooled fuel element from the Advanced Test Reactor to the Idaho Chemical Processing considered to be the maximum reasonably foreseeable accident. The melted spent nucl potential to relocate into a critical configuration. However, the probability of a much less than 1 x 10(-7) per year and would be considered to be not reasonably for 5.11-1 lists the calculated maximally exposed individual dose and collective dose t in the maximally impacted sector and corresponding risk of fatal cancers. The dose exposed individual is considered an occupational exposure.

As listed in Table 5.11-1, the total number of fatal cancers expected in the su affected by the transportation for neutral and stable meteorological conditions wou respectively. For the neutral case, this would represent a 0.01-percent increase fr fatal cancers that would be likely from normal incidence in the affected population case, this would represent a 0.20-percent increase from the number of fatal cancers likely from normal incidence in the affected population.

The total number of fatal cancers expected in the rural population affected by for neutral and stable meteorological conditions would be 0.75 and 6.0, respectivel

**Table 5.11-1.** Impacts from maximum reasonably foreseeable spent nuclear fuel trans and suburban population densities).

| Population density categoryb | Meteorologyc | Accident frequencyd (events/yr) | Dose to MEIe (rem) | Offsite population dose (person-rem) | Risk fatal per y |
|---|---|---|---|---|---|
| Rural | Neutral | 1.0y10-6 | 7.6y101 | 1.5y103 | 7.5y1 (7.5y |
| Rural | Stable | 1.0y10-7 | 2.5y102 | 1.2y104 | 6.0y1 (6.0y |
| Suburban | Neutral | 1.0y10-6 | 7.6y101 | 2.1y104 | 1.1y1 (1.1y |
| Suburban | Stable | 1.0y10-7 | 2.5y102 | 1.7y105 | 8.5y1 (8.5y |

a. Source: Enyeart (1994).
b. Results are for generic rural and suburban population densities. The generic ru persons per square kilometer; the generic suburban population density has an ave comparison, the sector with the highest population density within 80 kilometers Plant and Test Reactor Area at the INEL with an average population density of 53
c. Neutral meteorology is characterized by Stability Class D, 4 meters-per-second w time. Stable meteorology is characterized by Stability Class F, 1 meter-per-sec the time.
d. Accident frequency includes both the event frequency and the frequency of the me approximately one-tenth the frequency of neutral meteorology.
e. Maximally exposed individual located at the point of maximum exposure to the air 1,280 feet) downwind, depending on meteorology. For onsite accidents the maxima worker.
f. Fatal cancer risk = dose times accident frequency times (ICRP 60 risk factor for cancer per rem for public, 4.0 y 10-4 fatal cancer per rem for workers. For dos doubled. Numbers in parentheses indicate the total number of fatal cancers in t exposed individual dose is considered an occupational exposure.

case, this would represent a 0.09-percent increase from the number of fatal cancers likely from normal incidences in the affected population. For the stable case, this 1.7-percent increase from the number of fatal cancers that would he likely from nor the affected population.

The estimated maximum nonradiological occupational and general population traff over 40 years due to any of the spent nuclear fuel management alternatives would be 2.5 x 10(-3), respectively. These estimated fatalities were based on fatality risk shipments (Cashwell et. al 1986).

### 5.11.6 Onsite Mitigative and Preventative Measures

All onsite shipments would be in compliance with DOE ID Directive 5480.3, "Haza Materials Packaging and Transportation Safety Requirements." These requirements prc that, under normal conditions, the INEL would meet as-low-as-reasonably-achievable reasonably foreseeable accident situations (those with a probability of occurrence per year) would not result in a loss of shielding or containment or a criticality, release of radioactive maSerial would generate a timely response.

DOE would approve the type packages used for onsite shipments or would obtain a Regulatory Commission or DOE certificate of compliance. If the Type B onsite packag Nuclear Regulatory Commission or DOE certification, the user of the package would h how administrative controls and site-mitigating circumstances would ensure that the maintain containment and shielding integrity. The administrative and emergency resp considerations would provide sufficient control so that accidents would not result containment or shielding, in criticality, or in an uncontrolled release of radioact create a hazard to the health and safety of the public or workers.

In the event of an accident, each DOE site has an established emergency managem This program incorporates activities associated with emergency planning, preparedne Participating government agencies with plans that are interrelated with the INEL Em Action include the State of Idaho, Bingham County, Bonneville County, Butte County, Jefferson County, the Bureau of Indian Affairs, and Fort Hall Indian Reservation. W emergency condition exists at a facility, the Emergency Action Director is responsi classification, notification, and protective action recommendations. At INEL emerge resources include fire protection, radiological and hazardous chemical material res control center, the INEL Warning Communication Center, the INEL Site Emergency Oper Center, and medical facilities.

## 5.12 Occupational and Public Health and Safety

This section presents DOE's estimates of the health effects from spent nuclear activities at the INEL for the following human receptor groups:

- Involved Workers - workers at the facilities involved with spent nuclear fu including existing workers and new hires for selected alternative
- Maximally Exposed Individual (MEI) - person residing at the INEL site bounc
- Population - the general offsite population in the INEL region
- Construction Worker - labor force associated with construction activities
- Nonconstruction Worker - DOE labor force associated with nonconstruction ac

Radiological, chemical, and industrial safety hazards were considered in the es

### 5.12.1 Radiological Exposure and Health Effects

The measure of impact used for evaluation of potential radiation exposures is r cancers. Worker and maximally exposed individual effects are reported as individua (in rem) and the estimated lifetime probability of fatal cancer. Population effect collective radiation dose (in person-rem) and the estimated number of fatal cancers population. Tables 5.12-1, 5.12-2, 5.12-3, and 5.12-4 summarize the radiological h calculations for each alternative.

Activities that workers would perform under each of the alternatives would be s currently performed at the INEL. Therefore, the potential hazards encountered in t be similar to those that currently exist at the INEL. Further, DOE would mitigate occupational and radiological safety programs operating under the same regulatory s that currently apply at the INEL. For these reasons, DOE anticipates that the ave annual occupational radiation exposure and employment summary.

**Table 5.12-1.** Annual occupational radiation exposure and employment summary.

| | No Action (1) | Decentralization (2) | 1992/1993 Planning Basis (3) | Regionalization by Fuel Type (4a)b |
|---|---|---|---|---|
| Number of Workers (annual average over years 1995-2004)c | 1 | 1 | 200 | 200 |

| | | | | |
|---|---|---|---|---|
| Worker Collective Dosed (person-rem/year) | 0.027 | 0.027 | 5.4 | 5.4 |

a. Source: Johnson (1995).
b. Alternative 4b(1), Regionalization by Geography (INEL), values are the same as t Regionalization by Geography (Elsewhere), values are the same as those for Alter
c. This 10-year average yields conservatively high employment; the 40-year average
d. Based on thermoluminescence dosimetry records.

**Table 5.12-2.** Annual nonoccupational radiation exposure summary.

| | No Action (1) | Decentralization (2) | 1992/1993 Planning Basis (3) | Regionalization by Fuel Type (4a)b |
|---|---|---|---|---|
| MEI Dose (mrem/year) | 3.5y10-3 | 3.5y10-3 | 8.0y10-3 | 8.0y10-3 |
| Population Dosea (person-rem/year) | 1.0y10-1 | 1.0y10-1 | 1.9y10-1 | 1.9y10-1 |

a. Population dose is calculated based on the projected population in 2000.
b. Alternative 4b(1), Regionalization by Geography (INEL), values are the same as t Regionalization by Geography (Elsewhere), values are the same as those for Alter

**Table 5.12-3.** Annual fatal cancer incidence and probability summary from radiologi

| | No Action (1) | Decentralization (2) | 1992/1993 Planning Basis (3) | Regionalization by Fuel Type(4a)b |
|---|---|---|---|---|
| Worker | | | | |
| probability | 1y10-5 | 1y10-5 | 1y10-5 | 1y10-5 |
| incidence | 1y10-5 | 1y10-5 | 2y10-3 | 2y10-3 |
| Maximally exposed member of the public | | | | |
| probability | 2y10-9 | 2y10-9 | 4y10-9 | 4y10-9 |
| Population incidence | 5y10-5 | 5y10-5 | 1y10-4 | 1y10-4 |

a. Risk factors for the worker (4y10-4 probability of occurrence per rem) or offsit recommended by the International Commission on Radiological Protection (ICRP 199
b. Alternative 4b(1), Regionalization by Geography (INEL), values are the same as t Regionalization by Geography (Elsewhere), values are the same as those for Alter

**Table 5.12-4.** 40-year fatal cancer incidence summary from radiological exposure.

| | No Action (1) | Decentralization (2) | 1992/1993 Planning Basis (3) | Regionalization Fuel Type (4a) |
|---|---|---|---|---|
| Workers | | | | |
| incidence | 4y10-4 | 4y10-4 | 8y10-2 | 8y10-2 |
| Population | | | | |
| incidence | 2y10-3 | 2y10-3 | 4y10-3 | 4y10-3 |

a. Alternative 4b(1), Regionalization by Geography (INEL), values are the same as t Regionalization by Geography (Elsewhere), values are the same as those for Alter

and the number of reportable cases of injury and illness would be proportional to t workers at the INEL under each alternative.

Table 5.12-1 lists involved worker doses based on an historic annual average dc determined from thermoluminescent dosimeter data of workers involved in various INE work over the period 1987 to 1991 (see Appendix F of Volume 2). As mentioned abov associated with spent nuclear fuel activities are the same as the hazards associate activities. Table 5.12-2 lists the exposure summaries for the maximally exposed in population, based on radioactive emissions from normal operations and those resulti proposed facilities for the various alternatives. Note that population collective worker collective dose only under alternatives 1 and 2. For the alternatives, ther worker averaged over 40 years. The nonoccupational population has more people to b When the worker population increases under Alternatives 3, 4, and 5, the worker dos than the population dose. Section 5.7 presents the exposure information. Dose cal on air emissions only, and not water pathways because none of the alternatives woul discharge of pollutants to surface waters or to the subsurface. Section 5.8 summar

Table 5.12-3 summarizes the fatal cancer incidence and probability for workers, exposed individuals, and the offsite population based on the risk factors consisten recommended by the International Commission on Radiological Protection (ICRP 1991). alternatives, the probability of developing fatal cancer for any individual would t maximum value of 1 y 10-5 for the involved worker. The calculated incidence of fat total number of workers for each alternative and the offsite population would be le

Table 5.12-4 summarizes the 40-year projection of fatal cancer incidence associ worker and offsite populations. The highest involved worker and offsite populatior 0.01, respectively, would be associated with Alternative 5b.

Radiation doses associated with construction activities would be as low as reas and no greater than 2 rem per year to any worker. Historical offsite doses associa are summarized in the Idaho National Engineering Laboratory Historical Dose Evaluat The Centers for Disease Control and Prevention is conducting a more comprehensive r doses from INEL operations.

### 5.12.2 Nonradiological Exposure and Health Effects

The air quality data listed in Tables 5.7-1 and 5.7-2 were used to evaluate hea associated with potential exposure to two compound classes, criteria pollutant and lists five pollutant criteria and Table 5.7-2 lists six toxic air pollutant compour compounds were classified as noncarcinogens or carcinogens, consistent with EPA des published in the Integrated Risk Information System (IRIS) data base. However, the does not include sufficient data to perform a quantitative inhalation cancer risk a

Nonradiological health effects (hazard indices) for the INEL worker or maximall individual were estimated by summing the ratios of the appropriate pollutant concen applicable standards presented in Table 5.7-1 and Table 5.7-2. Table 5.7-1 present concentrations at public access roads, which are the maximum of those calculated at boundary, public access roads inside the INEL site boundary, and the Craters of the Area. The hazard index for the five criteria pollutants is less than 1 (0.2) for t maximally exposed individual, based on concentrations for the longest averaging tim **Table 5.7-1.** Table 5.7-2 presents toxic air pollutant concentrations at the public are the maximum when compared with concentrations at the INEL site boundary and the Moon Wilderness Area. The hazard index for the toxic air pollutants is also less t workers or the maximally exposed individual, based on concentrations with annual av consideration. Accordingly, health effects are unlikely for either the criteria pc pollutants from spent nuclear fuel-related activities. The hazard index is not a s therefore, it cannot be interpreted as such.

### 5.12.3 Industrial Safety

This section describes the following measures of impact for workplace hazards: reportable injuries and illness and (2) fatalities in the work force. This analysi fatality rates for construction workers only since the alternatives do not result i in operations employment. Table 5.12-5 lists the maximum annual number of projecte illnesses and fatalities for construction workers by alternatives based on the maxi levels for any year between 1995-2035.

**Table 5.12-5.** Annual industrial safety health effects incidence summary. ,b

| | No Action (1) | Decentralization (2) | 1992/1993 Planning Basis (3) | Regionalizatic by Fuel Type (4a)c |
|---|---|---|---|---|
| Construction workers | | | | |
| Injury/illness | 0 | 0 | 23 | 23 |
| Fatality | 0 | 0 | <1 | <1 |

a. 1988-1992 averages for occupational injury/illness and fatality rates for DOE an
b. Sources: DOE (1993b) and Section 5.3 of this appendix.
c. Alternative 4b(1) values are the same as those for Alternative 5b. Alternative

## 5.13 Idaho National Engineering Laboratory Services

This section discusses the potential impacts from spent nuclear fuel management

energy at the INEL. It considers the consumption of water, electrical energy, foss wastewater discharge at the INEL site.

### 5.13.1 Construction

Table 5.13-1 summarizes estimates of annual requirements for electricity, water diesel fuel for construction activities associated with each alternative and compar 1995 use levels for these resources. In general, the smallest increase in the dema would result from Alternatives 4b(2) and 5a [Regionalization by Geography (Elsewher Centralization at Other DOE Sites] and the largest increase would be associated wit 4b(1) and 5b [Regionalization by Geography (INEL) and Centralization at INEL].

**Table 5.13-1.** Estimated increase in annual electricity, water, wastewater treatmen requirements for construction activities associated with each alternative.

| Service | Projected 1995 usage w/o Alternative | Estimated additional demand construction | | |
|---|---|---|---|---|
| | | Alternatives 1 and 2 | Alternatives 3 and 4a | Al 4b |
| Electricity (MWHa per year) | 208,000 | 71 | 150 | 2, |
| Water (millions of liters per year)b | 6,450 | No increase | 2.1 | 2. |
| Sanitary wastewater (millions of liters per year) | 540 | No increase | 1.5 | 4. |
| Diesel fuel (liters per year) | 5,830,000 | 6,400 | 8,500 | 14 |

a. MWH = megawatt hours.
b. To convert liters to gallons, multiply by 0.264.
Source: Hendrickson (1995).

Under Alternatives 4b(1) and 5b, the estimated annual increases in utility and from construction activities would be 2,100 megawatt-hours of electricity, 2.2 mill (580,000 gallons) of water, 4.5 million liters (1,200,000 gallons) of wastewater di 14,000 liters (3,700 gallons) of diesel fuel. These changes represent modest incr near zero percent to 1.0 percent above projected 1995 usage levels and are well wit capabilities and usage limits (see Section 4.13). The other alternatives would res increases in energy usage and would have no adverse impact on utility services at t

### 5.13.2 Operations

Table 5.13-2 summarizes estimates of annual requirements for electricity, water fuel for operations activities associated with each alternative and compares them t usage of these resources. In general, the smallest increase in the demand for site from Alternatives 1 and 2 (No-Action and Decentralization) and the largest would be Alternatives 4b(1) and 5b [Regionalization by Geography (INEL) and Centralization a

**Table 5.13-2.** Estimated increase in annual electricity, water, wastewater treatmen requirements for operations activities associated with each alternative.

| Service | Projected 1995 usage w/o Alternative | Estimated additional demand operation | | |
|---|---|---|---|---|
| | | Alternatives 1 and 2 | Alternatives 3 and 4a | Al 4b |
| Electricity (MWHa per year) | 208,000 | 180 | 2,200 | 11 |
| Water (millions of liters per year)b | 6,450 | No increase | No increase | 48 |
| Sanitary wastewater (millions of liters per year)c | 540 | No increase | No increase | 0. |
| Fuel oil (liters per year) | 11,100,000 | 28,000 | 330,000 | 1, |

a. MWH = megawatt hours.
b. To convert liters to gallons, multiply by 0.264.
c. Some industrial wastewater, such as steam condensate, is also discharged to eva
Sources: Hendrickson (1995).

Under Alternatives 4b(1) and 5b, the estimated annual increases in utility and from operations activities would be 11,000 megawatt-hours of electricity, 48 millic gallons) of water, 0.3 million liters (79,000 gallons) of wastewater, and 1,100,000

(290,000 gallons) of fuel oil. These changes represent modest increases ranging fr percent to 10 percent and are well within current system capabilities and usage lim Section 4.13). The other alternatives would result in smaller increases in energy have no adverse impact on utility services at the INEL.

## 5.14 Materials and Waste Management

This section discusses the impacts to the management of materials and wastes at and Idaho Falls facilities as a result of the implementation of the spent nuclear f alternatives. Alternatives 4b(1), and 5b, both with the spent fuel processing opti upper bound of potential impacts on projected rates of generation, treatment, stora inventories of materials and wastes. Table 5.14-1 and 5.14-2 summarize waste gener for each alternative. The tables present average generating rates over the life cy and maximum annual increments over peak generation periods.

### 5.14.1 Alternative 1 - No Action

Under the No Action Alternative, 9 cubic meters of industrial solid waste would during construction of the Alternate Fuel Storage Facility for the TAN Pool Fuel Tr the Idaho Chemical Processing Plant. At the completion of this project in 1998, th 485 cubic meters of non-fuel solid low-level waste consisting of Three Mile Island metals that would be removed and dispositioned in a separate project. These impact description of impacts for the other spent nuclear fuel management alternatives wit Alternatives 4b(2) and 5a. The non-fuel solid low-level waste is already existing; included in Table 5.14-1 as an increase in low-level waste generation.

### 5.14.2 Alternative 2 - Decentralization

In general, the character of the impacts to materials and waste management woul those under the No Action Alternative.

### 5.14.3 Alternative 3 - 1992/1993 Planning Basis

Industrial solid waste would be generated from construction and operation of th projects under Alternative 3. This nonradioactive waste would be disposed of in th Area landfill. Landfill space is nonrestrictive for industrial solid waste disposa activities would generate a cumulative total of 620 cubic meters of industrial and

**Table 5.14-1.** Average annual waste generation projections for selected SNF manage

| Alternative | Waste type | Phase |
|---|---|---|
| No Action (Alternative 1) and Decentralization (Alternative 2) | Industrial | Construction |
| 1992/1993 Planning Basis (Alternative 3) and Regionalization by Fuel Type (Alternative 4a) | Industrial | Construction |
| | | Operation |
| | Low-Levelb,c | Construction |
| | | Operation |
| | High-Level | Operation |
| | Mixed Low-Level | Operation |
| | Transuranic | Operation |
| Regionalization by Geography (INEL) [Alternative 4b(1)] and Centralization at INEL (Alternative 5b) | Industrial | Construction |
| | | Operation |
| | Low-Levelb,c | Construction |
| | | Operation |
| | High-Level | Operation |
| | Mixed Low-Level | Operation |
| | Transuranic | Operation |
| Regionalization by Geography (Elsewhere) [Alternative 4b(2)] and Centralization at Other | Industrial | Construction |
| | | Operation |

| | | |
|---|---|---|
| DOE Sites (Alternative 5a) | Low-Level | Operation |
| | High-Level | Operation |
| | Mixed Low-Level | Operation |
| | Transuranic | Operation |

a. Source: Appendix C of Volume 2 of this EIS.
b. Low-level waste from TAN Pool Fuel Transfer Project to be removed and dispositic
c. Low-level waste generated from dispositioning and decontamination of fuel racks

**Table 5.14-2.** Peak waste generation highlights for selected SNF management alterna

| Alternative | Waste type | Phase |
|---|---|---|
| No Action (Alternative 1) and Decentralization (Alternative 2) | Industrial | Construction |
| 1992/1993 Planning Basis (Alternative 3) and Regionalization by Fuel Type (Alternative 4a) | Industrial | Construction |
| | | Operation |
| | Low-Levelb,c | Construction |
| | | Operation |
| | | Concurrent Acti |
| | High-Level | Operation |
| | Mixed Low-Level | Operation |
| | Transuranic | Operation |
| Regionalization by Geography (INEL) [Alternative 4b(1)] and Centralization at INEL (Alternative 5b) | Industrial | Construction |
| | | Operation |
| | Low-Levelb,c | Construction |
| | | Operation |
| | | Concurrent Acti |
| | High-Level | Operation |
| | Mixed Low-Level | Operation |
| | Transuranic | Operation |
| Regionalization by Geography (Elsewhere) [Alternative 4b(2)] and Centralization at Other DOE Sites (Alternative 5a) | Industrial | Construction |
| | | Operation |
| | Low-Level | Operation |
| | High-Level | Operation |
| | Mixed Low-Level | Operation |
| | Transuranic | Operation |

a. Source: Appendix C of Volume 2 of this EIS.
b. Low-level waste from TAN Pool Fuel Transfer Project to be removed and dispositic
c. Low-level waste generated from dispositioning and decontamination of fuel racks
d. Construction and operations occurring simultaneously.

waste. The Fuel Receiving, Canning, Characterization, and Shipping Facility will g industrial waste of any of the projects, 490 cubic meters per year from 2005 throug

In addition, the Fuel Receiving, Canning, Characterization, and Shipping Facili 220 cubic meters per year of low-level waste during the same period. The Dry Stora generate an additional 5 cubic meters of low-level waste annually from 2005 through liquid low-level waste, the Increased Rack Capacity and Additional Increased Rack C would increase generation rates by 570 cubic meters annually during construction fr 1997. Low-level waste would decrease to approximately 160 cubic meters per year fr 1999 with the completion of the Increased Rack Capacity project. Liquid low-level disposed in existing liquid waste processing systems at the Idaho Chemical Processi radioactive wastes would be packaged and disposed of at the Radioactive Waste Manag Complex, or incinerated at the Waste Experimental Reduction Facility, whichever is Low-level waste from reracking fuel racks for the Increased Rack Capacity Project w decontaminated and dispositioned by a licensed commercial vendor.

Experimental Breeder Reactor-II Blanket Treatment will generate 7 cubic meters waste for 1 year from 1997 to 1998.

The storage of low-level waste for incineration is not considered to be restric through 2005. However, beyond 2005, low-level waste storage capacity may become st commercial facilities to incinerate the backlog of low-level waste is under conside reduce or prevent the accumulation of low-level waste, but no firm commitment or cc been established (EG&G 1993a).

The Radioactive Waste Management Complex appears to have adequate disposal capa low-level waste between 1995 and 2005. However, beyond 2005, additional capacity m Excess capacity would be provided with the development of the proposed Low-Level Wa

Low-Level Waste Disposal Facility (EG&G 1993a).

The Electrometallurgical Process Demonstration Project will generate high-level level, low-level, transuranic, and industrial wastes from the demonstration and tes fuel management processes from 1996 through 2024.

Experimental Breeder Reactor-II Blanket Treatment will also generate high-level level, and transuranic wastes.

High-level waste would be immobilized after 2005, and may eventually be transpc Federal high-level waste and spent nuclear fuel repository for disposal. Transuran waste acceptance criteria to be developed could be shipped to a potential Federal r disposal should one be selected (EG&G 1993a).

### 5.14.4 Alternative 4a - Regionalization by Fuel Type

In general, the character of the impacts to materials and waste management woul those under Alternative 3.

### 5.14.5 Alternative 4b(1) - Regionalization by Geography (INEL)

The character and intensity of impacts on waste management activities at the IN those under Alternatives 3 and 4a for some of the SNF management projects including Fuel Transfer Project at the Idaho Chemical Processing Plant; the Increased Rack Ca Additional Increased Rack Capacity projects; the Experimental Breeder Reactor-II Bl facility; and the Electrometallurgical Process Demonstration Project. Under Altern Fuel Storage Facility is expanded and Fuel Receiving, Canning/Characterization, and waste streams decrease relative to Alternatives 3 and 4a; however, the net effect c on industrial/commercial solid waste generation and low-level waste generation for and operation results in waste generation rates similar to those under Alternatives

The increase in average and peak generation rates over Alternatives 3 and 4a (T 5.14-2) is due to the Spent Fuel Processing option included under Alternative 4b(1) for the relative increase in generation rates over Alternatives 3 and 4a. Fuel prc in order to stabilize the spent nuclear fuel and remove risks associated with stora to manage the resultant high-level waste in a cost-effective manner. If this alter aggressively, the generated high-level waste residual resulting from segregating fi the spent nuclear fuel may require additional high-level waste tankage. This incre would be covered by the High-Level Tank Farm New Tanks project described in Volume

Capacity discussions for industrial/commercial solid waste and low-level waste Alternative 3 apply to Alternative 4b(1).

### 5.14.6 Alternative 4b(2) - Regionalization by Geography (Elsewhere)

Construction phase activities would generate a cumulative total of 50 cubic met and commercial solid waste. Overall, waste generation would be lower than all of t management alternatives, with the exceptions of the No Action and Decentralization

### 5.14.7 Alternative 5a - Centralization at Other DOE Sites

In general, the character of the impacts to materials and waste management woul those under Alternative 4b(2).

### 5.14.8 Alternative 5b - Centralization at the INEL

In general, the character of the impacts to materials and waste management woul those under Alternative 4b(1).

## 5.15 Accidents

### 5.15.1 Introduction

Activities associated with the transportation, receipt, handling, stabilization nuclear fuel at the INEL involve substantial quantities of radioactive materials an toxic chemicals. Under certain circumstances, the potential exists for accidents i materials to occur, which would result in exposure to INEL workers or members of th contamination of the surrounding environment. Accidents can be categorized as foll

- Abnormal events such as minor spills
- Design-basis events, which a facility is designed to withstand
- Beyond-design-basis events, which a facility is not designed to withstand ( consequences it may nevertheless mitigate)

This section summarizes postulated radiological and toxic material accidents in category and describes their estimated consequences to workers, members of the publ environment. The scope of this section is limited to accidents within facilities; accidents between facilities are addressed in Section 5.11. [Further information c summarized in this section, as well as information on other "lower consequence" acc provided in Slaughterbeck et al. (1995)].

An accident is a series of unexpected or undesirable "initiating" events that l radioactive or toxic materials within a facility or to the environment. This analy events that can lead to a spent nuclear fuel-related facility accident in three brc initiators, internal initiators, and natural phenomena initiators. External initia and nearby explosions or toxic material releases) originate outside the facility an of the facility to maintain confinement of radioactive or hazardous material. Inte originate within a facility (e.g., equipment failures or human error) and are usual operation. Sabotage and terrorist activities (i.e., intentional human initiators) or internal initiators. Natural phenomena initiators include weather-related (e.g. and seismic events. This analysis defines initiators in terms of events that cause a release of radioactive or hazardous materials within a facility or to the environ bypass of confinement.

Tables 5.15-1 through 5.15-4 summarize the radiological results of the analyses section. Section 5.15.2 summarizes historic accidents at the INEL associated with fuel-related activities. Section 5.15.3 describes the methodology used to identify radiological accidents associated with spent nuclear fuel receipt, handling, storag transportation activities. Sections 5.15.4 and 5.15.5 evaluate the postulated maxi foreseeable radiological and toxic material accidents, respectively.

## 5.15.2 Historic Perspective

Many of the actions proposed under the different spent nuclear fuel management considered in this EIS are continuations or variations of past practices at the INE consequences to the public from historic INEL accidents in detail and has determine (DOE 1991).

Consequences of accidents can involve fatalities, injuries, or illness. Fatali (immediate), such as in construction accidents, or latent (delayed), such as cancer exposure. While public comments received in scoping meetings for this EIS included about potential accidents at the INEL, the historic record demonstrates that DOE fa the INEL, have a very good safety record, particularly in comparison to commercial (e.g., agriculture and construction). Figure 5.15-1 shows the rate of worker fatal other DOE sites (DOE 1993b) compared to national-average rates that the National Sa compiled over a 10-year period for various industry groups (NSC 1993) and State of rates (Hendrix 1994). While past accident occurrence rates are not necessarily inc rates, the historic record reflects the DOE emphasis on safe operations.

There have been no prompt fatalities and no known latent fatalities to members from accidental releases of radioactive or hazardous materials associated with spen management activities in the 40-year history of INEL facilities, although some acci

**Table 5.15-1.** Summary of radiological accidents for worker located 100 meters down

| Accident Description | Attribute | Alternative 1 No Action | Alternative Decentraliz |
|---|---|---|---|
| 1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEFb | Consequencesc | (d) | (d) |
| | Adjusted annual frequency | 1.0y10-2 | 1.2y10-2 |

| | | | |
|---|---|---|---|
| | Adjusted point estimate of riske | (d) | (d) |
| 2. Uncontrolled chain reaction (criticality) at ICPPf | Consequencesc | 3.9y10-5 | 3.9y10-5 |
| | Adjusted annual frequency | 1.0y10-3 | 1.0y10-3 |
| | Adjusted point estimate of riske | 4.0y10-8 | 4.0y10-8 |
| 3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach | Consequencesc | 2.5y10-4 | 2.5y10-4 |
| | Adjusted annual frequency | 1.0y10-5 | 1.0y10-5 |
| | Adjusted point estimate of riske | 2.5y10-9 | 2.5y10-9 |
| 4. Material release from HFEF resulting from aircraft crash and ensuing fire | Consequencesc | 1.8y10-3 | 1.8y10-3 |
| | Adjusted annual frequency | 1.0y10-7g | 1.0y10-7g |
| | Adjusted point estimate of riske | 1.8y10-10 | 1.8y10-10 |
| 5. Inadvertent nuclear criticality at ICPPf CPP-666 during processing | Consequencesc | (h) | (h) |
| | Adjusted annual frequency | (h) | (h) |
| | Adjusted point estimate of riske | (h) | (h) |
| 6. Hydrogen explosion in ICPPf CPP-666 dissolver | Consequencesc | (h) | (h) |
| | Adjusted annual frequency | (h) | (h) |
| | Adjusted point estimate of riske | (h) | (h) |
| 7. Inadvertent dissolution of 30-day cooled fuel at ICPPf CPP-666 | Consequencesc | (h) | (h) |
| | Adjusted annual frequency | (h) | (h) |
| | Adjusted point estimate of riske | (h) | (h) |

a. The radiological accident results for Alternative 4b(1), "Regionalization by Gec Alternative 5b, as discussed in Section 5.15.4.4. The radiological accident res presented for Alternative 5a, as discussed in Section 5.15.4.4.
b. HFEF = Hot Fuel Examination Facility.
c. Consequences are presented in terms of latent fatal cancers based on conservativ estimated exposure (i.e., dose) by an International Commission on Radiological F cancer per rem if the estimated exposure is greater than 20 rem).
d. The safety analysis report utilized for this accident analysis does not provide As demonstrated by the dose to the maximally exposed individual, consequences tc 4. However, given the high frequency for Accident 1 compared to Accidents 2 thr
e. This attribute is equal to consequences y frequency (events per year). The infc
f. ICPP = Idaho Chemical Processing Plant.
g. This frequency is a qualitative bounding estimate for a potential aircraft crash
h. Resuming processing at the INEL under this alternative is not considered.

**Table 5.15-2.** Summary of radiological accidents for individual located at the near

| Accident Description | Attribute | Alternative 1 No Action | Alternative Decentraliz |
|---|---|---|---|
| 1. Fuel handling accident, fuel | Consequencesc | (d) | (d) |

| | | | |
|---|---|---|---|
| pin breach, venting of noble gases and iodine at HFEFb | | | |
| | Adjusted annual frequency | 1.0y10-2 | 1.2y10-2 |
| | Adjusted point estimate of riske | (d) | (d) |
| 2. Uncontrolled chain reaction (criticality) at ICPPf | Consequencesc | 7.0y10-7 | 7.0y10-7 |
| | Adjusted annual frequency | 1.0y10-3 | 1.0y10-3 |
| | Adjusted point estimate of riske | 7.0y10-10 | 7.0y10-10 |
| 3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach | Consequencesc | 3.3y10-4 | 3.3y10-4 |
| | Adjusted annual frequency | 1.0y10-5 | 1.0y10-5 |
| | Adjusted point estimate of riske | 3.3y10-9 | 3.3y10-9 |
| 4. Material release from HFEF resulting from aircraft crash and ensuing fire | Consequencesc | 1.6y10-4 | 1.6y10-4 |
| | Adjusted annual frequency | 1.0y10-7g | 1.0y10-7g |
| | Adjusted point estimate of riske | 1.6y10-11 | 1.6y10-11 |
| 5. Inadvertent nuclear criticality ICPPf CPP-666 during processing | Consequencesc | (h) | (h) |
| | Adjusted annual frequency | (h) | (h) |
| | Adjusted point estimate of riske | (h) | (h) |
| 6. Hydrogen explosion in ICPPf CPP-666 dissolver | Consequencesc | (h) | (h) |
| | Adjusted annual frequency | (h) | (h) |
| | Adjusted point estimate of riske | (h) | (h) |
| 7. Inadvertent dissolution of 30-day cooled fuel at ICPPf CPP-666 | Consequencesc | (h) | (h) |
| | Adjusted annual frequency | (h) | (h) |
| | Adjusted point estimate of riske | (h) | (h) |

a. The radiological accident results for Alternative 4b(1), "Regionalization by Gec
same as those presented for Alternative 5b, as discussed in Section 5.15.4.4. The
"Regionalization by Geography (Elsewhere)," are identical to those presented for Al
b. HFEF = Hot Fuel Examination Facility.
c. Consequences are presented in terms of latent fatal cancers based on conservativ
Consequences are calculated by multiplying the estimated exposure (i.e., dose) by a
Protection conversion factor of 5.0 y 10-4 cancer per person-rem for the offsite pc
the estimated population exposure is greater than 20 rem for any individual member
d. The safety analysis report utilized for this accident analysis does not provide
to DOE Order 5480.23 requiring this information. As demonstrated by the dose to the
public from this accident could be less than the consequences from Accidents 2 thrc
this accident compared to Accidents 2 through 4, the risk could actually be greater
e. This attribute is equal to consequences y frequency (events per year). The infc
meteorological conditions.
f. ICPP = Idaho Chemical Processing Plant.
g. This frequency is a qualitative bounding estimate for a potential aircraft crash

h. Resuming processing at the INEL under this alternative is not considered.

**Table 5.15-3.** Summary of radiological accidents for maximally exposed hypothetical

| Accident Description | Attribute | Alternative 1 No Action | Alternative Decentraliz |
|---|---|---|---|
| 1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEFb | Consequencesc | 1.0y10-6 | 1.0y10-6 |
| | Adjusted annual frequency | 1.0y10-2 | 1.2y10-2 |
| | Adjusted point estimate of riskd | 1.0y10-8 | 1.2y10-8 |
| 2. Uncontrolled chain reaction (criticality) at ICPPe | Consequencesc | 5.0y10-7 | 5.0y10-7 |
| | Adjusted annual frequency | 1.0y10-3 | 1.0y10-3 |
| | Adjusted point estimate of riskd | 5.0y10-10 | 5.0y10-10 |
| 3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach | Consequencesc | 2.5y10-3 | 2.5y10-3 |
| | Adjusted annual frequency | 1.0y10-5 | 1.0y10-5 |
| | Adjusted point estimate of riskd | 2.5y10-8 | 2.5y10-8 |
| 4. Material release from HFEF resulting from aircraft crash and ensuing fire | Consequencesc | 2.5y10-3 | 2.5y10-3 |
| | Adjusted annual frequency | 1.0y10-7f | 1.0y10-7f |
| | Adjusted point estimate of riskd | 2.5y10-10 | 2.5y10-10 |
| 5. Inadvertent nuclear criticality ICPPe CPP-666 during processing | Consequencesc | (g) | (g) |
| | Adjusted annual frequency | (g) | (g) |
| | Adjusted point estimate of riskd | (g) | (g) |
| 6. Hydrogen explosion in ICPPe CPP-666 dissolver | Consequencesc | (g) | (g) |
| | Adjusted annual frequency | (g) | (g) |
| | Adjusted point estimate of riskd | (g) | (g) |
| 7. Inadvertent dissolution of 30-day cooled fuel at ICPPe CPP-666 | Consequencesc | (g) | (g) |
| | Adjusted annual frequency | (g) | (g) |
| | Adjusted point estimate of riskd | (g) | (g) |

a. The radiological accident results for Alternative 4b(1), "Regionalization by Gec Alternative 5b, as discussed in Section 5.15.4.4. The radiological accident res presented for Alternative 5a, as discussed in Section 5.15.4.4.
b. HFEF = Hot Fuel Examination Facility.
c. Consequences are presented in terms of latent fatal cancers based on conservativ estimated exposure (i.e., dose) by an International Commission on Radiological F (or 1.0 y 10-3 cancer per rem if the estimated population exposure is greater th
d. This is equal to consequences y frequency (events per year). The information is
e. ICPP = Idaho Chemical Processing Plant.
f. This frequency is a qualitative bounding estimate for a potential aircraft crash

g. Resuming processing at the INEL under this alternative is not considered.

**Table 5.15-4.** Summary of radiological accidents for offsite population within 80 k

| Accident Description | Attribute | Alternative 1 No Action | Alternative Decentraliz |
|---|---|---|---|
| 1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEFb | Consequencesc | (d) | (d) |
| | Adjusted annual frequency | 1.0y10-2 | 1.2y10-2 |
| | Adjusted point estimate of riske | (d) | (d) |
| 2. Uncontrolled chain reaction (criticality) at ICPPf | Consequencesc | 3.0y10-4 | 3.0y10-4 |
| | Adjusted annual frequency | 1.0y10-3 | 1.0y10-3 |
| | Adjusted point estimate of riske | 3.0y10-7 | 3.0y10-7 |
| 3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach | Consequencesc | 7.0y100 | 7.0y100 |
| | Adjusted annual frequency | 1.0y10-5 | 1.0y10-5 |
| | Adjusted point estimate of riske | 7.0y10-5 | 7.0y10-5 |
| 4. Material release from HFEF resulting from aircraft crash and ensuing fire | Consequencesc | 1.0y100 | 1.0y100 |
| | Adjusted annual frequency | 1.0y10-7g | 1.0y10-7g |
| | Adjusted point estimate of riske | 1.0y10-7 | 1.0y10-7 |
| 5. Inadvertent nuclear criticality ICPPf CPP-666 during processing | Consequencesc | (h) | (h) |
| | Adjusted annual frequency | (h) | (h) |
| | Adjusted point estimate of riske | (h) | (h) |
| 6. Hydrogen explosion in ICPPf CPP-666 dissolver | Consequencesc | (h) | (h) |
| | Adjusted annual frequency | (h) | (h) |
| | Adjusted point estimate of riske | (h) | (h) |
| 7. Inadvertent dissolution of 30-day cooled fuel at ICPPf CPP-666 | Consequencesc | (h) | (h) |
| | Adjusted annual frequency | (h) | (h) |
| | Adjusted point estimate of riske | (h) | (h) |

a. The radiological accident results for Alternative 4b(1), "Regionalization by Gec Alternative 5b, as discussed in Section 5.15.4.4. The radiological accident res presented for Alternative 5a, as discussed in Section 5.15.4.4.

b. HFEF = Hot Fuel Examination Facility.

c. Consequences are presented in terms of latent fatal cancers based on conservativ estimated exposure (i.e., dose) by an International Commission on Radiological F (or 1.0 y 10-3 cancer per rem if the estimated population exposure is greater th

d. The safety analysis report utilized for this accident analysis does not provide As demonstrated by the dose to the maximally exposed individual, consequences tc 4. However, given the high frequency for this accident compared to Accidents 2

e. This attribute is equal to consequences y frequency (events per year). The infc
f. ICPP = Idaho Chemical Processing Plant.
g. This frequency is a qualitative bounding estimate for a potential aircraft crash
h. Resuming processing at the INEL under this alternative is not considered.

Figure 5.15-1. Comparison of fatality rates among workers in various industry gr
Processing Plant CPP-601 Fuel Element Cutting Facility failed during decontaminatic estimated 100 curies of particulate radioactivity were released over an area of apr (0.809 square kilometers) in the vicinity of the Idaho Chemical Processing Plant. 39 curies became airborne, resulting in an estimated dose of 0.11 millirem to a hyp individual located at the nearest site boundary (DOE 1991).

Three inadvertent nuclear chain reactions (i.e., nuclear criticalities) occurre Chemical Processing Plant in 1959, 1961, and 1978. The 1959 criticality occurred i and cell floor drain collection tank. Available evidence indicates that the critic from an accidental transfer of concentrated uranyl nitrate solution to the waste cc a line normally used to transfer decontaminating solutions to the waste tank. The release from this incident was 3,700 curies, and the estimated dose to the maximall hypothetical individual located at the nearest site boundary was 1.1 millirem (DOE and 1978 nuclear criticalities resulted from spent nuclear fuel dissolution and rep Estimated releases to the environment as a result of these accidents were 120 curie the 1961 and 1978 accidents, respectively, and the calculated radiation doses at th boundary were less than 0.1 millirem for both releases (DOE 1991).

The INEL Fluorinel and Storage (FAST) facility (CPP-666), which historically pe nuclear fuel-related reprocessing activities, is currently shut down. Activities a this facility in a permanent shutdown mode. Restart of this facility and the poten nuclear criticality resulting from operating this facility are considered in Sectic [Alternatives 4b(1) and 5b, respectively]. Because DOE has no current plans to res fuel reprocessing activities at the Idaho Chemical Processing Plant, events similar nuclear criticalities discussed above will be unlikely in future INEL spent nuclear activities. Additional information regarding the historical accidents summarized a Slaughterbeck et al. (1995).

In the site's 40-year history, three prompt fatalities of INEL workers have occ involving radiation exposure. In 1961, a steam explosion resulting from an unplann criticality in an experimental reactor (Stationary Low-Power Reactor No. 1) killed were manually moving reactor control elements. The estimated dose from this accide hypothetical individual located at the nearest site boundary was approximately 3 mi All the accidents discussed above have caused contamination that has led to seconda as the contamination of facility equipment and land inside the site boundary, and h cleanup.

Twenty workers at the Argonne National Laboratory-West facility area were injur 1994 when, in an accident involving toxic material exposure, approximately 9 kilogr of chlorine gas used to treat potable (i.e., drinking) water were accidently releas Although an investigation into this incident by the DOE was still ongoing at the ti performed, the accident is presumed to have occurred while a vendor was removing an nearly empty chlorine cylinder. A maintenance employee assisting in the activity a disconnected the nearly empty in-service chlorine gas cylinder from the potable wat cylinder valve in the open position, resulting in the remaining tank contents being environment. As a result of the accidental release, 20 workers were sent to a loca workers reported for treatment of minor respiratory distress, one worker reported s serious respiratory problems, and one worker reported back injuries as a result of responding to the accident. (ANL 1994 and DOE 1994b).

## 5.15.3 Methodology for Determining the Maximum Reasonably Foreseeable Radiological Accidents

### 5.15.3.1 Selection of Spent Nuclear Fuel Facilities and Operations Requiring

Accident Analyses. The accident analyses performed to support this EIS considered nonreactor nuclear facilities that support spent nuclear fuel-related activities wi those at the Naval Reactors Facility (NRF) area. Appendix D of this EIS discusses nuclear fuel management alternatives and postulated accident scenarios associated w Reactors Facility and other naval spent nuclear fuel facilities.

DOE Order 5480.23 (DOE 1992a) defines nonreactor nuclear facilities as those ac

operations that involve radioactive or fissionable materials in such form and quant hazard potentially exists to the workers or the general public. This analysis cons fuel facilities designed and constructed as direct support to reactor facilities (e Reactor Storage Canal, which stores spent nuclear fuel and irradiated fuels) as non fuel facilities.

DOE manages spent nuclear fuel at the following INEL facility areas: Idaho Che Processing Plant, Naval Reactors Facility, Test Reactor Area, Auxiliary Reactor Are Facility, Argonne National Laboratory-West, and Test Area North. For further infor the activities conducted in these areas, refer to Chapter 2. After identifying all facilities within these facility areas that stabilize, handle, or store spent nucle ranked the facilities according to potential hazards using preexisting facility "ha DOE Order 5480.23 requires contractors operating nonreactor nuclear facilities to p classification of a facility to assess the consequences of an unmitigated release c hazardous material in one of the following categories(1):

- Category 1. The hazard analysis shows the potential for significant offsite
- Category 2. The hazard analysis shows the potential for significant onsite
- Category 3. The hazard analysis shows the potential for only significant lc consequences.

The classification of nonreactor nuclear facilities in one of these three categ accordance with DOE Standard DOE-STD-1027-92 (DOE 1992b). This standard provides g for the hazard categorization of nuclear facilities based on facility inventories c potential for those radionuclides to affect workers or the public if released to th

This analysis used these categories as a screening threshold to identify those (i.e., those spent nuclear fuel-related facilities with sufficient quantities of ra potential for significant impacts to workers or the public if released to the envir excluded (screened out) Category 3 (low hazard) facilities if they present possible consequences enveloped by postulated accidents at Category 2 facilities. Facilitie classification of 2 or greater (or Category 3 facilities that were not screened out further, as discussed in the next section.

#### 5.15.3.2 Determination of Maximum Reasonably Foreseeable Radiological

Accidents. After determining spent nuclear fuel-related facilities with sufficient radionuclides to present radiological consequences to workers or the public (as dis

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1. These categories were formerly labeled "high", "moderate," and "low" in accordan with DOE Order 5480.23 for nonreactor nuclear facilities.

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Section 5.15.3.1), the analysis generated potential accident scenarios for each of by performing the following activities:

- Reviewing historic spent nuclear fuel-related accidents that have occurred history of the INEL.
- Reviewing existing accident analyses and safety analysis reports for spent fuel-related activities and facilities.
- Identifying potential internal, external, and natural phenomena events that spent nuclear fuel-related accidents other than those previously analyzed.
- Performing additional accident analyses for those accidents considered to p consequences to workers or the public, as necessary.

The analysis considered internal and external initiators associated with a wide (e.g., research and development and construction or modification of facilities) not in existing safety analyses. For example, potential radiological accident scenaric construction activities associated with constructing new spent nuclear fuel-relatec modifying existing spent nuclear fuel-related facilities (as proposed under the var were postulated. Typically, events involved in the construction of new spent nucle facilities would act as external initiators to existing facilities, while events in existing spent nuclear fuel facilities would act as internal initiators. Examples industrial-type events that could initiate a radiological accident included fires, puncture events, equipment failure, and human error.

Additional considerations used to determine potential internal and external ini lead to spent nuclear fuel-related radiological accidents included vulnerabilities handling, stabilizing, and storing severely degraded spent nuclear fuel and equipme November 1993, DOE issued a report (DOE 1993c) discussing vulnerabilities associate spent nuclear fuel-related facilities across the DOE complex. The report identifie

the CPP-603 Underwater Fuel Storage Facility, as requiring immediate management att unnecessary increases in worker exposures, cleanup costs, and postulated accident f Activities have begun to stabilize spent nuclear fuel inventories in the CPP-603 fa them to another facility (CPP-666); these activities will continue for several year 1995 Record of Decision for this EIS. Therefore, the analysis considered postulate associated with stabilizing and relocating CPP-603 spent nuclear fuel inventories t accident initiators in developing the radiological accidents summarized in this EIS accident scenarios considered as a result of degraded spent nuclear fuel or facilit inadvertent nuclear criticalities, physical damage of spent nuclear fuel and spent and radionuclide releases resulting from handling and stabilizing degraded spent nu postulated accident scenarios at facilities other than the CPP-603 Underwater Fuel analysis also considered the potential for long-term degradation of facility struct spent nuclear fuel inventories that could lead to an increased probability for radi

To compare the various possible spent nuclear fuel-related accident scenarios a those maximum reasonably foreseeable accidents that present the greatest consequenc the public, the analysis divided each postulated spent nuclear fuel-related acciden frequency category (abnormal events, design-basis accidents(2), or beyond-design-ba according to its estimated frequency of occurrence. Table 5.15-5 lists the frequen with the abnormal event, design-basis accident, and beyond-design-basis accident ca in Section 5.15.1.

The estimated frequency of each postulated accident was based on an identificat physical basis for the accident and the events required for the accident to occur. postulated accidents or their constituent events (initiators or precursors) have ra frequency data based on historic experience were not available. Therefore, in many necessary to develop a frequency estimate on the basis of events for which experien engineering judgment. More than 40 sources of frequency data for the accident even reviewed, including analyses and reports prepared for the DOE, U.S. Nuclear Regulat (NRC), Electric Power Research Institute, and private industry. [For further infor development of estimated accident frequencies, refer to Slaughterbeck et al. (1995)

After the division of the postulated spent nuclear fuel-related accidents into defined in Table 5.15-5, the analysis identified the postulated nonprocessing-relat each frequency range determined to present the maximum offsite consequences as a ma

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2. For facilities where design-basis accident analyses were unavailable, evaluation accident scenarios (postulated accident scenarios used where documented design basi analyses do not exist) were considered in accordance with DOE-DP-STD-3005-YR (DOE 1

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**Table 5.15-5.** Accident frequency categories.

| Frequency Category | Accident Frequency Range (accidents per year) |
|---|---|
| Abnormal events | frequency > 1y10-3 per year |
| Design-basis accidents | 1y10-3 per year > frequency > 1y10-6 per year |
| Beyond-design-basis accidents | 1y10-6 per year > frequency > 1y10-7 per year |

reasonably foreseeable radiological accident to be further analyzed for this EIS. nonprocessing-related accident scenarios were chosen as maximum reasonably foreseea because of the shutdown status of the INEL facility (CPP-666) that historically prc fuel. However, because existing inventories of spent nuclear fuel at the INEL woul increase under Alternatives 4b(1) and 5b [Regionalization by Geography (INEL) and C the INEL, respectively], there could be a need to resume processing operations to s spent nuclear fuel operations and assure adequate storage space for spent nuclear f other sites(3). Therefore, in addition to the maximum reasonably foreseeable nonpr accident scenarios, this analysis considers the three postulated processing-relatec the maximum offsite consequences as additional maximum reasonably foreseeable accic Alternatives 4b(1) and 5b.

In addition, a postulated inadvertent nuclear criticality accident at the CPP-6 Storage Facility was considered for further analysis because significant vulnerabil its spent nuclear fuel inventories have been identified (DOE 1993b) and postulated have been addressed in virtually all nonreactor DOE EISs and safety analysis report accidents are reasonably foreseeable because of public concerns regarding their pot the seven radiological accidents summarized in Section 5.15.4 were determined to be reasonably foreseeable radiological accidents (i.e., greatest consequences). Furth analysis information for each of these accidents, as well as other accidents analyz Slaughterbeck et al. (1995). Appendix D identifies maximum reasonably foreseeable

associated with transporting, receiving, handling, and storing naval spent nuclear
The postulated accidents summarized in this section considered with the INEL facili

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3. Processing would be performed in the Flourinel and Storage (FAST) facility (CPP-
a new facility to be constructed, the Fuel Processing Restoration (FPR) facility (C
Processing would consist of dissolving spent nuclear fuel to immobilize radionuclic
final waste disposal.

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Appendix D provide a basis for characterizing the potential risks and consequences
managing spent nuclear fuel at the INEL over the next 40 years.

Seismic events were the only identified common-cause initiators with the potent
radioactive material releases to the environment at more than one spent nuclear fue
the INEL. However, a seismic event resulting in significant damage and radioactive
facilities in more than one facility area (e.g., Idaho Chemical Processing Plant an
considered beyond reasonably foreseeable (frequency less than one in ten million ye
the physical distance and isolation between facility areas. In accordance with DOE
1994a), a seismic event initiating multiple-facility releases in more than one faci
was screened from further consideration because of its extremely low frequency of c

Analyses were performed that evaluated the potential consequences and risks ass
multiple-facility releases within a single INEL facility area resulting from a seve
(Slaughterbeck et al. 1995). For example, within a 500-meter radius in the Idaho C
Plant facility area, there are several spent nuclear fuel facilities, the primary f
749 dry storage facilities and the CPP-666 and CPP-603 underwater fuel storage faci
analysis was performed (Slaughterbeck et al. 1995) to determine whether simultaneou
these facilities could result from a severe seismic event. Because the CPP-666 and
were designed and qualified to withstand a severe seismic event, they are not expec
the consequences and risks resulting from a severe seismic event impacting the Idah
Processing Plant. However, because of known structural deficiencies and vulnerabil
nuclear fuel at the CPP-603 facility, the CPP-603 facility is expected to be signif
following a severe seismic event, resulting in one or more criticalities and the le
basin water to the surrounding environment. While the consequences from these simu
multiple-release mechanisms (one or more criticalities and water drainage) would be
single criticality analyzed for CPP-603 facility (Section 5.15.3.3.2), the conseque
releases are expected to be bounded by the other accidents analyzed in the EIS--pri
event that causes fuel melting at the Argonne National Laboratory-West Hot Fuel Exa
(highest consequence accident), and a fuel handling accident in the same facility (
where risk = consequence x frequency). Similar analyses (DOE 1993a) for the Test A
Argonne National Laboratory-West also demonstrate that potential multiple-facility
multiple-release mechanisms from a single facility resulting from a severe seismic
bounded by accidents postulated for the Hot Fuel Examination Facility. Based on th
the accident selection methodology described 5.15.3.1, the consequences and risks a
multiple-facility releases were screened from further consideration since they do n
bounding accident scenarios within the frequency categories defined in Table 5.15-5

In addition, the screening methodology did not specifically include potential a
associated with operating new spent nuclear fuel handling and storage facilities pr
various alternatives considered in this EIS because postulated accident scenarios f
would bound the consequences associated with potential accidents at new facilities.
is appropriate for two primary reasons. First, the missions of new spent nuclear f
be similar to the missions of existing spent nuclear fuel-related DOE facilities, w
DOE would consider the same types of accident scenarios for the new facilities it c
existing facilities. Second, DOE would design and build new facilities that would
preventive and mitigative features to reduce the frequency and potential consequenc
postulated accidents.

To compare the consequences of the same accident scenario at an identical hypot
constructed at each DOE site included in this EIS (based on local geological and me
conditions), Appendix D summarizes postulated accident scenarios for a new Expended
at Oak Ridge, Hanford Site, Savannah River Site, or Nevada Test Site.

To determine the radiological and toxicological consequences presented throughc
associated with the postulated accidents and with spent nuclear fuel-related activi
the following definitions:

- Worker. An individual 100 meters (328 feet) downwind of the facility locat
  release occurs.4
- Nearest Public Access. The nearest point of public access to the location
  occurs, sometimes inside the site boundary.

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4. The worker is defined as the individual located at 100 meters because reliable s quantifying the impacts (e.g., dose and health effects) to workers at distances les (i.e., "close-in" workers) meters fram an accidental release of radionuclides are u The effects on and risks to workers closer in than 100 meters are recognized and di Section 5.15.3.3. Each of the maximum reasonably forseeable accidents considered in particularly the design-basis and beyond-design-basis accidents, contains some risk or death at distances closer than 100 meters.

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- Maximally Exposed Offsite Individual. A hypothetical resident at the site to the facility where the release occurs.
- Offsite Population. The collective total of individuals within an 80-kilom radius of the INEL.
- Environment. The area outward from 100 meters (328 feet) downwind of the f the release occurs.

**5.15.3.3 Impact of Accidents on Close-In Workers. An evaluation has been made on the**

radiological impact to close-in workers from the selected accident scenarios. Inju might occur due to an external event, such as a severe seismic disturbance or airpl structure, are not considered in this evaluation since they are not attributable tc consequences. Seven accident scenarios for nonprocessing-related and processing-re considered maximum reasonably foreseeable accidents.

**5.15.3.3.1 Mechanical Handling Accident at the Argonne National Laboratory**

West Hot Fuel Examination Facility - This accident is assumed to result in fuel pin venting of noble gases and iodine.
No fatalities to workers are expected from this event. However, a substantial iodine dose to the thyroid could cause radiation-induced hypothyroidism disorder.

**5.15.3.3.2 Criticality Accident at the Idaho Chemical Processing Plant -**

CPP-603 - This event is an unplanned nuclear criticality associated with underwater fuel storage at the CPP-603 facility.
Based on shielding provided by the pool water, it is likely that no fatalities would occur. To the extent water is expelled due to the energy of th workers could receive substantial radiation exposure. Worker presence in the area very close to the edge of the pool is not routine. The impact of the event would l nearby equipment operators if the criticality were initiated by a handling error.

**5.15.3.3.3 Seismic Event Leading to Fuel Melt at the Argonne National**

Laboratory West Hot Fuel Examination Facility - A seismic event is postulated to r breech of the main cell used for examination of the fuel, which is assumed to lead fuel cooling system.
It is likely that the release of radioactive materials from fuel melting would occu slowly enough to allow evacuation of all workers before any appreciable exposure. radiation-induced fatalities would be expected.

**5.15.3.3.4 Airplane Crash and Fire at Argonne National Laboratory West Hot**

Fuel Examination Facility - An airplane crash and subsequent fire sustained by airp could result in a major breach of the confinement barriers and could lead to a subs release of radionuclides.
Workers unaffected by the airplane crash or fire would not be expected to remain in the area long enough to receive substantial radiation exposure. It is as of the radioactive material due to the fire would mitigate the direct radiological workers, substantially reducing the likelihood of radiation induced worker fataliti

**5.15.3.3.5 Criticality Accident During Processing at the Idaho Chemical**

Processing Plant - CPP-666 - This is the first of three evaluated accidents that cc if processing were resumed at the Fluorinel and Storage Facility (FAST). Three inadvertent nuclear criticalities have occurred in INEL processing facilities and none has resulted in each event, radioactive material was released to the atmosphere and close-in worker exposure. If processing were resumed, the techniques and controls implemented to p of processing-related criticalities would be employed again. Due to the cell wall concrete walls that are several feet thick, it is expected that no workers would re radiation exposure.

**5.15.3.3.6 Hydrogen Explosion at the Idaho Chemical Processing Plant - A**

hydrogen explosion in the dissolver off-gas system of the Flourinel and Storage (FA result in release of radioactive material to the facility. If workers were near the dissolver off-gas system, they could receive substantial radiation exposure from the explosion. No f expected, but radiation-induced health detriments could occur.

**5.15.3.3.7 Dissolution of Short-Cooled Fuel at the Idaho Chemical Processing**

Plant - An explosion in the dissolver tank could occur if fuel that has not cooled was inadvertently shipped to the dissolver at the Flourinel and Storage Facility (F This energetic event would likely breach the dissolver off gas system and could breach the dissolv in the areas closely associated with the dissolver tank could receive substantial r it is likely that no radiation-induced fatalities would occur.

**5.15.3.4 Analysis of Radiological Accident Consequences. The quantities of**

radioactive materials and the ways these materials interact with human beings are i determining health effects. The ways in which radioactive materials reach human be absorption and retention in the body, and the resulting health effects have been st The International Commission on Radiological Protection (ICRP) has made specific re for quantifying these health effects (ICRP 1991). This organization is the recogni establishing standards for the protection of workers and the public from the effect exposure. Health effects can be classified into two categories: prompt (also refe latent. Prompt health effects are those experienced immediately after exposure and the body up to and including death. Latent health effects are those experienced sc exposure and include cancers and hereditary symptoms. An INEL-developed computer c Radiological Safety Analysis Computer Program-5 (RSAC-5), estimates potential radia maximally exposed individuals or population groups from accidental releases of radi code, which is customized to specific INEL conditions, uses well-established and ge scientific engineering principles as the basis for its various calculational steps. guidance provided in NRC Guide 1.145 (NRC 1983) and has been validated to comply wi standards for such software. [For a detailed description of RSAC-5, refer to Slaug (1995).]

The RSAC-5 code determined estimated consequences to the worker, an individual be stranded at the nearest point of public access, the maximally exposed hypothetic nearest site boundary, and the offsite population within 80 kilometers (50 miles) c accidents postulated under Alternative 1, No Action. Postulated frequencies and cc analyzed under Alternative 1 are based on (1) the approximate amount of spent nucle at the INEL [measured in Metric Tons Heavy Metal (MTHM)], (2) the estimated increas inventories resulting from spent nuclear fuel generated by operating INEL reactors removed from a reactor that has not had sufficient time to cool), and (3) the estim handling activities associated with stabilizing or relocating spent fuel inventorie boundary. Although the four nonprocessing-related maximum reasonably foreseeable r accident scenarios identified for Alternative 1 are also considered under Alternati proposed changes in INEL spent nuclear fuel inventories and the number of fuel hand

associated with these changes could affect the estimated frequencies and consequenc Alternatives 2 through 5. Therefore, to reasonably estimate the frequencies and cc associated with activities proposed under Alternatives 2 through 5, the frequencies for the accidents presented under Alternative 1 require appropriate "adjustment" or

To be conservative, the analysis assumed that the increase in the annual freque handling accidents would be equal to the estimated increase in the annual number of proposed under Alternatives 2 through 5. However, the consequences associated with handling accident would not vary with a change in the number of handling events bec of material involved in each event would not change. To determine potential change mechanical handling accident frequencies between the different spent nuclear fuel m alternatives, the analysis based its estimates of the annual number of fuel handlin alternative on spent fuel shipment rates anticipated for the next 40 years, as disc Estimates of long-term (40-year) and short-term (5-year) shipments at the INEL were determining the annual shipment rates for each alternative. The basis for the numb shipments include spent nuclear fuel the INEL will continue to receive from operati DOE, Naval Nuclear Propulsion Program, university, and research reactors. Short-te consist of shipments that would be required to relocate existing spent fuel invento under the various alternatives. Table 5.15-6 summarizes the estimated annual shipm from the INEL under each alternative, and within INEL site boundaries. The estimat Table 5.15-6 consider both onsite and offsite shipments.

**Table 5.15-6.** Determination of accident frequency adjustment factors for Alternati based on estimated number of annual spent nuclear fuel shipments under each alterna

| Alternative | Estimated Shipment Rate (per year)a | Adjustment Fact (shipment rate/baseline) |
|---|---|---|
| 1. No Action | 41 | Baseline |
| 2. Decentralization | 50 | 1.2 |
| 3. 1992/1993 Planning Basis | 128 | 3.1 |
| 4a. Regionalization by Fuel Type | 195 | 4.8 |
| 4b(1) Regionalization by Geography (INEL) | 824 | 20.0 |
| 4b(2) Regionalization by Geography (Elsewhere) | 351 | 8.6 |
| 5a. Centralization at Other DOE Sites | 351 | 8.6 |
| 5b. Centralization at the INEL | 824 | 20.0 |

a. Data presented for the estimated annual shipment rate is based on information ta Appendix I. The annual shipment rate for the No-Action Alternative (baseline) i Table 3 of Wichmann 1994.

Based on the number of annual shipments estimated for Alternatives 2 through 5, Table 5.15-6, the analysis calculated multiplication factors by dividing the estima **under Alternatives 2 through 5 by the baseline (Alternative 1) shipment rate.** To d estimated frequency for the maximum reasonably foreseeable mechanical handling acci each alternative, the frequency identified for Alternative 1 was multiplied by the adjustment factor. The same approach determined estimated frequencies for Accident breach and noble gases and iodine release from the Hot Fuel Examination Facility) u Alternatives 2 through 5. For Accident 2 (inadvertent criticality in the CPP-603 U Storage Facility resulting from a handling accident associated with degraded spent estimated frequency considered under Alternative 1 (1 y 10-3 event per year) is bas handling activities associated with relocation of the CPP-603 spent nuclear fuel in CPP-666 facility. Because proposed changes in INEL inventories under the different would not affect handling events associated with relocating spent fuel from the CPP CPP-666 facility, the estimated frequency for this mechanical handling event would result of this approach and the fact that 3 of the 4 accident scenarios that presen consequences are not handling accidents, Accident 1 is the only accident requiring each alternative.

Variable source-term-sensitive accidents would have consequences that depended c spent nuclear fuel in storage. One example is the accidental drainage of a spent f results in the release of corrosion products in the canal to the environment. The inventory in the canal, the larger the release of corrosion products to the environ draining the canal. (Drainage of a water canal completely filled with spent nuclea considered in the determination of the maximum reasonably foreseeable accidents and to present lower consequences than other accident scenarios analyzed.) Variable sc accidents depend only on spent nuclear fuel inventories and do not require adjustme estimated frequencies of occurrence. Because none of the postulated accidents summ

Alternative 1 is source-term sensitive (e.g., spent nuclear fuel inventories in the Facility are not likely to increase), adjustment of the estimated consequences calc Alternative 1 is not required for Alternatives 2 through 5.

## 5.15.4 Impacts from Postulated Maximum Reasonably Foreseeable Radiological Accidents

Section 5.15.4.1 summarizes impacts (e.g., exposures and health effects) from th nonprocessing-related maximum reasonably foreseeable radiological accidents postula Alternative 1 (No Action). Sections 5.15.4.4.2.1 through 5.15.4.5.2 describe chang postulated accident impacts resulting from changes in spent nuclear fuel inventorie activities under the other alternatives. Sections 5.15.4.4.2.1 and 5.15.4.5.2 alsc from three additional maximum reasonably foreseeable accidents associated with resu processing activities at the INEL. Section 5.15.6 provides more information about and analyses performed for each of the radiological accidents discussed under each

### 5.15.4.1 Alternative 1: No Action. Based on the quantity of spent nuclear fuel at the INEL

(excluding naval fuel at Naval Reactors Facility, which is analyzed in Appendix D), configuration (wet versus dry), the amount of time the spent fuel has been allowed consideration of various internal, external, and natural phenomena initiators (as d Section 5.15.3), the postulated accidents listed in Table 5.15-7 would have the gre consequences within the abnormal event, design-basis accident, and beyond-design-ac under this alternative. For each accident, Table 5.15-7 also lists estimated accid radiation exposures to the offsite population within 80 kilometers (50 miles), a me stranded at the nearest point of public access inside the INEL site boundary, a hyp exposed individual (MEI) at the nearest site boundary, and a worker; point estimate risk of the maximally exposed individual contracting a fatal cancer during his/her of the radiation exposure; and point estimates of risk of the expected number of fa (annualized and total) in the offsite population. The estimates of the consequence offsite population are based on conservative (95 percentile) and average (50 percen conditions(5). The estimates of the consequences and risk to the maximally exposed based on conservative (95 percentile) meteorological conditions. The postulated ac Table 5.15-7, in conjunction with the maximum reasonably foreseeable spent nuclear identified for the INEL Naval Reactors Facility in Appendix D, characterize the pot and risks associated with the proposed spent fuel management activities at the INEL alternative.

Atmospheric transport of radionuclides from the postulated accidents could resu **secondary impacts, such as contamination of the environment or impacts to national**

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5. Conservative (95 percentile) meteorological conditions are defined as the meteorlogical conditions that, for a given release, the concentration at a fixed receptor location will not be exceeded 95 percent of the time. Average (50 percenti meteorological conditions are defined as the meteorological conditions that, for a given release, the concentration at a fixed receptor location will not be exceeded 50 percent of the time.

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**Table 5.15-7.** Impacts from selected maximum reasonably foreseeable radiological ac Alternative 1, No Action (50 and 95 percentile meteorological conditions).

| Accident | Frequency (events per year) | Worker Dosea (rem) | Nearest Public Accessb (rem) | Dose to MEIc (rem) | Offsite Population Dose (95%) (person-rem) | Pc (p MF 95 |
|---|---|---|---|---|---|---|
| 1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEFe | 1.0y10-2 | (f) | (f) | 2.0y10-3 | (f) | 1. |
| 2. Inadvertent criticality in ICPPg CPP-603 storage facilityh | 1.0y10-3 | 9.7y10-2 | 1.4y10-3 | 1.0y10-3 | 5.9y10-1 | 5. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach | 1.0y10-5 | 6.2y10-1 | 6.5y10-1 | 5.0y100 | 1.4y104 | 2. |
| 4. Material release from HFEF resulting from aircraft crash and ensuing fire | 1.0y10-7(i) | 4.6y100 | 3.2y10-1 | 5.0y100 | 2.0y103 | 2. |

a. A worker is defined as a worker located 100 meters (328 feet) from the point of
b. Public individual assumed to be stranded at the nearest point of public access i
c. MEI = Maximally exposed hypothetical offsite individual, located at the nearest
d. Maximally exposed individual and offsite population fatal cancer risk = dose y a 5.0 y 10-4 fatal cancer per rem (ICRP-60 conversion factor) if dose is less than more the ICRP-60 conversion factor is doubled, or 1.0 y 10-3. Numbers in parent number of fatal cancers in the population if the accident occurred.
e. HFEF - Hot Fuel Examination Facility.
f. The safety analysis report utilized for this accident analysis does not provide developed prior to DOE Order 5480.23 requiring this information. As demonstrate maximally exposed individual, consequences to the public from this accident coul consequences from Accidents 2 through 4.
g. ICPP = Idaho Chemical Processing Plant.
h. Although three nuclear criticalities associated with spent nuclear fuel reproces the INEL during its 40-year operating history, the estimated frequency for an in based on historic reprocessing data because reprocessing is not considered under frequency estimates vary from 1.0 y 10-4 (CPP-666 underwater storage facility) t underwater storage facility) event per year.
i. This frequency is a qualitative bounding estimate for a potential aircraft crash Section 5.15.6.4.

prevent these radionuclides from increasing any potential safety concerns, DOE woul activities if an accident occurred, and no irreversible environmental impacts would Table 5.15-8 summarizes postulated secondary impacts resulting from the postulated accidents listed in Table 5.15-7.

This analysis takes limited credit for emergency response actions in determining **listed in Table 5.15-7.** DOE would initiate INEL emergency response programs, as ap following the occurrence of an accident to prevent or mitigate potential consequenc emergency response programs, implemented in accordance with 5500-DOE series Orders, involve emergency planning, emergency preparedness, and emergency response actions. emergency response plan utilizes resources specifically dedicated to assist a facil management. These resources include but are not limited to the following:

- INEL Warning Communications Center
- INEL Fire Department
- Facility Emergency Command Centers
- DOE Emergency Operations Centers
- County and State Emergency Command Centers
- Medical, health physics, and industrial hygiene specialists
- Protective clothing and equipment (respirators, breathing air supplies, etc.)
- Periodic training exercises and drills within and between the organizations i implementing the response plans

**5.15.4.2 Alternative 2: Decentralization. Adjustments in estimated accident frequencies**

and point estimates of risk presented for Alternative 1 would be related to (1) the and storage activities associated with the additional spent nuclear fuel inventorie in overall spent nuclear fuel-related storage, relocation, and handling activities Alternative 1. Because no changes in the accident consequences estimated for Alter to occur under this alternative from increased fuel inventories (i.e., the same amo material would accidentally be released to the environment as discussed in Section changes are likely in the postulated secondary impacts listed in Table 5-15-8. Tab summarizes the four postulated accidents with the greatest radiological impacts und

**Table 5.15-8.** Estimated secondary impacts resulting from the maximum reasonably fo Action, assuming conservative (95 percentile) meteorological conditions.

Environmental or Social Impacts

| Radiological Accident Summary | (Assuming 88 millirem per year limit with 24-hour-per-day expc | | | |
|---|---|---|---|---|
| | Biotic Resources | Water Resources | Economic Impacts | Na De |
| 1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEFb (1x10-2 per year) | Limited adverse effects expected vegetation or wildlife. | Limited adverse effects expected to surface water or groundwater. | Limited economic impacts expected. Any cleanup required would be localized and could be accomplished with existing workforce and equipment. | Nc na ex |
| 2. Uncontrolled chain reaction (criticality) at ICPPc (1x10-3 per year) | Limited adverse effects expected vegetation or wildlife. | Limited adverse effects expected to surface water or groundwater. | No economic impacts expected. Any cleanup required would be localized and could be accomplished with existing workforce and equipment. | Nc na ex |
| 3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach (1x10-5 per year) | Limited adverse effects expected vegetation or wildlife. | Limited adverse effects expected to surface water or groundwater. | Potential interdiction of affected agricultural products on nearby lands. Local cleanup in the vicinity of HFEF. | Nc na ex |
| 4. Material release from HFEF resulting from aircraft crash and ensuing fire (1x10-7 per year) | Limited adverse effects expected vegetation or wildlife. | Limited adverse effects expected to surface water or groundwater. | Potential interdiction of affected agricultural products on nearby lands. Local cleanup in the vicinity of HFEF. | Nc na ex |

a. Postulated secondary impacts based on 10-microrem-per-hour exposure (88 millirem from the plume. This approach in estimated secondary impacts is conservative be background radiation is 100 millirem per year.
b. HFEF = Hot Fuel Examination Facility.
c. ICPP = Idaho Chemical Processing Plant.
d. To convert acres to square kilometers, multiply by 0.004.

**Table 5.15-9.** Impacts from selected maximum reasonably foreseeable accidents - Alt Decentralization (50 and 95 percentile meteorological conditions).

| Accident | Adjusted Frequencya (events per year) | Worker Doseb (rem) | Nearest Public Accessc (rem) | Dose to MEId (rem) | Offsite Population Dose (95%) (person-rem) |
|---|---|---|---|---|---|
| 1. Fuel handling accident, fuel pin breach, venting of noble gas and iodine at HFEFf | 1.2y10-2 (1.2) | (g) | (g) | 2.0y10-3 | (g) |
| 2. Inadvertent criticality in ICPPh CPP-603 storage facilityi | 1.0y10-3 (1.0)j | 9.7y10-2 | 1.4y10-3 | 1.0y10-3 | 5.9y10-1 |

| | | | | | |
|---|---|---|---|---|---|
| 3. Fuel melting of small number of assemblies at HFEF resulting fr seismic event and ce breach | 1.0y10-5 (1.0) | 6.2y10-1 | 6.5y10-1 | 5.0y100 | 1.4y104 |
| 4. Material release from HFEF resulting from aircraft crash and ensuing fire | 1.0y10-7(k) (1.0) | 4.6y100 | 3.2y10-1 | 5.0y100 | 2.0y103 |

a. Numbers in parentheses indicate multiplication factor used to scale or adjust es under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of
c. Public individual assumed to be stranded at the nearest point of public access i
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest s
e. Maximally exposed individual and offsite population fatal cancer risk = dose y a 5.0 y 10-4 fatal cancer per rem (ICRP-60 conversion factor) if dose is less than or more, the ICRP-60 conversion factor is doubled, or 1.0 y 10-3. Numbers in pa number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide developed prior to DOE Order 5480.23 requiring this information. As demonstrate maximally exposed individual, consequences to the public from this accident coul consequences from Accidents 2 through 4.
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reproces the INEL during its 40-year operating history, the estimated frequency for an in based on historic reprocessing data since reprocessing is not considered under t frequency estimates vary from 1.0 y 10-4 (CPP-666 underwater storage facility) t underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was nc alternative.
k. This frequency is a qualitative bounding estimate for a potential aircraft crash Section 5.15.6.4.

5.15.4.3 Alternative 3: 1992/1993 Planning Basis. Under this alternative, the receive the following spent nuclear fuel:

- Spent nuclear fuel from domestic DOE and university reactors and foreign re reactors
- All Training Reactor Isotopics General Atomics (TRIGA) spent nuclear fuel f and Hanford reactors
- Fort St. Vrain spent nuclear fuel from Public Service Company of Colorado
- Special case commercial pressurized water reactor and boiling water reactor fuel from West Valley, New York
- Naval spent nuclear fuel from sites such as the Norfolk or Puget Sound Nava

Adjustments in estimated accident frequencies and point estimates of risk prese Alternative 1 would be related to (1) the receipt, handling, and storage activities additional spent nuclear fuel inventories; and (2) the increase in overall spent fu relocation, and handling activities not allowed under Alternative 1. Because no ch accident consequences estimated for Alternative 1 are likely to occur under this al increased fuel inventories (i.e., the same amount of radioactive material would acc to the environment as discussed in Section 5.15.3.3), no changes are likely in the impacts listed in Table 5.15-8. Table 5.15-10 summarizes the postulated accidents radiological impacts under this alternative.

5.15.4.4 Alternative 4: Regionalization. Under this alternative, there are t Regionalization alternatives: (1) Alternative 4a (Regionalization by Fuel Type), w spent nuclear fuel inventories will be distributed between the DOE sites based prim similarity of fuel types, although DOE would also consider transportation distances stabilization capabilities, available storage capacities, or a combination of these (2) Alternative 4b (Regionalization by Geography), where existing and new spent nuc inventories in the western region of the country will be centralized at a single we existing and new spent nuclear fuel inventories in the eastern region of the countr at a single eastern site.

**Table 5.15-10.** Impacts from selected maximum reasonably foreseeable accidents - Al Planning Basis (50 and 95 percentile meteorological conditions).

| Accident | Adjusted | Worker | Nearest | Dose to | Offsite | A |
|---|---|---|---|---|---|---|

| | Frequencya (events per year) | Doseb (rem) | Public Accessc (rem) | MEId (rem) | Population Dose (95%) (person-rem) | C M 9 |
|---|---|---|---|---|---|---|
| 1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEFf | 3.1y10-2 (3.1) | (g) | (g) | 2.0y10-3 | (g) | 3 |
| 2. Inadvertent critical in ICPPh CPP-603 storage facilityi | 1.0y10-3 (1.0)j | 9.7y10-2 | 1.4y10-3 | 1.0y10-3 | 5.9y10-1 | 5 |
| 3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach | 1.0y10-5 (1.0) | 6.2y10-1 | 6.5y10-1 | 5.0y100 | 1.4y104 | 2 |
| 4. Material release from HFEF resulting from aircraft crash and ensuing fire | 1.0y10-7(k) (1.0) | 4.6y100 | 3.2y10-1 | 5.0y100 | 2.0y103 | 2 |

a. Numbers in parentheses indicate multiplication factor used to scale or adjust es under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of
c. Public individual assumed to be stranded at the nearest point of public access i
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest s
e. Maximally exposed individual and offsite population fatal cancer risk = dose y a 5.0 y 10-4 fatal cancer per rem (ICRP-60 conversion factor) if dose is less than or more, the ICRP-60 conversion factor is doubled, or 1.0 y 10-3. Numbers in pa number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide developed prior to DOE Order 5480.23 requiring this information. As demonstrate maximally exposed individual, consequences to the public from this accident coul consequences from Accidents 2 through 4. However, given the high frequency for Accidents 2 through 4, the risk could actually be greater than for Accidents 2 t
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reproces the INEL during its 40-year operating history, the estimated frequency for an in based on historic reprocessing data since reprocessing is not considered under t frequency estimates vary from 1.0 y 10-4 (CPP-666 underwater storage facility) t underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was nc alternative.
k. This frequency is a qualitative bounding estimate for a potential aircraft crash Section 5.15.6.4.

**5.15.4.4.1 Alternative 4a - Regionalization By Fuel Type - Adjustments in the estimated**

accident frequencies and point estimates of risk presented for Alternative 1 would receipt, handling, and storage activities associated with the additional spent nucl and (2) the increase in overall spent nuclear fuel-related storage, relocation, and allowed under Alternative 1.

Because no changes in the accident consequences estimated for Alternative 1 are likely to occur under this alternative from increased fuel invent amount of radioactive material would accidentally be released to the environment as Section 5.15.3.3), no changes are likely in the postulated secondary impacts listed Table 5.15-11 summarizes the postulated accidents with the greatest radiological im alternative.

**5.15.4.4.2 Alternative 4b - Regionalization by Geography - Under this alternative, spent**

nuclear fuel inventories in the western region of the country would be centralized
Hanford Site, or Nevada Test Site.
**Alternative 4b(1) considers regionalization at the INEL.**
Alternative 4b(2) considers regionalization at the Hanford Site or Nevada Test Site

**5.15.4.4.2.1 Alternative 4b(1) - Regionalization by Geography (INEL) - Under**

this alternative, existing and new spent nuclear fuel inventories in the western re would be centralized at the INEL. Fuel stabilization would be performed in the Flu (FAST) facility (CPP-666) and a new facility to be constructed, the Fuel Processing facility (CPP-691), to dissolve spent nuclear fuel and stabilize (i.e., immobilize) Because the volume of spent nuclear fuel considered under this alternative is only that considered under Alternative 5b, adjustments in the estimated accident frequen estimates of risk for the four accidents presented under Alternative 1 were conserv equivalent to the adjustments required under Alternative 5b (i.e., centralization c Nuclear Propulsion Program, university, and research reactor spent nuclear fuel in INEL). Adjustments in the estimated accident frequencies and point estimates of ri accidents presented under Alternative 1 would be related to (1) the receipt, handli activities associated with the additional spent nuclear fuel inventories; and (2) t spent nuclear fuel-related storage, relocation, and handling activities not allowed Because no changes in the accident consequences estimated for Alternative 1 are lik this alternative from increased fuel inventories (i.e., the same amount of radioact accidentally be released to the environment as discussed in Section 5.15.3.3), no c the postulated secondary impacts listed in Table 5.15-8.

**Table 5.15-11.** Impacts from selected maximum reasonably foreseeable accidents - Al Regionalization by Fuel Type (50 and 95 percentile meteorological conditions).

| Accident | Adjusted Frequencya (events per year) | Worker Doseb (rem) | Nearest Public Accessc (rem) | Dose to MEId (rem) | Offsite Population Dose (95%) (person-rem) | Ad ca ME 95 |
|---|---|---|---|---|---|---|
| 1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEFf | 4.8y10-2 (4.8) | (g) | (g) | 2.0y10-3 | (g) | 4. |
| 2. Inadvertent criticality in ICP CPP-603 storage facilityi | 1.0y10-3 (1.0)j | 9.7y10-2 | 1.4y10-3 | 1.0y10-3 | 5.9y10-1 | 5. |
| 3. Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach | 1.0y10-5 (1.0) | 6.2y10-1 | 6.5y10-1 | 5.0y100 | 1.4y104 | 2. |
| 4. Material release from HFEF resultin from aircraft cras and ensuing fire | 1.0y10-7(k) (1.0) | 4.6y100 | 3.2y10-1 | 5.0y100 | 2.0y103 | 2. |

a. Numbers in parentheses indicate multiplication factor used to scale or adjust es under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of
c. Public individual assumed to be stranded at the nearest point of public access i
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest s
e. Maximally exposed individual and offsite population fatal cancer risk = dose y a 5.0 y 10-4 fatal cancer per rem (ICRP-60 conversion factor) if dose is less than or more, the ICRP-60 conversion factor is doubled, or 1.0 y 10-3. Numbers in pa number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide

developed prior to DOE Order 5480.23 requiring this information. As demonstrate maximally exposed individual, consequences to the public from this accident coul consequences from Accidents 2 through 4. However, given the high frequency for Accidents 2 through 4, the risk could actually be greater than for Accidents 2 t

h. ICPP = Idaho Chemical Processing Plant.

i. Although three nuclear criticalities associated with spent nuclear fuel reproces the INEL during its 40-year operating history, the estimated frequency for an in based on historic reprocessing data since reprocessing is not considered under t frequency estimates vary from 1.0 y 10-4 (CPP-666 underwater storage facility) t underwater storage facility) events per year.

j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was nc alternative.

k. This frequency is a qualitative bounding estimate for a potential aircraft crash Section 5.15.6.4.

Because the option exists to restart processing activities, three additional proc maximum reasonably foreseeable accidents are considered under this alternative (as Section 5.15.3.2). Since the amount of radioactive material that would accidentall environment from these accidents is expected to be lower than in Accidents 3 and 4 melt and aircraft crash at the Hot Fuel Examination Facility, respectively), potent associated with these additional processing-related accidents would be less severe for the nonprocessing-related accidents in Table 5.15-8.

Table 5.15-12 summarizes the postulated accidents with the greatest radiological alternative.

**5.15.4.4.2.2 Alternative 4b(2) - Regionalization by Geography (Elsewhere) - Under this**

alternative, existing and new spent nuclear fuel inventories in the western region be centralized at either the Hanford Site or Nevada Test Site. Similar to Alternat considers centralization of existing INEL spent nuclear fuel inventories at another inventory of spent nuclear fuel at the INEL would be reduced substantially so that nuclear fuel at the INEL would consist of fresh fuel generated from operating INEL not cooled sufficiently for relocation to the regionalized or centralized site. Th considers the same amount of material considered under Alternative 1 until the regi accept existing inventories of INEL spent nuclear fuel and freshly generated spent sufficiently cooled.

Table 5.15-13 summarizes the postulated accidents with the greatest radiological alternative.

**5.15.4.5 Alternative 5: Centralization. Under this alternative, DOE would collect all**

current and future spent nuclear fuel inventories from both DOE and the Naval Nucle Program at one site. For the INEL, there are two possibilities: (1) Alternative 5 spent fuel inventories and activities would take place at the Hanford Site, Savanna Test Site, or Oak Ridge Reservation; or (2) Alternative 5b, in which all spent fuel activities would be centralized at the INEL.

**5.15.4.5.1 Alternative 5a: Centralization at Other DOE Sites - This alternative**

would consider approximately the same amount of material considered under Alternati centralized site could accept existing INEL spent nuclear fuel inventories and fres Table 5.

**15-12.** Impacts from selected maximum reasonably foreseeable accidents - Alternativ Regionalization by Geography (INEL) (50 and 95 percentile meteorological conditions

| Accident | Adjusted Frequencya (events per year) | Worker Doseb (rem) | Nearest Public Accessc (rem) | Dose to MEId (rem) | Offsite Population Dose (95%) (person-rem) | A c M 9 |
|---|---|---|---|---|---|---|
| 1. Fuel handling | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | accident, fuel pin breach, venting of noble gases and iodine at HFEFf | 2.0y10-1 (20.0) | (g) | (g) | 2.0y10-3 | (g) | 2 |
| 2. | Inadvertent critical in ICPPh CPP-603 storage facilityi | 1.0y10-3 (1.0)j | 9.7y10-2 | 1.4y10-3 | 1.0y10-3 | 5.9y10-1 | 5 |
| 3. | Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach | 1.0y10-5 (1.0) | 6.2y10-1 | 6.5y10-1 | 5.0y100 | 1.4y104 | 2 |
| 4. | Material release from HFEF resulting from aircraft crash and ensuing fire | 1.0y10-7(k) (1.0) | 4.6y100 | 3.2y10-1 | 5.0y100 | 2.0y103 | 2 |
| 5. | Inadvertent nuclear criticality ICPPh CPP-666 during processingl | 1.0y10-3 | 9.1y10+ 0 | 4.9y10-2 | 2.8y10-2 | 5.6y10+0 | 1 |
| 6. | Hydrogen in ICPPh CPP-666 dissolver | 1.0y10-5 | (m) | (m) | 6.3y10-4 | 8.1y10-1 | 3 |
| 7. | Inadvertent dissolution of 30-d cooled fuel at ICPPh CPP-666 | 1.0y10-6 | (m) | (m) | 3.0y10-2 | 2.9y10+1 | 1 |

a. Numbers in parentheses indicate multiplication factor used to scale or adjust es described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of
c. Public individual assumed to be stranded at the nearest point of public access i
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest s
e. Maximally exposed individual and offsite population fatal cancer risk = dose y a (ICRP-60 conversion factor) if dose is less than 20 rem. For doses of 20 rem or 1.0 y 10-3. Numbers in parentheses indicate total number of fatal cancers in th
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide Order 5480.23 requiring this information. As demonstrated by the dose to the ma from Accident 1 could be less than the consequences from Accidents 2 through 4. compared to Accidents 2 through 4, the risk could actually be greater than for A
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reproces operating history of CPP-666, the estimated frequency for an inadvertent critica nuclear conditions and fuel vulnerabilities. Nominal estimates vary from 1.0 y 10-3 (CPP-603 underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was nc
k. This frequency is a qualitative bounding estimate for a potential aircraft crash
l. The Idaho Chemical Processing Plant has experienced three inadvertent nuclear cr 14 years ago. This frequency is based on modern facility conditions and safegua
m. The safety analysis report utilized for this accident does not provide this infc Order 5480.23 requiring this information. However, a comparison of the data pre a relative measure of the impacts to this receptor.

**Table 5.15-13.** Impacts from selected maximum reasonably foreseeable accidents - Al Regionalization by Geography (Elsewhere) (50 and 95 percentile meteorological condi

| Accident | | Adjusted Frequencya (events per year) | Worker Doseb (rem) | Nearest Public Accessc (rem) | Dose to MEId (rem) | Offsite Population Dose (95%) (person-rem) | A c M 9 |
|---|---|---|---|---|---|---|---|
| 1. | Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEFf | 8.6y10-2 (8.6) | (g) | (g) | 2.0y10-3 | (g) | 8 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2. | Inadvertent critical in ICPPh CPP-603 storage facilityi | 1.0y10-3 (1.0)j | 9.7y10-2 | 1.4y10-3 | 1.0y10-3 | 5.9y10-1 | 5 |
| 3. | Fuel melting of small number of assemblie at HFEF resulting from seismic event and cell breach | 1.0y10-5 (1.0) | 6.2y10-1 | 6.5y10-1 | 5.0y100 | 1.4y104 | 2 |
| 4. | Material release from HFEF resulting from aircraft crash and ensuing fire | 1.0y10-7(k) (1.0) | 4.6y100 | 3.2y10-1 | 5.0y100 | 2.0y103 | 2 |

a. Numbers in parentheses indicate multiplication factor used to scale or adjust es under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of
c. Public individual assumed to be stranded at the nearest point of public access i
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest s
e. Maximally exposed individual and offsite population fatal cancer risk = dose y a 5.0 y 10-4 fatal cancer per rem (ICRP-60 conversion factor) if dose is less than or more, the ICRP-60 conversion factor is doubled, or 1.0 y 10-3. Numbers in pa number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide developed prior to DOE Order 5480.23 requiring this information. As demonstrate maximally exposed individual, consequences to the public from this accident coul consequences from Accidents 2 through 4. However, given the high frequency for Accidents 2 through 4, the risk could actually be greater than for Accidents 2 t
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reproces the INEL during its 40-year operating history, the estimated frequency for an in based on historic reprocessing data since reprocessing is not considered under t frequency estimates vary from 1.0 y 10-4 (CPP-666 underwater storage facility) t underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was nc alternative.
k. This frequency is a qualitative bounding estimate for a potential aircraft crash Section 5.15.6.4.

fuel that had cooled sufficiently. On demonstration of the centralized site's capa spent nuclear fuel, the inventory of spent fuel at the INEL would be reduced substa only spent nuclear fuel at the INEL would consist of fresh fuel generated from oper reactors that had not cooled sufficiently for relocation to the centralized site.

Adjustments in estimated accident frequencies and point estimates of risk prese Alternative 1 would be related to (1) the receipt, handling, and storage activities additional spent nuclear fuel inventories; and (2) the increase in overall spent fu relocation, and handling activities not allowed under Alternative 1. Because no ch accident consequences estimated for Alternative 1 are likely to occur under this al increased fuel inventories (i.e., the same amount of radioactive material would acc to the environment as discussed in Section 5.15.3.3), no changes are likely in the impacts presented in Table 5.15-8. Table 5.15-14 summarizes the postulated acciden greatest radiological impacts under these alternatives.

**5.15.4.5.2 Alternative 5b: Centralization at the INEL - Adjustments in estimated**

accident frequencies and point estimates of risk presented for Alternative 1 would receipt, handling, and storage activities associated with the additional spent nucl and (2) the increase in overall spent nuclear fuel-related storage, relocation, and allowed under Alternative 1.

Because no changes in the accident consequences estimated for Alternative 1 are likely to occur under this alternative from increased fuel invent amount of radioactive material would accidentally be released to the environment as Section 5.15.3.3), no changes are likely in the postulated secondary impacts presen Table 5.15-15 summarizes the postulated accidents with the greatest radiological in alternative.

Because the option exists to restart processing activities, three additional pr

maximum reasonably foreseeable accidents are considered under this alternative (as **Section 5.15.3.2)**. Since the amount of radioactive material that would accidentall environment from these accidents is expected to be lower than Accidents 3 and 4 (i. and aircraft crash at the Hot Fuel Examination Facility, respectively), potential s associated with these additional processing-related accidents would be less severe for the nonprocessing-related accidents in Table 5.15-8.

**Table 5.15-14.** Impacts from selected maximum reasonably foreseeable accidents - Al Centralization at Other DOE Sites (50 and 95 percentile meteorological conditions).

| Accident | Adjusted Frequencya (events per year) | Worker Doseb (rem) | Nearest Public Accessc (rem) | Dose to MEId (rem) | Offsite Population Dose (95%) (person-rem) | A c M 9 |
|---|---|---|---|---|---|---|
| 1. Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEFf | 8.6y10-2 (8.6) | (g) | (g) | 2.0y10-3 | (g) | 8 |
| 2. Inadvertent critical in ICPPh CPP-603 storage facilityi | 1.0y10-3 (1.0)j | 9.7y10-2 | 1.4y10-3 | 1.0y10-3 | 5.9y10-1 | 5 |
| 3. Fuel melting of small number of assemblie at HFEF resulting from seismic event and cell breach | 1.0y10-5 (1.0) | 6.2y10-1 | 6.5y10-1 | 5.0y100 | 1.4y104 | 2 |
| 4. Material release from HFEF resulting from aircraft crash and ensuing fire | 1.0y10-7(k) (1.0) | 4.6y100 | 3.2y10-1 | 5.0y100 | 2.0y103 | 2 |

a. Numbers in parentheses indicate multiplication factor used to scale or adjust es under Alternative 1, as described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of
c. Public individual assumed to be stranded at the nearest point of public access i
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest s
e. Maximally exposed individual and offsite population fatal cancer risk = dose y a 5.0 y 10-4 fatal cancer per rem (ICRP-60 conversion factor) if dose is less than or more, the ICRP-60 conversion factor is doubled, or 1.0 y 10-3. Numbers in pa number of fatal cancers in the population if the accident occurs.
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide developed prior to DOE Order 5480.23 requiring this information. As demonstrate maximally exposed individual, consequences to the public from this accident coul consequences from Accidents 2 through 4. However, given the high frequency for Accidents 2 through 4, the risk could actually be greater than for Accidents 2 t
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reproces the INEL during its 40-year operating history, the estimated frequency for an in based on historic reprocessing data since reprocessing is not considered under t frequency estimates vary from 1.0 y 10-4 (CPP-666 underwater storage facility) t underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was nc alternative.
k. This frequency is a qualitative bounding estimate for a potential aircraft crash Section 5.15.6.4.

**Table 5.15-15.** Impacts from selected maximum reasonably foreseeable accidents - Al Centralization at the INEL (50 and 95 percentile meteorological conditions).

| Accident | Adjusted Frequencya (events per year) | Worker Doseb (rem) | Nearest Public Accessc (rem) | Dose to MEId (rem) | Offsite Population Dose (95%) (person-rem) | A c |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | M 9 |
| 1. | Fuel handling accident, fuel pin breach, venting of noble gases and iodine at HFEFf | 2.0y10-1 (20.0) | (g) | (g) | 2.0y10-3 | (g) | 2 |
| 2. | Inadvertent criticality in ICP storage facilityi | 1.0y10-3 (1.0)j | 9.7y10-2 | 1.4y10-3 | 1.0y10-3 | 5.9y10-1 | 5 |
| 3. | Fuel melting of small number of assemblies at HFEF resulting from seismic event and cell breach | 1.0y10-5 (1.0) | 6.2y10-1 | 6.5y10-1 | 5.0y100 | 1.4y104 | 2 |
| 4. | Material release from HFEF resultin from aircraft cras and ensuing fire | 1.0y10-7(k) (1.0) | 4.6y100 | 3.2y10-1 | 5.0y100 | 2.0y103 | 2 |
| 5. | Inadvertent nuclear criticality ICPPh CPP-666 during processingl | 1.0y10-3 | 9.1y10+0 | 4.9y10-2 | 2.8y10-2 | 5.6y10+0 | 1 |
| 6. | Hydrogen in ICPPh CPP-666 dissolver | 1.0y10-5 | (m) | (m) | 6.3y10-4 | 8.1y10-1 | 3 |
| 7. | Inadvertent dissolution of 30-day cooled fuel at ICPPh CPP-666 | 1.0y10-6 | (m) | (m) | 3.0y10-2 | 2.9y10+1 | 1 |

a. Numbers in parentheses indicate multiplication factor used to scale or adjust es described in Section 5.15.3.3.
b. A worker is defined as a worker located 100 meters (328 feet) from the point of
c. Public individual assumed to be stranded at the nearest point of public access i
d. MEI = Maximally exposed hypothetical offsite individual located at the nearest s
e. Maximally exposed individual and offsite population fatal cancer risk = dose y a (ICRP-60 conversion factor) if dose is less than 20 rem. For doses of 20 rem or 1.0 y 10-3. Numbers in parentheses indicate total number of fatal cancers in th
f. HFEF = Hot Fuel Examination Facility.
g. The safety analysis report utilized for this accident analysis does not provide Orders requiring this information. As demonstrated by the dose to the maximally this accident could be less than the consequences from Accidents 2 through 4. H compared to Accidents 2 through 4, the risk could actually be greater than for A
h. ICPP = Idaho Chemical Processing Plant.
i. Although three nuclear criticalities associated with spent nuclear fuel reproces operating history of CPP-666, the estimated frequency for an inadvertent critica nuclear conditions and fuel vulnerabilities. Nominal estimates vary from 1.0 y 10-3 (CPP-603 underwater storage facility) events per year.
j. Refer to Sections 5.15.3.3 and 5.15.6.2 for details on why this frequency was nc
k. This frequency is a qualitative bounding estimate for a potential aircraft crash
l. The Idaho Chemical Processing Plant has experienced three inadvertent nuclear cr 14 years ago. This frequency is based on modern facility conditions and safegua
m. The safety analysis report utilized for this accident does not provide this infc Order 5480.23 requiring this information. However, a comparison of the data pre provides a relative measure of the impacts to this receptor.

### 5.15.5 Impacts from Postulated Maximum Reasonably Foreseeable Toxic Material Accidents

Like radioactive materials, toxic materials (e.g., chemicals) are involved in a operations, including spent nuclear fuel-related activities, at the INEL. As a res and activities, the potential exists for releases of toxic materials to the environ types of initiators considered in determining the radiological accident scenarios d Section 5.15.4. This section summarizes analyses of postulated accident scenarios

spent nuclear fuel activities that could result in the release of toxic materials f

**5.15.5.1 Identification of Toxic Chemicals at the INEL. The facilities at the INEL use**

many types and quantities of chemically toxic materials. To determine the spent fu that exist in sufficient quantities to present health effects to workers or the off performed an initial screening of the chemical inventories at the INEL. This scree identifying those hazardous chemicals at the INEL listed in the Superfund Amendment Reauthorization Act of 1986 (SARA) 312 Report for 1992 (Priestly 1992) that (1) exi quantities [assumed to be greater than 227 kilograms (500 pounds)]; or (2) exceed r [usually 0.45 kilogram (1 pound)] on the EPA Title III List of Lists (EPA 1990), wh hazardous chemicals defined in the following:

- SARA Section 302, Extremely Hazardous Substances (40 CFR Part 355, Appendix B, List of Extremely Hazardous Substances and Their Threshold Planning Quan (CFR 1993)
- Comprehensive Environmental Response, Compensation, and Liability Act Hazar Substances (40 CFR Part 302, Table 302.4, Lists of Hazardous Substances and Quantities) (CFR 1992a)
- SARA Section 313, Toxic Chemicals (CFR 1992b)
- Federal Register list of 100 extremely hazardous chemicals (FR 1994)

**5.15.5.2 Selection of Spent Nuclear Fuel-Related Toxic Chemicals Requiring**

Accident Analysis. As indicated by the screening methodology discussed above, toxi inventories are located throughout INEL facilities in varying quantities and are in operations and activities performed by INEL facilities, including spent nuclear fue The screening identified no toxic chemicals associated with the dry storage of spen Except for processing-related activities that could be performed under the Regional Centralization at INEL alternatives [i.e., Alternatives 4b(1) and 5b, respectively] identified activities associated with the underwater storage of spent nuclear fuel water chemistry) as the only spent nuclear-fuel related activities that might utili sufficient quantities to present a potential for health effects to workers or the c potential contamination of the environment. For Alternatives 4b(2) and 5a, in whic relocate INEL spent nuclear fuel inventories and related activities to other DOE si chemical inventories at the INEL would be expected to slightly decrease. For Alter 5b, in which the INEL could potentially resume processing activities, a substantial chemical inventories, primarily hydrofluoric acid and anhydrous ammonia, would be e substantial changes in existing spent nuclear fuel-related toxic chemical inventori under Alternatives 1, 2, or 3.

To demonstrate how the consequences of the same accident at an identical hypoth constructed at the Hanford Site or the Savannah River Site under this alternative w INEL (based on local geological and meteorological conditions), Appendix D summariz accident scenarios for a new Expended Core Facility that DOE could construct at any considered in this EIS.

To determine potential accident scenarios associated with handling or storing t the various spent nuclear fuel-related facilities, DOE performed an extensive revie analyses and walkdowns of various facilities. This review identified two nonproces chemicals at the Idaho Chemical Processing Plant - nitric acid and chlorine - as re evaluation to determine potential health effects to workers and the offsite populat two toxic chemicals that would be required to support the resumption of processing Idaho Chemical Processing Plant - hydrofluoric acid and anhydrous ammonia - were id requiring further evaluation(6). Although spent fuel-related facilities at the Ida Plant use several other toxic chemicals (e.g., oxalic acid), the quantities of thes sufficient to present an impact to workers or the environment from accidental relea

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6. Although bulk quantities of nitric acid would be required to perform processing could be resumed Alternatives 4b(1) and 5b, the consequences of processing-related involving nitric acid would be bounded by the hydrofluoric acid and anhydrous accid Sections 5.15.3.3. and 5.15.3.4., respectively. Therefore, this analysis focuses on nitric acid accident resulting from the nonprocessing spent nuclear fuel-related ac considered under the other alternatives.

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environment. (For postulated accident scenarios involving Naval spent nuclear fuel

the INEL, refer to Appendix D.)

Because DOE determined that it needed to evaluate postulated toxic chemical acc Idaho Chemical Processing Plant as part of this EIS, it did not consider postulated accidents at the Advanced Test Reactor Storage Canal and the Hot Fuel Examination F could be involved in spent fuel-related activities(7) for further evaluation in thi reasons:

- In general, quantities of spent nuclear fuel-related chemicals at the Idahc Processing Plant are substantially greater than those at the Advanced Test Canal and Hot Fuel Examination Facility.
- The Idaho Chemical Processing Plant is located approximately 1,000 meters ( closer to the nearest site boundary than the Advanced Test Reactor.

Based on a review of safety documentation for the Test Area North spent nuclear storage facility and discussions with facility personnel, DOE determined that none chemicals identified in the screening (Section 5.15.5.1) is related to spent fuel h activities.

**5.15.5.3 Toxic Chemical Accident Analysis. For chemically toxic materials, several**

government agencies recommend quantifying health effects that cause short-term effe values of concentrations in air or water. The long-term health consequences of hum toxic materials are not as well understood as the long-term health consequences rel exposure. Thus, the potential health effects for exposures to toxic chemicals are those for radioactive materials. Factors such as receptor locations, terrain, mete release conditions, and characteristics of chemical inventories are required parame determinations of airborne concentrations of toxic chemicals at various distances f point of release.

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7. The scope of this analysis has been restricted to the Advanced Test Reactor fuel canal. Everything inside the reactor gas-tight boundary and associated with reactor has been excluded from consideration because reactor operations are not related to nuclear fual activities considered in this EIS.

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EPICodeTM was used to estimate airborne concentrations resulting from spent nuc toxic chemical releases at the INEL. [For a detailed description of EPICodeTM, ref et al. (1995).]

To determine the potential health effects from accidental releases of toxic che compared the concentrations determined by EPICodeTM against Emergency Response Plan Guideline values, where available. These values, which are specific for each subst three general severity levels:

- Exposure to concentrations greater than Emergency Response Planning Guideli for a period of time greater than 1 hour results in an unacceptable likelih would experience mild transient adverse health effects, or perception of a objectionable odor.
- Exposure to concentrations greater than Emergency Response Planning Guideli for a period of time greater than 1 hour results in an unacceptable likelih would experience or develop irreversible or other serious health effects, c could impair one's ability to take protective action.
- Exposure to concentrations greater than Emergency Response Planning Guideli for a period of time greater than 1 hour results in an unacceptable likelih would experience or develop life-threatening health effects.

If there were no Emergency Response Planning Guideline values for a toxic subst analysis substituted other chemical toxicity values, as follows:

- Threshold limit values/time-weighted average values (ACGIH 1988) substitute Emergency Response Planning Guideline-1. This is the time-weighted average for a normal 8-hour workday and a 40-hour workweek to which nearly all work repeatedly exposed, day after day, without adverse effect.
- Level of concern values (equal to 0.1 of the immediately dangerous to life see below) substituted for Emergency Response Planning Guideline-2. The le value is the concentration of a hazardous substance in the air above which serious irreversible health effects or death as a result of a single exposu short period of time.
- Immediately dangerous to life or health values are substituted for Emergenc Planning Guideline-3. The immediately dangerous to life or health value is concentration from which a person could escape within 30 minutes without a

without experiencing any impairment of escape or irreversible side effects
As stated in the above section, four toxic chemicals - chlorine, nitric acid, h and anhydrous ammonia - at the Idaho Chemical Processing Plant were identified as r evaluation to estimate potential health effects to workers and the public. The fol summarize the analyses performed for these chemicals.

**5.15.5.3.1 Accidental Chlorine Release - Chlorine, while not directly associated with**

spent nuclear fuel-related activities at the INEL, is used to treat drinking water spent fuel facilities.
Therefore, an analysis of a postulated accidental chlorine release at the Idaho Chemical Processing Plant was performed to determine potential impacts on workers c spent fuel-related facilities.

At the Idaho Chemical Processing Plant, chlorine is contained in two pressurize [65 atmospheres at 20yC (68yF)], a 68-kilogram (150-pound) bottle and a 55-kilogram (120-pound) bottle, totaling 123 kilograms (270 pounds). To be conservative, DOE a breach of the drain line causes an instantaneous release of the total inventory of highest chlorine concentrations at the receptor locations would result from the lar shortest time period. Therefore, the release duration was assumed to be approximat

An accidental chlorine release from one of the chlorine tanks could be initiate events, such as a handling event, piping or valve rupture, or human error. Because physically separated, an accidental simultaneous release from both tanks would requ initiator such as a delivery accident, a common maintenance failure, or a natural p (e.g., seismic) that damaged or punctured both tanks. The frequency of an accident pressurized tank is 1.0 y 10-4 event per year (EPA/FEMA/DOT 1987). A common cause resulting in the release of chlorine from two separated tanks is assumed to be no g of the time given for the first tank failure. Therefore, the estimated frequency c from both tanks is 5.0 y 10-6 events per year (with no credit taken for pressure ve training).

Table 5.15-16 summarizes the concentrations of the subject chlorine release at receptor locations: a facility worker, a member of the public stranded at the near access inside the INEL boundary, and a maximally exposed hypothetical member of the at the nearest site boundary. As listed in Table 5.15-10, the peak chlorine concen workers could result in life-threatening health effects (i.e., Emergency Response P values are exceeded) for both conservative (95 percentile) and average (50 percenti conditions.

**Table 5.15-16.** Summary of chemical concentrations for postulated nonprocessing-rel releases at the Idaho Chemical Processing Plant under Alternatives 1 through 5.

| Receptor Location | Chemical Concentrations (milligrams per cubic meter)a | | |
|---|---|---|---|
| | 95% Meteorologyb | | 50% |
| | Chlorine<br>ERPG-1d = 3 (1)<br>ERPG-2 = 9 (3)<br>ERPG-3 = 60 (20) | Nitric Acide<br>TWA = 5.2 (2)<br>LOC = 25.5 (10)<br>IDLH = 255 (100) | Chl<br>ERP<br>ERP<br>ERP |
| 1. Worker located at 100 meters (325 feet). | 84,000<br>(28,000) | 250<br>(95) | 1,6<br>(54 |
| 2. Nearest point of public access where a member of the public is assumed stranded at the time of the release.f | 19.5<br>(6.5) | 0.32<br>(0.12) | 1.8<br>(0. |
| 3. Maximally exposed hypothetical individual located at the nearest site boundary.g | 4.2<br>(1.4) | 0.12<br>(0.047) | 0.4<br>(0. |

a. Numbers in parentheses reflect concentrations in parts per million.
b. The 95 percentile meteorology is based on Class F (unfavorable) meteorological c second (1.1 miles per hour) wind speed for receptors located within 2 kilometers and 2 meters per second (4.5 miles per hour) for receptors beyond 2 kilometers c
c. The 50 percentile meteorology is based on Class D (typical) meteorological condi second (10 miles per hour) wind speed for all receptors.
d. ERPG = Emergency Response Planning Guidelines.

e. Because Emergency Response Planning Guideline values are not available for nitri average values are substituted for ERPG-1 values, level of concern values are su and immediately dangerous to life or health values are substituted for Emergency Guideline-3 values. Refer to Section 5.15.5.3 for further information regarding
f. The nearest point of public access from this postulated release is 5,870 meters
g. The nearest site boundary is located at 14,000 meters (15,310 yards).

Peak chlorine concentrations estimated at the nearest point of public access ca Emergency Response Planning Guideline-2 value assuming 95 percentile meteorological listed in Table 5.15-10. Symptoms associated with exposure to these concentrations burning of the eyes, nose, and throat, coughing, choking, and possibly skin burns.

As listed in Table 5.15-16, the estimated peak averaged chlorine concentration boundary would be above the Emergency Response Planning Guideline-1 value for 95 pe meteorological conditions. However, due to the nature of the release, this concent would not last for more than a few minutes. Therefore, it would be likely that inc distance would experience no more than mild transient adverse health effects.

This analysis took limited credit for emergency response actions following a ch calculating the concentrations listed in Table 5.15-16. To mitigate the consequenc release to the environment, the same emergency response programs and actions descri radiological accident scenarios (Section 5.15.4.1) would be initiated following the actual health effects experienced by persons inside the site boundary would realist the values listed in Table 5.15-16.

Because the estimated airborne concentration of chlorine at 100 meters (328 fee exceeds the guidelines listed in Table 5.15-16, workers could be fatally injured or long-term or permanent health effects. Potential secondary impacts associated with accident scenario would involve economic impacts such as workers' compensation, med potential lawsuits. No other secondary impacts, such as impacts on national defens resources, were identified.

**5.15.5.3.2 Accidental Nitric Acid Release - Nitric acid is used at various spent**

nuclear fuel-related storage facilities for maintaining the chemistry of the water storage facilities(8).

Based on the toxic chemical screening discussed in Section 5.15.5.1, review of existing safety analyses, walkdowns of spent nuclear fuel-related facilities, and i

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8. Although bulk quantities of nitric acid would be required to perform processing could be resumed under Alternatives 4b(1) and 5b, the consequences of processing-re involving nitric acid would be bounded by the hydrfluoric acid and anhydrous accide in Sections 5.15.5.3.3. and 5.15.5.3.4., respectively. Therefore, this analysis foc potential nitric acid accident resulting from the non-processing spent nuclear fuel activities considered under the other alternatives.

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personnel, DOE determined that the potential exists for an accidental release of ni two 1,135 liters (300-gallon) storage tanks used to support spent nuclear fuel-rela activities at the Idaho Chemical Processing Plant. Because one of the tanks is usu tanks have separate valves, and they are physically separated, DOE could not identi likely initiator that could cause an accidental simultaneous release from both tank

The quantity of nitric acid assumed available for release from a single initiat (1,135 liters) 300 gallons. The following assumptions were made for this analysis:

- An initiating event causes severe structural damage (e.g., large puncture)
- The entire inventory of nitric acid is released into the containment wall s storage tank.
- The area of the containment wall is approximately 28 square meters (300 squ
- The total release of nitric acid [i.e., 1.135 liters (300 gallons)] evapora atmosphere before the implementation of emergency response procedures can r nitric acid.

Table 5.15-16 summarizes the concentrations of the nitric acid release at the f locations for both conservative (95 percentile) and average (50 percentile) meteorc a facility worker, a member of the public stranded at the nearest point of public a INEL boundary, and a maximally exposed hypothetical member of the public at the nea boundary. The estimated frequency for this event is 1 y 10-5 events per year.

This analysis took limited credit for emergency response actions following a ni calculating the concentrations listed in Table 5.15-16. To mitigate the consequenc environment, the same emergency response programs and actions described for radiolc

scenarios (Section 5.15.4.1) would be initiated following a nitric acid release. T effects experienced by persons inside the site boundary would realistically be less listed in Table 5.15-16.

Other than limited economic secondary impacts, no other secondary impacts would this accident occurred.

### 5.15.5.3.3 Accidental Hydrofluoric Acid Release - To resume spent nuclear fuel

processing activities at the Fluorinel and Storage (FAST) facility (CPP-666), which shutdown and being placed in a permanent shutdown mode, bulk quantities of hydroflu be required to support the dissolution process.

A hydrofluoric acid storage tank with an operating capacity of approximately 30,283 liters (8,000 gallons) is located in the Idaho Che Plant facility area to support processing activities, although only 11,356 liters ( hydrofluoric acid remain in the tank, and efforts are currently underway to remove hydrofluoric acid in the tank from the INEL site.

Table 5.15-17 summarizes the potential impacts upon a maximally exposed hypothe individual located at the nearest site boundary [14,000 meters (15,310 yards)] resu potential hydrofluoric acid release at the Idaho Chemical Processing Plant assuming meteorological conditions. Slaughterbeck et al. (1995) provides further details an regarding this postulated accident scenario. Although Slaughterbeck et al. (1995) only the maximally exposed offsite hypothetical individual resulting from this post 95 percentile meteorological conditions, a comparison of the airborne concentration acid at 14,000 meters (15,310 yards) to the airborne concentrations from other post accident scenarios (as presented in Table 5.15-16) at the same receptor distance pr perspective on the significance of this accident.

**Table 5.15-17.** Summary of chemical concentrations for postulated processing-relate releases at the Idaho Chemical Processing Plant under Alternatives 4b(1) and 5b.

| Receptor Location | Chemical Concentrations (milligrams per cubic meter)a 95% Meteorologyb Hydrofluoric Acid ERPG-1c = 4 (5) ERPG-2 = 17 (20) ERPG-3 = 43 (50) | Anhydrous Ammc ERPG-1 = 17 (2 ERPG-2 = 136 ( ERPG-3 = 680 ( |
|---|---|---|
| Maximally exposed hypothetical individual located at the nearest boundaryd | 0.078 (0.09) | 82 (120.6) |

a. Numbers in parentheses reflect concentrations in parts per million.
b. The 95 percentile meteorology is based on Class F (unfavorable) meteorological c 0.5 meter per second (1.1 miles per hour) wind speed for receptors located withi (1.2 miles) of the release and 2 meters per second (4.5 miles per hour) for rece 2 kilometers of the release.
c. ERPG = Emergency Response Planning Guidelines.
d. The nearest site boundary is located at 14,000 meters (15,310 yards).

The estimated frequency for this event is 1 y 10-5 events per year. It should potential accident applies only to Alternatives 4b(1) and 5b, and is in addition tc and nitric acid release accidents described in Sections 5.15.5.3.1 and 5.15.5.3.2,

This analysis took limited credit for emergency response actions following a hy release in calculating the concentrations listed in Table 5.15-17. To mitigate the release to the environment, the same emergency response programs and actions descri radiological accident scenarios (Section 5.15.4.1) would be initiated following a h release. Therefore, actual health effects experienced by persons inside the site b realistically be less than the values listed in Table 5.15-17.

Other than limited economic secondary impacts, no other secondary impacts would this accident occurred.

### 5.15.5.3.4 Accidental Anhydrous Ammonia Release - To resume spent nuclear

fuel processing activities at the Fluorinel and Storage (FAST) facility (CPP-666), anhydrous ammonia would be required to support operation of the NOx-Abatement Facil (CPP-1670), a facility that would be constructed to treat airborne effluents from t facilities before being released to the environment.

The NOx-Abatement Facility would be expected to utilize two anhydrous ammonia t

with a storage capacity of 68,000 liters (18,000 gallons). Table 5.15-17 summarize impacts upon the maximally exposed hypothetical offsite individual located at the n boundary [14,000 meters (15,310 yards)] resulting from a short-term release of the storage tanks [i.e., 136,000 liters (36,000 gallons)] at the Idaho Chemical Process 95 percentile meteorological conditions. Slaughterbeck et al. (1995) provides furt discussion regarding this postulated accident scenario. Although Slaughterbeck et only impacts to the maximally exposed offsite hypothetical individual resulting frc accident for 95 percentile meteorological conditions, a comparison of the airborne anhydrous ammonia at 14,000 meters (15,310 yards) to the airborne concentrations fr postulated chemical accident scenarios (as presented in Table 5.15-16) at the same meaningful perspective on the significance of this accident.

The estimated frequency for this event is 5 y 10-6 events per year. The basis frequency is identical to that described for an accidental chlorine release from tw described in Section 5.15.5.3.1. It should be noted that this potential accident a Alternatives 4b(1) and 5b, and is in addition to the potential chlorine and nitric described in Sections 5.15.5.3.1 and 5.15.5.3.2, respectively.

This analysis took limited credit for emergency response actions following an a ammonia release in calculating the concentrations listed in Table 5.15-17. To miti consequences of a release to the environment, the same emergency response programs described for radiological accident scenarios (Section 5.15.4.1) would be initiatec hydrofluoric acid release. Therefore, actual health effects experienced by persons boundary would realistically be less than the values listed in Table 5.15-17.

Other than limited economic secondary impacts, no other secondary impacts woulc this accident occurred.

## 5.15.6 Maximum Reasonably Foreseeable Radiological Accident Scenario Descriptions

The purpose of this section is to summarize the different accident scenarios ic Section 5.15.4. The Facility Safety Report for the Argonne National Laboratory-Wes Examination Facility (ANL 1975) contains further details and discussions for Accide below. Slaughterbeck et al. (1995) provides further details, discussions, and refe through 7, discussed below. Additional discussions and references regarding the pr accidents summarized in this section are also provided in a study performed to dete impacts spent nuclear fuel processing-related accidents could have on the siting of reactor at the INEL (EG&G 1993b). These documents contain additional information, fractions, source terms, and other assumptions used in the accident analyses. Appe postulated accident scenarios associated with Naval spent nuclear fuel-related faci the INEL.

### 5.15.6.1 Accident 1: Fuel Pin Breach and Venting of Noble Gases and Iodine to

the Environment from a Mechanical Handling Accident at the Argonne National Laboratory-West Hot Fuel Examination Facility. The accident screening methodology in Section 5.15.3 identified a mechanical handling event at the Argonne National La Fuel Examination Facility as an initiator to the maximum reasonably foreseeable acc abnormal event frequency range. This event would result in a fuel pin breach and v gases and iodine to the environment. The identification of this accident as a maxi foreseeable accident is based on the estimated radiological consequences to the max hypothetical offsite individual at the nearest site boundary presented in the Hot F Facility Safety Report (ANL 1975). Other postulated accidents associated with hanc fuel in the Hot Fuel Examination Facility before the identification of the fuel pin the maximum reasonably foreseeable accident included an inadvertent criticality anc fuel pin breach accident was chosen as the maximum reasonably foreseeable accident estimated frequencies for an inadvertent criticality and a sodium fire in the facil (ANL 1975).

The analyses defined in the Facility Safety Report (ANL 1975) made the followin

- The fuel subassemblies and experimental capsules being examined in the faci cooled for at least 15 days to ensure that the short-lived fission products
- The noble gases and iodines that could be released from this accident scena immediately released.
- One hundred percent of the noble gases, 25 percent of the iodines, and 1 pe particulates were available for escape to the atmosphere.
- The building containment structure, including the building ventilation syst

Cell, including the argon ventilation system, remained operational followin accident. This assumption is considered appropriate because the mechanical accident scenario under consideration would not initiate a failure in these (Accident 3 considers the simultaneous failure of all these systems in conj melting of fuel assemblies stored in the facility).

The Facility Safety Report (ANL 1975) contains specific information on the sour associated with breaching the fuel section of a pin. Because that report does not frequency of occurrence for the subject mechanical handling accident scenario, the historic information and engineering judgment to determine the conservatively estin this accident of 1.0 y 10-2 event per year.

For determining the impacts from this postulated accident scenario, the nearest access is equivalent to the nearest site boundary, which is 5,240 meters (5,730 yar the release. Although the Facility Safety Report (ANL 1975) does not estimate cons offsite population resulting from this accident scenario, this analysis reasonably exposures (i.e., dose) to the offsite population would be less than the offsite pop for Accidents 2 through 4 because the dose to the maximally exposed hypothetical in nearest site boundary from this accident would be less than that estimated for Acci

**5.15.6.2 Accident 2: Inadvertent Nuclear Chain Reaction in Wet Spent Nuclear**

Fuel Storage (1 y 1019 fissions, 8-hour release) at the Idaho Chemical Processing F CPP-603 Underwater Fuel Storage Facility. The accident screening methodology discu Section 5.15.3 identified an inadvertent nuclear criticality associated with underw storage at the CPP-603 Underwater Fuel Storage Facility as an accident requiring fu Other postulated accidents that were considered before the identification of an ina accident as a maximum reasonably foreseeable accident included pool leaks, fuel dam loss of cooling events. This analysis selected an inadvertent nuclear criticality EIS over the other accidents for the following reasons:

- Postulated inadvertent nuclear criticality accidents have been addressed in nonreactor EISs and safety analysis reports in which such accidents were re foreseeable because of public concerns regarding the potential for these ac
- The Idaho Chemical Processing Plant has experienced three inadvertent nucle accidents. Although none of these accidents involved a fuel storage facili demonstrate the potential and concern for such events.
- The consequences of water leakage from a pool-draining event would present consequences to workers than a criticality because the INEL could implement response plans to evacuate workers before the risk to these workers could s increase. In addition, a pool drain was considered to be an initiator to a
- Mechanical fuel damage events are less impacting than a nuclear chain react because some degree of fuel damage is part of the criticality accident scen

Of the different Idaho Chemical Processing Plant facility areas that store spen CPP-603 Underwater Fuel Storage Facility was selected for analysis of a criticality following reasons:

- CPP-603 facility storage includes most types of spent nuclear fuel stored e site. Fuel stored at reactor basins is an exception (but was considered in of other reasonably foreseeable accident scenarios) because of its much sho after removal from a reactor.
- CPP-603 facility spent nuclear fuel storage quantities are comparable to or nuclear fuel inventories stored elsewhere on the site.
- The CPP-603 facility is an older facility that does not contain all the pre mitigative design features found in more modern facilities, such as the CPP Storage Area.

The analysis selected the underwater fuel storage portion of the CPP-603 facili Irradiated Fuels Storage Facility portion of the CPP-603 facility because accidents fuels in dry storage probably would have less severe potential consequences because removed from reactors for a much longer period of time and, because of their design most of the remaining fission products from being released if a criticality acciden

Initiating events that the analysis considered possible to lead to an inadverte included operator error, hanger corrosion, equipment failure, an earthquake, pool d crash. The scenario discussed in this EIS assumes a postulated criticality scenari initiated by human error, equipment failure, or earthquake. Heat generated from th would easily dissipate and thereby avoid fuel melting but would still cause the rel products associated with 1 y 1019 fissions over an 8-hour period.

Between 1945 and 1980, 40 known inadvertent criticalities occurred worldwide, n

involved the handling or storage of spent nuclear fuel in an underwater fuel storag addition, between 1975 and 1980, there were 160 nuclear power reactor facilities wi storage facilities worldwide. None of these facilities ever had a nuclear critical underwater storage facilities. Therefore, it is generally assumed that the likelih in a modern underwater storage facility is unlikely, with a frequency estimated at year. This estimated frequency is supported by information in the safety analysis CPP-666 underwater storage facility, which is a modern facility (e.g., 1980s vintag to store various types of spent nuclear fuel. In the CPP-603 Underwater Fuel Stora however, where spent nuclear fuel inventories have substantially corroded or degrac and where the design of the facility and its supporting equipment do not meet curre specifications, activities associated with handling and storing spent nuclear fuel the likelihood for an inadvertent nuclear criticality accident by as much as an orc Therefore, this analysis conservatively assumes the estimated frequency for an inac criticality associated with handling spent nuclear fuel in the CPP-603 Underwater F to be 1 y 10-3 event per year for this analysis.

The handling activities associated with stabilizing CPP-603 facility spent nucl would occur under each of the five alternatives considered in this EIS. The estima inadvertent criticality at the CPP-603 facility is an order of magnitude larger tha INEL facility (e.g., 1 y 10-3 event per year), and is considered a "worst-case" fre changes in estimated criticality frequencies at other INEL facilities resulting frc activities associated with changes in spent nuclear fuel inventories. Therefore, u criticality frequency related to the CPP-603 as the estimated frequency under each a conservative bound on the estimated criticality frequencies for other spent nucle handling and storage facilities.

To determine the accident impacts from this postulated accident scenario, the a the worker to be located 100 meters (328 feet) from the event, the nearest point of Route 20/26) is 5,870 meters (6,420 yards), and the nearest site boundary is locate (15,310 yards).

#### 5.15.6.3 Accident 3: Earthquake-Induced Breach and Fuel Melt at the Argonne

National Laboratory-West Hot Fuel Examination Facility. The accident screening methodology discussed in Section 5.15.3 identified an earthquake-induced breach anc Argonne National Laboratory-West Hot Fuel Examination Facility as a maximum reasona foreseeable accident that would present higher radiological consequences to facilit offsite population than other postulated accidents analyzed in the same accident fr postulated events leading to atmospheric release of radionuclides are as follows:

- The earthquake results in a peak horizontal ground acceleration of sufficie cause structural damage to the building structure and a large breach in the
- Coincident with the breach, a failure of the fuel subassembly cooling syste resulting in the melting of fresh assemblies.
- Radionuclides from the melting fuel subassemblies are released to the atmos

The estimated probability of an earthquake in the Argonne National Laboratory-W resulting in a peak horizontal acceleration of sufficient magnitude to damage the f breach the cell is 1 y 10-5 event per year. This analysis conservatively assumes t failure of the building structure, Main Cell, and subassembly cooling to be 1.0, gi earthquake has occurred. A preliminary assessment of the seismic integrity of the Examination Facility, as discussed in Slaughterbeck et al. (1995), indicates that, of analysis, significant failures could result at the Hot Fuel Examination Facility

In determining the number of fuel assemblies that would be affected during this analysis assumed that 20 fuel subassemblies would melt due to failure of the forcec accident. Although 40 storage positions are available for fuel that would require current plans do not estimate the need to use more than 20 of these positions. The this scenario is 30 days. To prevent doses greater than 5 rem to the public from t analysis assumed intervention by evacuation or prevention of contaminated food cons calculated doses reflecting this assumption.

To determine the impacts from this postulated accident scenario, the analysis a to be located 100 meters (328 feet) from the event, and the nearest point of public Route 20) and the nearest site boundary at 5,240 meters (5,730 yards).

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9. As discussed in Slaughterbeck et al. (1995), accelerations with any of several p seismic events with a combined estimated frequency of 1 * 10(-5) per year are beyon design of the Hot Fuel Examination Facility and were determined to compromise the a of the structure to maintain confinement. Events this rare are beyond the requireme

DOE Order 5480.28 and DOE-ID Architechtural Engineering Standards for Category 1 (h
hazard) facilities.

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### 5.15.6.4 Accident 4: Radiological Material Release from the Argonne National

Laboratory-West Hot Fuel Examination Facility Resulting from an Aircraft Crash and Ensuing Fire. The accident screening methodology discussed in Section 5.15.3 ident radioactive material release from the Argonne National Laboratory-West Hot Fuel Exa resulting from an aircraft crash as the maximum reasonably foreseeable accident in basis accident frequency range. Of externally initiated events, an aircraft crash Examination Facility is a maximum reasonably foreseeable accident because it could breach of confinement barriers, (2) involve a large portion of the material at risk energy release mechanism (physical impact followed by a sustained fire). The analy other accident scenarios considered in this frequency range because they would not energy sources to cause a large breach of confinement and release to the atmosphere facility contains little combustible material to sustain a fire, a fire caused by a the crash could increase potential consequences over other beyond-design-basis acci events of an aircraft crash scenario are as follows:

- A large or high-velocity aircraft (e.g., commercial or military) crashes di Fuel Examination Facility.
- The impact has sufficient force to cause catastrophic failure of the buildi of the Main Cell, and loss of forced cooling to subassemblies in the cell.
- The fuel in the aircraft is released to the facility and is ignited.
- The ensuing fire involves the contents of the Main Cell, Decontamination Ce Area, and Hot Repair Area, resulting in atmospheric release of radionuclide

To determine aircraft crash probability, the analysis limited this scenario to jet airplanes. High-velocity military jets from the U.S. Air Force Base at Mountai southwestern Idaho could enter the airspace of the INEL. In addition, large jet ai flown at low altitudes in landing configurations over portions of the INEL for vort likelihood of a large aircraft crash directly in the Hot Fuel Examination Facility possible. Analyses of jet aircraft crashes at specific facilities, such as the Ida Plant, have resulted in predicted frequencies on the order of 1.0 y 10-7 event per specific analyses have not determined the likelihood of an aircraft crash into the Facility (although it is expected that fewer flights occur over the Argonne Nationa facility area than the Idaho Chemical Processing Plant), the analysis conservativel frequency for an aircraft crashing into the Hot Fuel Examination Facility is 1.0 y

For determining impacts from this postulated accident scenario, the analysis as was located 100 meters from the event; and the nearest point of public access (U.S. nearest site boundary were both at 5,240 meters (5,730 yards).

### 5.15.6.5 Accident 5: Inadvertent Nuclear Chain Reaction During Spent Nuclear

Fuel Processing (1 x 1019 fissions) at the Idaho Chemical Processing Plant CPP-666 Fluorinel and Storage (FAST) Facility. The accident screening methodology discusse Section 5.15.3 identified an inadvertent nuclear criticality resulting from spent n reprocessing in the CPP-666 Fluorinel and Storage Facility as a maximum reasonably processing accident. Although the CPP-666 Fluorinel and Storage Facility, which hi reprocessed spent nuclear fuel to recover fissionable radionuclides (e.g., uranium- shutdown, there may be a need to resume processing operations to dissolve spent nuc stabilize the radionuclides in a waste form. Therefore, while the potential for th currently exist, the potential would exist if processing-related activities are res Alternatives 4b(1) and 5b (Regionalization and Centralization at the INEL, respecti

Initiating events that the analysis considered possible to lead to an inadverte during processing included human error, equipment failure, an earthquake, an aircra fissionable radionuclides in the spent nuclear fuel being processed, and reduced ne concentrations. Consistent with the inadvertent criticality scenario associated wi of spent nuclear fuel described in Section 5.15.6.2, the fission yield associated w assumed to be 1 y 1019 fissions. Further information and references regarding this scenario are provided in Slaughterbeck et al. (1995) and EG&G (1993b).

As discussed in Section 5.15.2, three inadvertent nuclear criticalities have oc processing facilities during the 40-year history of the INEL. The last of these cr 14 years ago. As a result of these accidents, administrative controls and facility

implemented to reduce the potential for inadvertent nuclear criticality accidents r
processing-related activities. If the decision is made to resume processing operat
controls would be utilized. Therefore, the estimated frequency for a potential ina
criticality is assumed to be 1 y 10-3 events per year, which is consistent with ass
regarding the potential for an inadvertent criticality resulting from underwater st
severely degraded spent nuclear fuel (as discussed in Section 5.15.6.2).

Limited credit was taken for mitigative features, such as emergency response pr
determining worker and public exposures resulting from this postulated accident sce
credit was taken for shielding walls placed in the facility to reduce potential per
resulting from an inadvertent nuclear criticality.

To determine the accident impacts from this postulated accident scenario, the a
the worker to be located 100 meters (328 feet) from the event, the nearest point of
(U.S., Route 20/26) is 5,870 meters (6,420 yards), and the nearest site boundary is
14,000 meters (15,310 yards).

**5.15.6.6 Accident 6: Radionuclide Release During Spent Nuclear Fuel Processing**

at the Idaho Chemical Processing Plant CPP-666 Fluorinel and Storage (FAST) Facilit
Resulting from a Hydrogen Explosion in the Dissolver Off-Gas System. The accident
screening methodology discussed in Section 5.15.3 identified a hydrogen explosion i
Fluorinel and Storage Facility dissolver off-gas system as a maximum reasonably for
processing accident. Despite CPP-666's current shutdown status, there may be a nee
processing operation to dissolve spent nuclear fuel and stabilize the radionuclides
Therefore, while the potential for this accident does not currently exist, the pote
processing-related activities are resumed under Alternatives 4b(1) and 5b (Regional
Centralization at the INEL, respectively).

Initiating events that the analysis considered possible to lead to a hydrogen e
dissolver off-gas system included human error, equipment failure, and an earthquake
information and references regarding this postulated accident scenario are providec
et al. (1995) and EG&G (1993b).

Limited credit was taken for mitigative features, such as emergency response pr
determining worker and public exposures resulting from this postulated accident sce
determine the accident impacts from this postulated accident scenario, the analysis
to be located 100 meters (328 feet) from the event, the nearest point of public acc
Route 20/26) is 5,870 meters (6,420 yards), and the nearest site boundary is locate
(15,310 yards).

**5.15.6.7 Accident 7: Radionuclide Release During Spent Nuclear Fuel Processing**

at the Idaho Chemical Processing Plant CPP-666 Fluorinel and Storage (FAST) Facilit
Resulting from the Inadvertent Dissolution of 30-Day Cooled Spent Nuclear Fuel. Th
accident screening methodology discussed in Section 5.15.3 identified a radionuclic
from the inadvertent dissolution of 30-day cooled spent nuclear fuel in the CPP-666
Storage Facility as a maximum reasonably foreseeable accident. There may be a neec
processing operation at CPP-666 to dissolve spent nuclear fuel and stabilize the ra
waste form. Therefore, while the potential for this accident does not currently ex
would exist if processing-related activities are resumed under Alternatives 4b(1) a
(Regionalization and Centralization at the INEL, respectively).

Upon removal from a nuclear reactor, spent nuclear fuel is placed in an underwa
(e.g., Advanced Test Reactor Storage Canal in the Test Reactor Area) to allow the f
cool and short-lived radionuclides to decay. Inadvertent processing of spent nucle
had the opportunity to sufficiently cool presents the potential for accidents durin
fuel. Examples of accidents that could potentially occur are explosions in the dis
inadvertent criticality. An explosion resulting from inadvertent dissolving spent
not sufficiently cooled (i.e., 30-day cooled fuel) is considered for this analysis
criticality is already considered (as discussed in Section 5.15.6.6).

The potential initiating event considered for this accident involves several op
result in the wrong spent nuclear fuel assemblies being dissolved. First, fuel coc
would have to be shipped to and received by the Fluorinel and Storage Facility. Se
the CPP-666 Fluorinel and Storage Facility would have to inadvertently dissolve the
cooled fuel. Based on the individual probability of these events, and the probabil
fuel would accidentally release radionuclides to the environment, the estimated fre
is 1 y 10-6 events per year. Further information and references regarding this pos

scenario are provided in Slaughterbeck et al. (1995) and EG&G (1993b).

Limited credit was taken for mitigative features, such as emergency response pr determining worker and public exposures resulting from this postulated accident sce determine the accident impacts from this postulated accident scenario, the analysis to be located 100 meters (328 feet) from the event, the nearest point of public acc Route 20/26) is 5,870 meters (6,420 yards), and the nearest site boundary is locate (15,310 yards).

## 5.16 Cumulative Impacts and Impacts from

Connected or Similar Actions

The INEL already contains major DOE facilities unrelated to spent nuclear f continue to operate throughout the life of the spent nuclear fuel management progra associated with these existing facilities produce environmental consequences that t in the baseline environmental conditions (Chapter 4) against which it has assessed the spent nuclear fuel alternatives. In addition, the cumulative impacts assessed other past, present, and reasonably foreseeable future actions that DOE expects to such as spent nuclear fuel management, Naval Nuclear Propulsion Program activities, restoration and waste management activities, as well as any known offsite projects government agencies, businesses, or individuals. Onsite projects include decontami decommissioning, repair, and upgrades of existing facilities. Offsite projects inc commercial development, and changes in manufacturing plants.

Consistent with the DOE sliding scale approach and the programmatic aspects of cumulative impacts are discussed commensurate with the degree of impact. Therefore of analysis from Chapter 5 is represented in this section. DOE used information an Volume 2 of this EIS as input for this section. Section 5.15 of Volume 2 provides discussion of cumulative impacts.

Tables 5.16-1 and 5.16-2 list the cumulative impacts identified for each altern necessary adjustments to accommodate the differences between Volume 1 and Volume 2 Cumulative impacts from Alternatives 3 and 4a are nominally the same, as are cumula from Alternatives 1 and 2, 5a and 4b(2), and 5b and 4b(1).

### 5.16.1 Land Use

Implementation of any of the alternatives would contribute to the cumulative lc open-space land use. However, the cumulative amount of land that would no longer b available for other land uses would be small compared to the size of INEL or region discussed in Section 5.2, Land Use, the maximum land disturbance, 31 acres (0.12 sq would occur under Alternative 4b(1) [Regionalization by Geography (INEL)] and 5b (C INEL). While exact maximum figures are not available, over 200 acres (0.81 square vacant land in nearby communities are scheduled for development. Projects that wou

**Table 5.16-1.** Nonhealth-related cumulative impacts.

| Discipline/Unit of measure | 1 (No Action) and 2 (Decentralization) | 3<br>4a |
|---|---|---|
| Land use/amount of land not available for other use | Small compared to regional land uses | Small comparec land uses |
| Socioeconomics/change in number of total jobs | Overall decrease of 4,800 | Overall decrea |
| Cultural resources/minimum number of potentially historic structures/archaeological sites disturbeda | 6 structures and 0 sites | 70 structures |
| Air resourcesb | Below applicable standards | Below applicak |

| | | | |
|---|---|---|---|
| Waste management/waste volume total pending disposition | High-leveld | 12,100 m3 | 12,500 m3 |
| | Transuranice | 67,000 m3 | 73,000 m3 |
| | Mixed low-level | 17,000 m3 | 17,000 m3 |
| | Low-levele | 46,000 m3 | 72,000 m3 |
| | Hazardousf | 12,000 m3 | 12,000 m3 |
| | Commercial and industriale | 540,000 m3 | 590,000 m3 |

a. Numbers for archaeological sites potentially impacted would be expected to incre
b. See Table 5.16-2 for cumulative health risks related to air emissions.
c. Derived in Freund (1994), Morton and Hendrickson (1995).
d. High-level waste includes both liquid and calcine forms. Liquid high-level wast of all high-level waste stored onsite.
e. Numbers do not include existing dispositioned waste stored or buried onsite.
f. Numbers represent total volume stored onsite.

**Table 5.16-2.** Health-related cumulative impacts.

| Radiologicala | Pathway | Type of impact | 1 (No Action 2 (Decentral |
|---|---|---|---|
| Public | Atmoshperic | Estimated excess fatal cancers | <1 |
| | Groundwater | Estimated excess fatal cancers | <1 |
| | Biotic | Estimated excess fatal cancers | <1 |
| Workersb | Atmospheric | Estimated excess fatal cancers | Negligible |
| | Occupational exposures | Estimated excess fatal cancers | 1 |
| Public | Atmospheric (Carcinogens) | Estimated lifetime cancers | <1 |
| | Atmospheric (Noncarcinogens)c | Estimated adverse health effects | 0 |

**Table 5.16-2.** (continued).

| Radiologicala | Pathway | Type of impact | 1 (No Action 2 (Decentral |
|---|---|---|---|
| Workersb | Atmospheric (Carcinogens) | Estimated lifetime cancers | <1 |
| | Atmospheric (Noncarcinogens)c | Estimated adverse health effects | 0 |
| | Routine workplace safety hazards | Estimated fatalities | 3 |

a. Approximate numbers. See Volume 2, Section 5.12 and Volume 2, Appendix F for de
b. Estimated excess fatal cancers calculated from dosimeter measurements.

disturb previously disturbed land are scheduled to take place on about 270 acres (1 at the INEL. An additional 1,060 acres (4.3 square kilometers) of open space INEL disturbed by potential projects.

### 5.16.2 Socioeconomics

Any of the spent fuel management alternatives would cause minimal cumulative im socioeconomic resources of the INEL region when combined with known onsite or offsi The implementation of any of the alternatives would create temporary additional emp construction; the upper bound of potential impact would occur under Alternatives 3, In the long term, the expected future decrease in employment at the INEL would more increase, as well as any increases from known offsite projects. Therefore, the cum employment would be an overall decrease. Potential population declines associated cumulative effect on regional employment are estimated to represent less than 2 per regional population. It is unlikely that a change in population of this size would long-term adverse impacts to housing, community services, or public finance in the

### 5.16.3 Cultural Resources

The types of cumulative impacts on cultural resources are the same for all alte the alternatives, when combined with associated onsite and offsite activities, coul cultural resources. However, surveying, recording, and stabilizing archeological a structures at the INEL would increase scientific knowledge of the region's cultural stabilizing resources may adversely affect their significance to Native American gr unchecked deterioration of both structures and historic documents on nuclear facili could have a long-term adverse impact on these resources. Long-term effects may al traditional resources that may not be mitigated through scientific studies. Cumula associated with Alternatives 3 and 4a (see 1992/1993 Planning Basis and Regionaliza Type) and Alternatives 5b and 4b(1) [Centralization at INEL and Regionalization by (INEL)] have the greatest potential for impacts. Alternatives 1 and 2 (No Action a would have the least potential for impacts.

### 5.16.4 Air Quality

For radiological emissions, all cumulative impacts at onsite and offsite locati applicable standards and are a small fraction of the dose received from natural bac The highest dose to a maximally exposed member of the public would be caused by Alt and 5b and would be about 0.05 millirem per year. When added to the projected dose INEL proposed projects of approximately 0.7 millirem per year and the maximum basel 0.05 millirem per year, this dose would be well below the National Emissions Standa Air Pollutants limit of 10 millirem per year (CFR 1992c). The National Council on Protection and Measurements has identified a dose rate below 1 millirem per year as 1987).

Cumulative nonradiological impacts were analyzed in terms of concentrations of toxic air pollutants in ambient air. At site boundary locations, the highest poten criteria pollutants remain well below applicable National Ambient Air Quality Stand Concentrations at public road locations within the INEL boundary could increase sig current levels, but would remain well below applicable standards.

### 5.16.5 Occupational and Public Health and Safety

Work activities and the exposure to radiological and chemical hazards under eac

alternatives would be similar to those at present. Therefore, average radiation dc chemicals, and associated health effects would be related to the number of site wor alternative. Because the cumulative impacts of any alternative would be a decrease workers, the cumulative impact of any alternative on occupational health would be health effects to the levels listed in Table 5.16-2. The incidence of expected hea similar for all alternatives because the relative difference in employment effects effects on the health of those employed) is very small. While air emissions presen pathway for public radiation exposure due to spent nuclear fuel management, groundw pathways are included in Table 5.16-2 due to Volume 2 analyses of environmental res waste management activities.

Occupational health data concerning historic accidents are incomplete and not r Though historical records of accidents at the INEL are available, occupational dose known and reported. Worker dose data are currently being collected and analyzed un Institute of Occupational Safety and Health program. Historical offsite doses assc are summarized in the Idaho National Engineering Laboratory Historical Dose Evaluat The Centers for Disease Control and Prevention is conducting a more comprehensive r doses from INEL operations. An assessment of the cumulative impacts of accidents a health of INEL workers is not available at this time.

Cumulative transportation impacts are addressed in Volume 1, Appendix I.

### 5.16.6 Materials and Waste Management

The total volumes of waste existing and projected to be generated or shipped tc spent nuclear fuel management, as well as known onsite and offsite projects over a presented by waste stream for each alternative in Table 5.16-1. The storage of low incineration is not considered to be restrictive between 1995 and 2005; however, be additional capacity may be required. Although spent nuclear fuel management would permitted storage capacity to exceed its limits without available treatment or disp Action and Decentralization Alternatives, it is anticipated that the permitted stor low-level waste will be exceeded during the first year of a 10-year timeframe. All include facility construction for storage of, or shipping of, mixed low-level waste capacity is accounted for.

## 5.17 Adverse Environmental Effects That Cannot Be Avoided

The construction and operation of any of the alternatives at the INEL could res impacts to the environment. Changes in project design and other measures would avc mitigate most of these impacts to minimal levels. This section identifies only adv mitigation could not reduce to minimal levels or avoid altogether.

Under each alternative, the continued deterioration of structures with histori potential and historic documents on nuclear facilities could have a long-term adver resources at the INEL. However, DOE would avoid potentially adverse impacts by pre historic value of the property through appropriate research, or by conducting limit these structures. This impact is discussed in Section 5.4.

As discussed in Section 5.2, the maximum loss of habitat would involve the con industrial use of about 31 acres (0.12 square kilometers) of previously disturbed h quality and limited use to wildlife; conversion would occur under Alternatives 4b(1

The amount of radiation exposure from normal operation of the spent nuclear fu would be a small fraction of the existing natural background at the INEL and would applicable regulatory standards. In all cases, the number of estimated additional fraction of 1 per year of site operation through 2035. This effect is discussed in

With the exception of the unavoidable temporary increase in noise due to const any impact of noise from activities under any of the alternatives would be minor an

An unavoidable adverse impact of the proposed activities with any of the alter an accident either at the involved facilities or during the transportation of const dismantled components. Accidents are discussed in Section 5.15; transportation is Section 5.11.

Spent nuclear fuel management supports the continuation of beneficial activiti radiopharmaceutical and other research. An unavoidable adverse impact of the No-Ac would be a reduction in the support of such activities.

As discussed in Section 5.14, the increased generation of industrial solid was under all alternatives is an unavoidable adverse impact. However, the amount gener

alternative would be a very small percentage increase from the projected 1995 basel

## 5.18 Relationship Between

Short-Term Use of the Environment and the
Maintenance and Enhancement of Long-Term Productivity

Under all alternatives, short-term use of the environment is generally associat demands for spent nuclear fuel management activities. Resources demands also inclu for upgrade, construction, and operation of facilities. These short-term demands a foundation and direction for the long-term productivity of INEL; they also have an success of future INEL missions. A brief discussion of the influence proposed acti the long-term productivity of the INEL follows. The INEL missions, including spent discussed in Section 2.1.

The No-Action Alternative would provide few long-term benefits and would not al DOE-Idaho Operations Office to fulfill its missions regarding the disposition and m nuclear fuel. The activities proposed in this alternative would not support future technology development. Further, the No-Action Alternative could bring enforcement it would not meet all the requirements of existing DOE regulatory commitments such in the Federal Facility Agreement and Consent Order.

To a varying degree, Alternatives 2, 3, and 4(a) would provide more flexibility alternatives for fulfilling existing or future missions and actions at INEL. Near- under these alternatives ensure compliance with regulatory requirements and protect environment. Furthermore, these alternatives would provide a diverse decisionmakin future actions concerning disposition of DOE spent nuclear fuel. Facilities constr technologies developed under these alternatives could be used for a wide range of a interim treatment and storage or preparation and packaging for transportation offsi

The approach that would be taken for spent nuclear fuel under Alternatives 4b(2 confine and hinder long-term productivity at INEL. Efforts would focus on shipment fuel to other locations. No emphasis would be placed on solving particular spent n problems or increasing the understanding of how certain spent nuclear fuels react c

Alternatives 4b(1) and 5b would direct INEL's future mission and development pr large-scale canning and characterization, storage, and disposal of all INEL and DOE complex-wide spent nuclear fuel. These alternatives could limit INEL's flexibility enhancing future INEL-specific missions.

## 5.19 Irreversible and Irretrievable Commitment of Resources

The irreversible and irretrievable commitment of natural and manmade resources the construction and operation of facilities related to the spent nuclear fuel alte materials and resources that could not be recovered or recycled or that would be cc to unrecoverable forms. Some of these commitments would be irretrievable because c the commitment or the cost of reclamation. For example, the construction and opera nuclear fuel facilities at the INEL would consume irretrievable amounts of electric concrete, steel, aluminum, copper, plastics, lumber, sand, gravel, groundwater, and chemicals.

Alternatives 4b(1) and 5b are each estimated to require approximately 11,000 m year of electricity, 1,100,000 liters (290,000 gallons) per year of fuel oil, and 4 (13 million gallons) per year of water above the projected baseline (1995) usage of (see Section 5.13). These changes would represent a modest increase of 5.3 percent 0.7 percent respectively, and are well within current system capabilities and usage alternatives would place smaller demands on these resources, commensurate with the construction and operation activities proposed.

Alternatives 4b(1) and 5b would also commit 31 acres (0.12 square kilometer) c disturbed land to industrial use; the conversion of this acreage would result in th quality wildlife habitat and natural resource services. Alternatives 4b(1) and 5b greatest irretrievable consumption of other resources, such as construction materia supplies. However, this demand would not constitute a permanent drain on local res any material that is in short supply in the region.

Other commitments would be irreversible because the construction or operation related to the spent nuclear fuel alternatives would consume the resource. Propose also require an expenditure of labor that would be irretrievable.

## 5.20 Potential Mitigation Measures

This section summarizes measures that DOE would use to avoid or reduce impacts environment caused by spent nuclear fuel management activities at the INEL. The pot measures for each aspect of the affected environment described below are the same u alternative. Section 5.7 of Volume 1 discusses other generalized measures DOE coulc

### 5.20.1 Pollution Prevention

DOE is committed to comply with Executive Order 12856, Federal Compliance with Know Laws and Pollution Prevention Requirements; Executive Order 12873. Federal Acq Recycling and Waste Prevention; and applicable DOE Orders and guidance documents in implementing pollution prevention at the INEL. The DOE views source reduction as th in its pollution prevention program, followed by an increased emphasis on recycling and disposal are considered only when prevention or recycling is not possible or pr

### 5.20.2 Cultural Resources

The lack of detailed specifications associated with the proposed construction a various alternatives precludes identifying specific project impacts and potential m particular structures and facilities. Basic compliance under cultural resource law that would be essentially the same under all alternatives. These steps are (a) iden evaluation of resources in danger of impact, (b) assessment of effects to these res with the State Historic Preservation Office and representatives of the Shoshone-Ban (c) development of plans and documents to minimize any adverse effects. (d) consult Advisory Council on Historic Preservation and tribal representatives as to the appr mitigation measures, and (e) implementation of potential mitigation measures. There resource survey has not been performed in an area planned for ground disturbance un proposed alternatives, consultation would be initiated with the Idaho State Histori and the survey would be conducted prior to any disturbance. If cultural resources w they would be evaluated according to National Register criteria. Wherever possible. resources would be left undisturbed. If the impacts are determined to be adverse an to leave the resource undisturbed, then measures would be initiated to reduce impac plans would be developed in consultation with the State Historic Preservation Offic Council on Historic Preservation and would conform to appropriate standards and gui established for historic preservation activities by the Secretary of the Interior.

Some actions may affect areas of religious, cultural, or historic value to Nati has implemented a Working Agreement (DOE 1992d) to ensure communication with the Sh Bannock Tribe, especially relating to the treatment of archeological sites during e mandated by the Archeological Resources Protection Act (ARPA 1979); the protection remains, as required under the Native American Graves Protection and Repatriation A 1990); and the free exercise of religion as protected by the American Indian Religi (AIRFA 1978). In keeping with DOE Native American policy (DOE 1990), DOE Order 1230 1992c), and procedures to be defined in the final Cultural Resources Management Pla DOE would conduct Native American consultation during the planning and implementati proposed alternatives. Procedures for dealing with the inadvertent discovery of hum be consistent with the Native American Graves Protection and Repatriation Act (NAGF human remains are discovered, DOE will notify all tribes that have expressed an int repatriation of graves as required under NAGPRA, including the Shoshone-Bannock, Sh and the Northwestern band of the Shoshone Nation. These tribes will then have an op claim the remains and associated artifacts in accordance with the requirements of N Procedures for the repatriation of "cultural items" in accordance with NAGPRA will curation agreement that will be finalized by June 1996.

In addition to consultation, other measures would mitigate potential adverse ef American Resources, in particular effects to air, water, plants, animals, and visua measures include avoidance of sensitive areas, placement of facilities within exist construction, revegetation with native plants of areas with ground disturbance, mon and animals within hunting and gathering areas for radiological contamination, redu night lights outside of existing facilities, monitoring tanks, ponds and runoff for minimizing ground disturbance, use of dust suppressers during construction, and use

other air pollutant control equipment to reduce air contaminants.

### 5.20.3 Traffic and Transportation

All onsite shipments of spent nuclear fuel would be in compliance with ID Direc "Hazardous Materials Packaging and Transportation Safety Requirements." These requi provide assurance that, under normal conditions, the INEL would meet as-low-as-reas achievable conditions, reasonably foreseeable accident situations (those with proba greater than 1x10^-7 per year) would not result in a loss of shielding or containme an unintentional release of radioactive material would result in a timely response.

DOE would approve the type packages used for onsite shipments or would obtain a Regulatory Commission or DOE certificate of compliance. If the onsite package did n Regulatory Commission or DOE certification, the user of the package would have to e administrative controls or other potential mitigating measures would ensure that th maintain containment and shielding integrity. The administrative and emergency resp considerations would provide sufficient control so that accidents would not result containment or shielding, in criticality, or in an uncontrolled release of radioact create a hazard to the health and safety of the public or workers. Accident mitigat below.

### 5.20.4 Accidents

The DOE would initiate INEL emergency response programs, as appropriate, follow occurrence of an accident to prevent or mitigate consequences. These emergency res implemented in accordance with 5300-DOE series Orders, typically involve emergency emergency preparedness, and emergency response actions. Participating government ag plans that are interrelated with the INEL Emergency Plan for Action include the Sta Bingham County, Bonneville County, Butte County, Clark County, Jefferson County, th Indian Affairs, and Fort Hall Indian Reservation. When an emergency condition exist the Emergency Action Director is responsible for recognition, classification, notif action recommendations. Each emergency response plan utilizes resources specificall assist a facility in emergency management. These resources include but are not limi following:

- INEL Warning Communications Center
- INEL Fire Department
- Facility Emergency Command Centers
- DOE Emergency Operations Centers
- County and State Emergency Command Centers
- Medical, health physics, and industrial hygiene specialists
- Protective clothing and equipment (respirators, breathing air supplies, etc
- Periodic training exercises and drills within and between the organizations implementing the response plans

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6. REFERENCES

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