Appendix C.4

Facility Accidents

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Facility Accidents

C.4.1 FACILITY OPERATIONAL ACCIDENTS FOR WASTE PROCESSING ALTERNATIVES

C.4.1.1 Introduction

C.4.1.1.1 *Purpose*

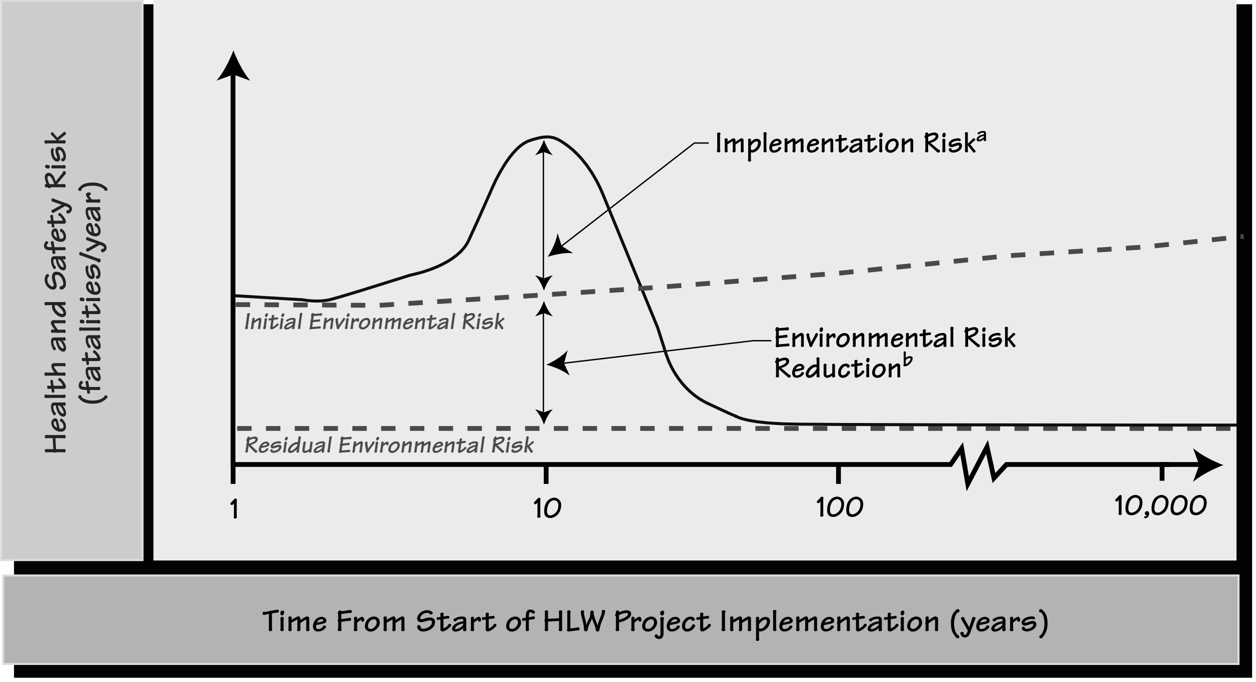
The purpose of Section C.4.1 is to present supporting analysis information for Section 5.2.14, Facility Accidents, including the three potential bounding accidents (abnormal events, design basis events, and beyond design basis events) for each of the waste processing alternatives. This appendix provides a descriptive interface between this environmental impact statement (EIS) and the technical analysis.

C.4.1.1.2 *Accident Analysis Definitions*

Accidents are unplanned, unexpected, and undesired events, or combinations of events, that can occur during or as a result of implementing an alternative and that have the potential to result in human health and environmental impacts. Human health effects could result from exposure to direct health impacts, such as exposure to fires or explosions, ionizing radiation, radiological or chemically hazardous releases, or combinations of these hazards. Environmental impacts include such effects as land use restrictions, ecological damage, and damage to or loss of natural resources. Facility accidents may provide a key discriminator among waste processing alternatives, particularly if the potential for accident impacts varies substantively for the different facilities and operations associated with the alternatives.

Environmental impacts are associated with existing environmental contamination or with materials that could constitute a hazard to humans or the ecology if released during an accident. The purpose of implementing any of the waste processing alternatives is to reduce existing impacts posed by calcine and mixed transuranic waste/sodium-bearing waste (referred to as mixed transuranic waste/SBW) in their present forms. In addition, the waste processing alternatives are associated with high-level waste (HLW) management facilities that may require eventual dispositioning. Reduction of environmental risk is accomplished by elimination or control of hazards associated with materials at a facility by removing them, rendering them immobile, or rendering them otherwise inaccessible to human or environmental contact. This constitutes a reduction in the potential for long-term exposures to the public or the environment. Existing hazards that would represent a risk to humans and the ecological environment, if they are not mitigated, may be thought of as the "risk of doing nothing." The effectiveness of environmental risk reduction is a discriminator among the potential waste processing alternatives.

During implementation, each of the waste processing alternatives temporarily adds risk to humans and the environment during the life of the project. This implementation risk is illustrated qualitatively in Figure C.4-1 as the potentially negative impact of a waste processing alternative (solid line). Implementation risk to humans is the sum of risk from facility accidents, transportation accidents, industrial accidents, and accrued occupational exposures during operations. Since the potential for facility accidents to contribute to implementation risk varies substantively for the different facilities and operations associated with waste processing alternatives, facility accidents may provide a key discriminator among the waste processing alternatives. Environmental risk is that risk associated with the existing condition that the waste processing alternative is intended to address (e.g., liquid waste stored long term in the below grade tanks). This risk is represented on Figure C.4-1 as both the initial environmental risk (upper dashed line) and the long-term residual environmental risk (lower dashed line). The impact of implementing the waste processing alternatives is to reduce the long-term environmental risk (difference between the upper and lower dashed lines) and the tradeoff, in a risk sense, is the acceptance of a short-term implementation risk versus a long-term environmental risk. In Figure C.4-1, human impacts (fatalities) are the primary focus since accidents with the



[a] Implementation Risk is that which results from the activities associated with implementing the waste processing alternative. Implementation Risk includes risk to involved workers, co-located workers, the public, and the environment. Implementation Risk is the sum of risk from facility accidents (i.e., release of radioactive and chemical materials), industrial accidents, and accrued occupational exposures during normal operations. Significant disparities in the expected Implementation Risk can be a discriminator among waste processing alternatives.

[b] Environmental Risk is associated with existing environmental contamination or with materials that could constitute a hazard to humans or the environment, if released. The purpose of the waste processing alternatives is the reduction of environmental risk associated with past processes at the Idaho Nuclear Technology and Engineering Center (INTEC) that resulted in accumulation of mixed HLW and related wastes. Environmental Risk Reduction involves removal of contamination or the hazards associated with materials at a facility by removing them, by rendering them immobile, or by otherwise rendering them inaccessible to human or environmental contact. The effectiveness of Environmental Risk Reduction is a potential discriminator among waste processing alternatives.

FIGURE C.4-1.
Conceptual relationship of implementation risk to environmental risk.

potential to have impacts on humans can be assumed to have a proportional impact on other life forms, including local flora and fauna.

Consequences of industrial accidents can involve fatalities, injuries, or illnesses. Fatalities can be prompt (immediate), such as in construction accidents, or latent (delayed), such as cancer caused from radiation exposure. While public comments received in scoping meetings for this EIS included concerns about potential accidents, the historical record shows the industrial accident rate for the U.S. Department of Energy (DOE) facilities at the Idaho National

Engineering and Environmental Laboratory (INEEL) is somewhat lower (Millet 1998) compared to the rate in the DOE complex overall. The historic accident rate also compares favorably to national average rates compiled for various industrial groups by the National Safety Council (NSC 1993) and Idaho averages compiled from state statistics (DOE 1993a).

One measure of the expected effectiveness of site management in controlling facility accident risks at future facilities is the effectiveness of current management in controlling risk to workers. The Computerized Accident Incident Reporting System database that chronicles injuries, accidents, and fatalities to workers at the INEEL can be used as a measure of management effectiveness in controlling the risk of fatal industrial accidents to involved and noninvolved workers. This assumption is based on the fact that control over all accidents in the workplace is a requirement for controlling fatal accidents. Historically at the INEEL, fatal accidents represent approximately 0.1 percent of all accidents.

Accident data is typically collected in terms of different types of activities. From the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs EIS* (SNF & INEL EIS) (DOE 1995), the rate of injury/illness for construction activities in the DOE complex was 6.2/100 worker-years, and the rate of injury/illness for construction activities in private industry was 13/100 worker-years from 1988-1992. From 1993-1997, the rate of injury/illness for construction activities at the INEEL was 5.4 per 100 worker-years (Fong 1999). This data supports the conclusion that the injury/illness rate at the INEEL is slightly lower than DOE as a whole and significantly lower than private industry. The fatality rate from 1993-1997 was 0.05 per 100 worker-years which is higher than the previously reported fatality rate for the period 1988-1992 and is due to the occurrence of a fatality at the INEEL in 1996. An additional INEEL fatality occurred in 1998. Incorporating this 1998 fatality into the industrial accident rate using a Bayesian update results in a fatality rate of 0.14 per 100 worker-years, which is clearly greater than the fatality rate for the DOE complex as a whole. However, a comprehensive correction action effort is currently being implemented to control and reduce the industrial accident rate at the INEEL. Over the time period of this EIS it can be assumed that the fatality rate at the INEEL will be similar to or lower than that of the DOE complex as a whole.

Waste processing alternatives and options being considered in this EIS require an analysis of facility accidents as one of the impacts associated with implementation. The scope of the accident analysis is to evaluate, for each waste processing alternative, the potential for facility accidents that would not necessarily occur but which are reasonably foreseeable and could result in significant impacts (DOE 1993b). The accident analysis must be sufficiently comprehensive to inform the public and other stakeholders of possible impacts and tradeoffs among major waste processing alternatives. Although most safety assurance evaluations of facility accidents indicate that industrial accidents are the largest single contributor to the overall health and safety risk to workers associated with the implementation of an alternative, industrial accident risks are evaluated separately in this EIS and are not part of the scope of the accident analysis.

C.4.1.2 Methodology of the Facility Accidents

The accident analysis requires technical information that includes descriptions of potentially bounding accident scenarios, as well as the likelihood, source term, and predicted health impacts of each accident. The extensive number of activities associated with implementing each of the waste processing alternatives required development of a comprehensive technical basis for identifying and evaluating potentially bounding accidents.

The accident analysis was developed during the course of the EIS process to provide a basis for information used in the evaluation of facility accidents and facility disposition accidents. The Final EIS accident analysis contains the most recent technical information.

The scope of the accident analysis consists of a systematic review of treatment alternatives for the purpose of identifying potentially bounding accidents for each waste processing alternative.

The scope of the accident analysis does not include:

- Evaluation of facility accidents occurring at sites other than the INEEL
- Evaluation of accidents associated with transportation of radioactive or hazardous material, other than transportation within a site as part of facility operations

Evaluation of environmental impacts are focused on human rather than flora or fauna impacts. The accident analysis mainly evaluates air release inhalation pathways for impacts on potential receptors. Ingestion and groundwater pathways have not been evaluated systematically for all facility accident scenarios in the document. Early sensitivity evaluations of health impacts from these two pathways performed during the development of the Draft EIS identified groundwater health impacts as a minor health risk driver when compared to air release pathways. Accident scenarios that result in major groundwater releases (and not air releases) were evaluated in the accident analysis.

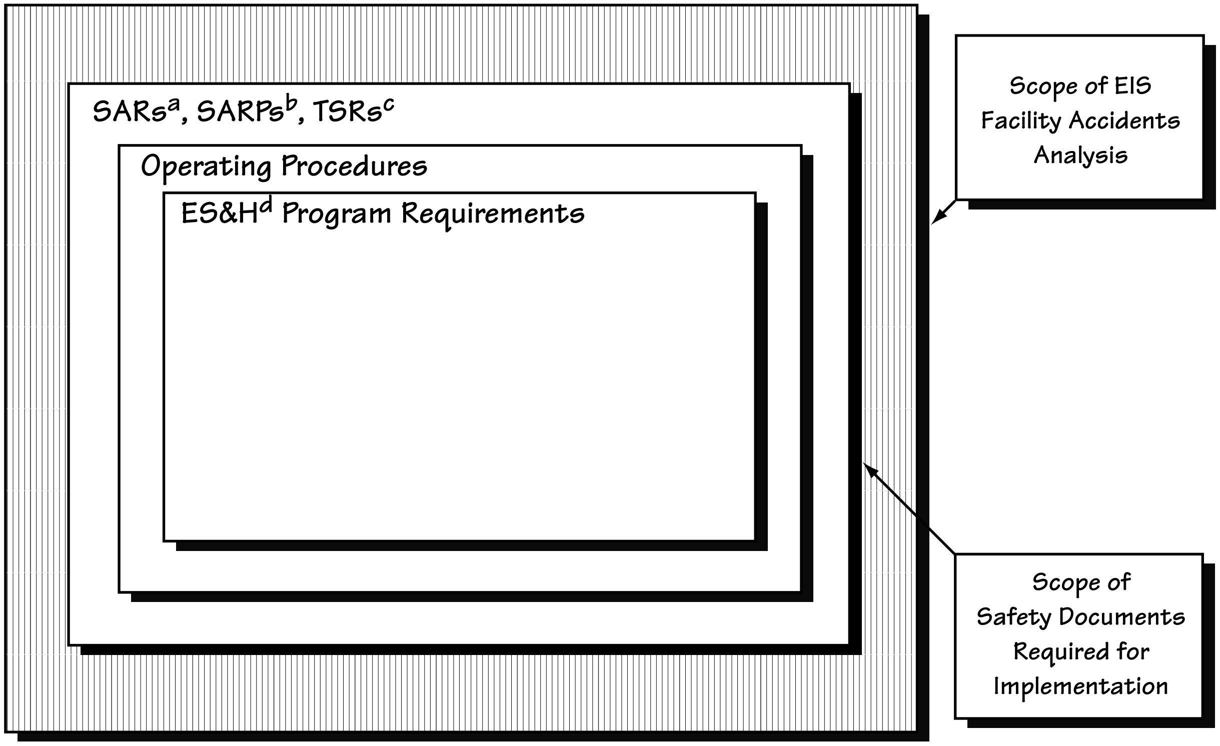
Since future facilities must be designed and operated to mitigate the risk of accidents, the accident analysis is intended to form a functional safety envelope for the safety assurance program for the waste processing alternative chosen for implementation. Subsequent programs such as the development of technical safety requirements, environmental safety and health programs, and safety analysis reports provide the protective features that ensure that safety is not compromised. The EIS facility accident analysis scope encompasses the limits of safety concerns for the future facilities needed to implement waste processing alternatives. At the time these facilities are designed, built, and operated, the safety documentation needed to maintain safety assurance at these facilities would use information in the accident analysis to bound concerns as well as to focus assessments and commitments. Safety analysis reports for packaging do not define new areas of concern but represent scenarios that are contained within the set of accidents outlined in this EIS. The EIS facility analysis scope as compared to future safety documentation is shown in Figure C.4-2.

The accident analysis provides input information to a consequence assessment that, in turn, provides estimated doses and health consequences to individuals and exposed populations. These results are presented in this appendix and Section 5.2.14. The relationship between the accident analysis and Sections 5.2.14 and 5.3.12 is shown in Figure C.4-3.

Source Term Identification

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

The potential for a criticality was assessed in each accident analysis evaluation. Only one reasonably foreseeable criticality accident scenario was identified in the accident analysis evaluations. An inadvertent criticality during transuranic waste shipping container-loading operations results from a vulnerability to loss of control over storage geometry. This scenario is identified under both the Transuranic Separations Option and the Minimum INEEL Processing Alternative. The frequency for this accident is estimated to be between once in a thousand years and once in a million years of facility operations. This event could result in a large dose to a nearby, unshielded maximally exposed worker that is estimated to be 218 rem, representing a 1 in 5 chance of a latent cancer



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☐ Since the facility accidents analysis includes information on process element hazards, material inventories at risk, accident initiators of concern, bounding accident descriptions, and source term assumptions, its scope also bounds the scope of other safety documentation that would be required for implementation of the waste processing alternative selected in the forthcoming Record of Decision.

▨ The scope of the EIS facility accidents analysis is intended to bound the potential realm of phenomena, hazards, and safety concerns that could impact the selection of waste processing alternatives. As such, the EIS scope includes sufficient information to assess hybrid waste processing alternatives as systems descriptions.

[a] Safety Analysis Reports

[b] Safety Analysis Reports for Packaging

[c] Technical Safety Requirements

[d] Environmental, Safety, and Health

FIGURE C.4-2.
Scope of EIS facility accidents analysis.

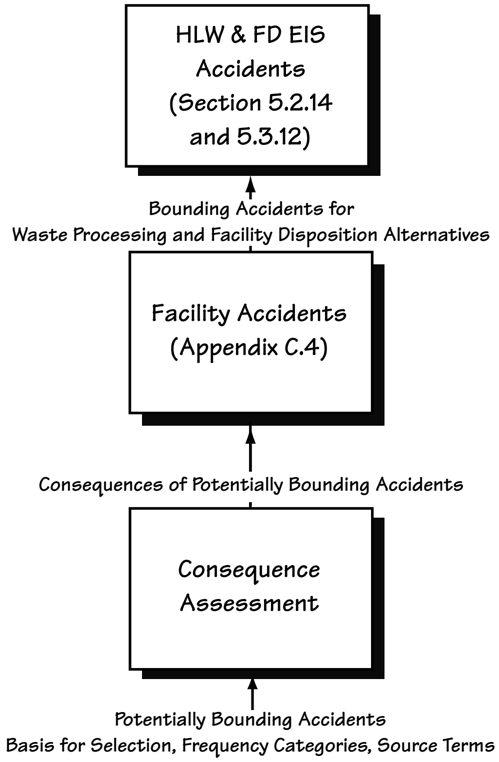


FIGURE C.4-3.
Facility Accidents Analysis relationship to sections of this EIS.

fatality. However, this same analysis estimates a dose to the maximally exposed offsite individual at the site boundary (15,900 meters down wind at the nearest public access) to be only 3 millirem, representing a 2 per million increase in cancer risk to the receptor.

Chemical Releases - Facility accidents may include sets of conditions leading to the release of hazardous chemicals that directly or indirectly threaten involved workers and the public. This EIS facility accident review includes an evaluation of the potential for chemical release accidents. Currently, there is insufficient information on chemical inventories of proposed future waste processing facilities to support a comprehensive and systematic review of chemical release accidents. However, the assumption was made that future requirements for hazardous chemicals during waste processing would be similar to present requirements. Chemicals that pose the greatest hazard to workers and the public are gases at ambient temperatures and pressures. An example of this type of gas is ammonia, which is stored under pressure as a liquid but quickly flashes to a vapor as it is released. Chemicals such as nitric acid that are liquids at ambient conditions also could pose a toxic hazard to involved workers. However, the potential for these types of chemicals to become airborne and travel to nearby or offsite facilities is low. The facility accident analysis focused on those chemicals that are gases at ambient conditions.

Receptor Identification

Radiological Releases - Human receptors are people who could potentially be exposed to or affected by radioactive releases resulting from accidents associated with the waste processing alternatives.

For radiological releases, DOE calculated the health impact of the bounding accidents by estimating the dose to human receptors. Four categories of human receptors are considered in this EIS:

- **Involved Worker:** A worker who is associated with a treatment activity or operation of the HLW treatment facility itself.

- **Maximally Exposed Individual:** A hypothetical individual located at the nearest site boundary from the facility location where the release occurs and in the path of an air release.

- **Noninvolved Worker:** An onsite employee not directly involved in the site's HLW management operations.

- **Offsite Population:** The population of persons within a 50-mile radius of INTEC and in the path of an air release.

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

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

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

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

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

Consequence Assessment

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

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

The consequences from accidental chemical releases were calculated using the computer program "Areal Locations of Hazardous Atmospheres (ALOHA)." Because chemical consequences are based on concentration rather than dose, the computer program calculated air concentrations at receptor locations. Meteorological assumptions used for chemical releases were the same as used for radiological releases. For each accident evaluation, conservative assumptions were applied to obtain bounding results. For the most part, the assumptions in this EIS are consistent with those applied in other EIS documents prepared at the INEEL, such as the SNF & INEL EIS. However, there were some assumptions that differed.

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

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

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

C.4.1.2.1 Basis for Selection of Potentially Bounding Accidents

For the accident analysis, the process of identifying potentially bounding accidents and source terms is initiated with screening evaluations to determine activities to implement waste processing alternatives that could result in bounding accidents. In addition, the process includes identification of accident scenarios, development of frequencies for accident scenarios, development of source terms for accident scenarios, and selection of potentially bounding accident scenarios for consequence evaluation. This systematic process includes the following functional actions:

- Identification of hazardous process elements - Involves identification of activities, projects, and facility operations that are required to implement the alternative, and that potentially pose a risk of health impacts to various receptor populations (i.e., the hazardous process elements.)

- Accident analysis - Provides an accident analysis for each identified hazardous process element to identify potentially significant accident scenarios. Each accident scenario consists of a set of events that could result in health impacts to one or more receptor populations. Development of each accident scenario includes hazard assessment, evaluation of accident phenomena, quantification of release frequency, and quantification of accident source terms.

- Identification of potentially bounding accident scenarios - Involves selection of a subset of accident scenarios that are potentially bounding based on size and makeup of source terms and frequency of occurrence. All accident scenarios are categorized in three frequency classes: abnormal (greater than once per thousand years), design basis (less than once per thousand years but greater than once per million years), and beyond design basis (less than once per million years). Bounding accidents for each waste processing alternative in each frequency category are selected based on the largest projected health impacts. Where the highest consequence accident scenario changes for different receptor populations, the bounding accident scenario is chosen on the basis of health impacts to the offsite population. Where two accident scenarios pose a similar potential for health impacts, the bounding accident will be chosen on the basis of estimated frequency of occurrence.

- Estimation of health impacts - Consists of estimating the potential for health impacts to result from each potentially bounding accident scenario in the three frequency classes.
- Identification of bounding accidents - Involves identifying the accident scenario that bounds the potential for health impacts in each frequency class for each alternative based on the information developed for the functional activities.

C.4.1.2.2 *Process Elements for Waste Processing Alternatives*

Each of the waste processing alternatives consists of a series of processes that must be implemented. Implementing each of these processes results in the temporary addition of risk to involved workers, noninvolved onsite workers, and the offsite public. Hazard evaluations of these processes form the basis of the facility accident analysis. The major process elements for the alternatives are shown in Table C.4-1.

For each waste processing alternative, those processes that have the most significant potential to result in additional health and safety risk to one or another of the major classes of receptors are described below.

C.4.1.2.3 *Technical Approach*

The technical approach and methods used in the accident analysis are intended to be fully compliant with DOE technical guidelines for accident analysis (DOE 1993b). These guidelines suggest exclusion of information that is previously addressed in other EIS documents. For example, the impacts of accidents at the Waste Isolation Pilot Plant have been excluded from predicted impacts. Such exclusions constitute a reasonable method of assuring that there is not a "double counting" of impacts associated with DOE activities. Technical guidelines require the identification of accidents for each alternative that are reasonably foreseeable and bounding. A bounding accident is defined as the reasonably foreseeable event that has the highest potential for environmental impacts, particularly human health and safety impacts, among all reasonably foreseeable accidents.

For the accident analysis, the term "reasonably foreseeable" is defined as the combined probability and consequences of accident events to include those scenarios with the potential for contributing a human health risk of once in 10 million years or greater. An accident that occurs with a frequency of once in 10 million years and would likely result in one or more fatalities is reasonably foreseeable.

Accident analysis of HLW management facilities that are currently operating has incorporated data from facility safety assurance documentation, facility operating experience, and probabilistic data from similar facilities and operations. Accident analyses of facilities that have not as yet been designed rely mainly on information from technical feasibility studies that establish basic design parameters and process implementation costs. Information used in the accident analyses included preliminary facility inventories, material at risk for major process streams within a facility, process design data, and some overall design features. Considering the early state of knowledge on most facility designs, methods used to assess the potential for facility accidents were based mainly on DOE guidance, experience with similar systems, and an understanding of the INTEC site layout. Documents such as safety analysis reports, safety reviews, and unresolved safety question determinations that routinely evaluate the poten-

Table C.4-1. Accident evaluations required.

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

- New Information -

Table C.4-1. Accident evaluations required (continued).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

tial for harm to human health were not available to support many of the accident analyses.

Data for identification of and initial screening of process elements, came by and large from feasibility studies conducted by the HLW technical sub-contractor, Fluor Daniel. These studies are part of the EIS administrative record and are referenced in the accident analysis. Data from these feasibility studies is used throughout the accident analysis and is the principle source of information for the description of facility design data in the accident analysis.

Detailed accident analysis included the description of activities, inventories, and conditions pertinent to the accident analysis, as well as development of a set of accident initiators. Accident initiating events consisted of conditions with varying frequency and severity that could challenge and degrade the safety functions of a facility. In the accident analysis, a standard set of "accident initiating events" was compared with the described set of activities, inventories, and operating conditions to identify and describe "accident scenarios." Six categories of initiators were used in the accident analysis:

- Failures resulting in fires during facility operations
- Failures resulting in explosions during facility operations
- Failures resulting in inventory spills
- Operational failures resulting in occurrence of criticality
- Occurrence of natural phenomena (such as seismic events or floods) that induce damage to a facility and require safe shutdown
- Occurrence of external events (usually human-initiated events not occurring in a facility)

Accident scenarios were defined consisting of a related set of causal events, starting with an initiating event, ultimately leading to release of radioactive or hazardous materials with the potential to impact workers or the public.

The accident analysis provides summaries of the accident evaluations for all potentially risk contributing process elements, using the accident analysis evaluation methodology. Data used to establish frequencies and frequency categories of accident scenarios were derived from numerous external sources. The accident analysis provided an appraisal of the frequency of "external" accident initiating events (i.e., events, such as external events, that are not the result of equipment failures or human errors in a facility, but can result in failure of facility equipment or containment); and natural phenomena (such as floods and earthquakes) that could impact HLW facilities at the INEEL. A basis for upgrading the second level screening to reflect additional vulnerabilities that may be discovered over time or may result of proposed future projects was described in the accident analysis.

HLW feasibility studies provided inventories of radioactive and chemically hazardous materials that could be released given the accidents defined for each process element. The feasibility study inventories were based mainly on material balances for the processes that were modeled in the feasibility evaluations. Bounding material at risk inventories of radioactive and chemically hazardous materials were provided in each accident analysis. Several of the material at risk evaluations (particularly those for the bin sets storing calcine) were updated over the course of the development of the accident analysis, based on information provided by the site management and operations contractor. These upgraded material at risk values and the basis for their inclusion are discussed in the accident analysis .

Source terms, or the amount of material that could be released in a specific accident scenario, were a critical element of the accident analysis procedure. A procedure for estimating source terms for specific accident scenarios, based on DOE guidance is discussed in the accident analysis.

The results of accident analyses provided include potentially bounding accident scenarios, sufficient data on probability of occurrence to place them in frequency "bins," and the predicted source terms if they were to occur. Potentially bounding accident scenarios for each of the accident analyses include radioactive and chemical release accidents, respectively, and the consequences (potential health impacts on downwind receptors) associated with the accident scenarios.

In general, the accident analysis considered accident scenarios that could result in air releases of radioactive or chemically hazardous material; releases that could adversely affect downwind receptors through inhalation of or direct contact pathways. The basis for excluding ingestion and drinking water pathways from the accident analyses was primarily that for the material at risk and source terms describing each accident, the major contribution to health impacts came from downstream inhalation of released material. Technical data, based on detailed assessments of the sensitivity of accident consequences, performed for a small subset of radioactive release accidents. Some exceptions were made to this rule, particularly for releases to groundwater that might not be fully remediated or interdicted, either because they were too large, or because they occur after the period of institutional control. The basis for these bounding groundwater evaluations is described in the accident analysis.

Based on the results of the consequence assessments, potentially bounding radiological accident scenarios for each of the waste processing alternatives and options were selected. These potentially bounding events were chosen primarily based on their potential to add risk to one or more downstream receptors, particularly the offsite public.

Of the potentially bounding radiological events, one in each of the three probability categories was chosen to be the bounding accident, in accordance with DOE National Environmental Policy Act guidance, again primarily based on their risk potential. The bounding radiological accidents for each of the EIS alternatives and options are listed in the accident analysis and Section 5.2.14 of this EIS. Bounding chemical release accidents are provided in Section 5.2.14 of this EIS. Potentially bounding groundwater release accidents are provided in the accident analysis.

C.4.1.3 Natural Phenomena/ External Events

A number of natural phenomena and external events could potentially impact the site and result in releases of radiological and/or chemical inventories. For natural phenomena hazards, DOE-STD-1021 has established performance categorization guidelines for structures, systems, and components (DOE 1996a). The rating system is out of a scale from one (PC-1) to four (PC-4) with four being the most restrictive. However, the PC-4 categorization is reserved for facilities that could result in offsite release consequences greater than or equal to the unmitigated release from a large (>20 MW) Category A reactor accident. The INEEL facilities pose potential adverse release consequences but do not fall within the definition of a PC-4 facility. Therefore, most INEEL HLW management facilities are classified as PC-3.

Per DOE-STD-1020, PC-3 structures, systems, and components are assigned mean annual probabilities of exceeding acceptable behavior limits of 1.0×10^{-4} per year (DOE 1996b). The natural phenomena evaluations in this analysis are linked to the design criteria associated with the 10,000-year event (1.0×10^{-4} per year). Since the structures, systems, and components are to be designed to these criteria, they are not anticipated to fail until a larger magnitude-initiating event with a lower frequency ($<1.0\times10^{-4}$ per year) occurs. Even with larger magnitude initiating events, there is still only a conditional probability (e.g., fragility curves for seismic evaluations) that a structure, system, or component will fail. However, these conditional probabilities vary with the types of initiators and are also dependent upon specific design details of the structure, system, or components. Although this approach may appear overly conservative from a frequency standpoint, there may be no impact from a relative frequency standpoint. The following paragraphs define the frequency ranges assigned to various natural phenomena in this EIS.

Range Fire

A range fire could result in loss of offsite power that, in turn, results in loss of ventilation to the facility and a slow release of radioactive or hazardous material. Range fires have occurred on or in the vicinity of the INEEL during 1994, 1995, 1996, 1999, and 2000. While a range fire would not endanger the process element under consideration, due to defoliated zones, location of the facility fences, etc., smoke from the fire could require personnel evacuation and disrupt operations. Loss of building confinement would create leakage pathways through doorways, airlocks, loading docks, and other building access points. The consequences associated with a range fire are anticipated to be minimal and in most cases would be bounded by operational events such as an electrical panel/motor fire. Unless specific design features of the process element warrant a lower frequency, range fires are generally placed in the abnormal event frequency bin.

Design Basis Seismic Event

A design basis event seismic event could cause failure of the facility structure and/or equipment such that a release occurs with a pathway to the environment. The design basis event seismic scenario frequency is dominated by failure of bin set 1 since its seismically induced failure frequency (5.0×10^{-3} per year) is substantially greater than that of the other six bin sets (5.0×10^{-5} per year). The frequency 5.0×10^{-3} per year was assumed for bin set 1 since the DOE-STD-1021 prescribes that Category 3 facilities withstand a 1.0×10^{-4} per year earthquake (DOE 1996a). Bin set 1 does not meet this standard and its probabilistic performance has been degraded by a factor 5. So instead of a 10,000 year earthquake failing bin set 1, it was evaluated as failing at a 2,000 year return period.

The analysis of design basis event seismic initiators in the accident analysis implies that under severe seismic loading one bin set may fail catastrophically. A question has been raised as to why only one bin set may fail, and not the other six bin sets. Failure of bin sets is considered a design basis event. The seismic "fragility" curve shows that although a failure could occur at a specific seismic level, it probably will not. Thus, seismicity as a common cause source for failures does not prevent one unit failing and the others not. In fact, reviews of seismic damage to commercial facilities routinely reveal one specific component failing while all others, more or less with the same loading, do not. Thus, it would be overly conservative to assume "complete coupling" in seismic failures of multiple bin sets.

Flood-Induced Failure

A major flood could cause damage to the facility structure and subsequent equipment failures, thereby causing a release of materials from the facility to the environment. In particular, bin set 1 has been determined, by analysis, to be statically unstable. Under flood conditions, the berm surrounding bin set 1 could be undermined with subsequent collapse of the cover onto the four internal vaults. Material released from the vaults would then be transported by floodwaters to the surrounding area and released to the environment as dust once the flood recedes. Early predictions of the frequency of such a flood were 1.0×10^{-4} per year at a maximum elevation of 4,916.6 feet mean sea level, above the 4,912 feet needed to wet the bottom of the bin set 1 berm. The site design accounts for this restriction and new facilities are (or would be designed to be) located above this elevation. Additionally, since floodwaters in relatively flat terrain such as the INEEL rise slowly, adequate time should be available to take protective measures to prevent water from entering the facility (DOE orders require re-evaluation if there has been a significant change in understanding that results in an increase in the site natural phenomena hazard). Given that flood induced failure of bin set 1 was estimated at a frequency of 1.0×10^{-4} per year and failure of one of the remaining bin sets is an order of magnitude less likely, the total probability of a flood-induced release would be 6.4×10^{-3} per year.

More recent flood data indicate that a flood threatening bin set 1 may be much less likely than the 10,000-year flood assumed above and that flood-induced failure of bin sets 2 to 7 are not credible events. If the present frequency of bin set 1 failure (1.0×10^{-4}) is assumed to be a 95 percent (upper) confidence bound on frequency and a 5 percent (lower) confidence bound of

1.0×10^{-7} is used, then a geometric mean of 3.2×10^{-6} per year for flood failure of bin set 1 is estimated. Therefore, the total probability of a flood induced release would be 2.0×10^{-5}, again a design basis event. From this data, it is concluded that the frequency of a flood at the INTEC makes this scenario a design basis event.

No arguments have been made that preclude 1.0×10^{-4} from being an upper bound. In addition, even if a lower bound probability of a flood 3 to 4 orders of magnitude lower were used, the geometric mean of two referenceable sources would be 4.0×10^{-4}. Unless specific design features of the process element warrant a lower frequency, flood-induced failure of bin set 1 is placed in the design basis events frequency bin.

External Event

NRC's Standard Review Plan [Section 3.5.1.6 in NRC (1997)] assesses the risk of external events involving nuclear facilities to be on a sliding scale ranging from 1.67×10^{-7} to 1.2×10^{-9} events per square mile. INTEC facilities occupy nearly a square mile of area at the INEEL. However, critical facilities such as the bin sets, Tank Farm tanks, and future waste processing facilities associated with various waste processing alternatives do not occupy nearly as much surface area of land. As such, the average surface area of a critical facility is estimated to be approximately 6 acres or 9.4×10^{-3} square miles. Therefore, the frequency of critical facility external events at INTEC is 2.1×10^{-8} per year.

It is noted that this frequency is outside the 1.0×10^{-6} per year to 1.0×10^{-7} per year range for beyond design basis events. However, due to the potentially catastrophic effects of external events to INTEC, such events are included as an accident initiator in the beyond design basis frequency category.

Extreme-Lightning Damage

Lightning strikes could cause damage to facility structures, loss of electric power, and damage to operating and safety equipment. The result could be a release of material and a direct pathway to the environment. Three or four lightning strikes have occurred at INTEC in the last 20 years. These lightning strikes resulted in minor damage but did not lead to releases of radiological and/or chemical inventories. The facility structures will be equipped with lightning protection systems designed in accordance with the requirements of the National Fire Protection Association (NFPA 1997); thus, failures as a result of lightning strikes would be extremely unlikely. In addition to defeating the lightning protection system, a lightning strike would have to be powerful enough to damage facility structures to create a direct leak path to the environment. The frequency of such a strike is deemed to be in the beyond design basis bin, although a lightning-initiated fire could be self-sustaining in many locations and could raise the likelihood of a material release.

High Wind-Induced Failure

High winds, in the form of tornadoes or straight-line winds, could cause failure of facility structures, operating equipment, safety equipment, or electric power and may result in releases of material and creation of pathways to the environment. The design basis wind for PC-3 facilities is 95 miles per hour with an annual probability of 1.0×10^{-4} per year. The INEEL Wind Hazard Curve indicates that a straight-line wind with this return frequency would be approximately 90 miles per hour. The wind design criteria for the newly constructed buildings would exceed this threshold. Stronger winds would have an annual probability of less than 1.0×10^{-4} per year and would have to be strong enough to breach the facility structure and internal process systems in order to create a leakage pathway to the environment. Little if any material is at risk. Although the high wind initiator itself is placed in the design basis frequency bin, the high wind-induced failure scenarios are placed in the beyond design basis frequency bin. Unlike seismic events, which impact the facility structure and internal equipment concurrently, high winds primarily impact the external facility structure. An additional sequence of events would have to occur before contained material inventories were impacted.

Beyond Design Basis Seismic Event

The beyond design basis event earthquake would have a peak ground acceleration that exceeds the design capacity of the facilities and would have a return period greater than 1,000,000 years (1.0×10^{-6} to 1.0×10^{-7} per year). The event would be powerful enough to breach internal process systems (high-efficiency particulate air filters, doors, airlocks, etc.) in order to create a leakage pathway(s) to the environment. This event could be as severe as the external event in the bounding accident determination. The frequency of such an event is deemed to be in the beyond design basis event bin.

Volcanism

Volcanic activity (volcanism) occurring at near field and distant volcanic sources represents a potential external event that could lead to releases of radiological or chemical inventories associated with the waste processing alternatives.

The information in the INEEL Three Mile Island-2 Safety Analysis Report (DOE 1998) and EDF-TRA-ATR-804 (Hackett and Khericha 1993) indicates that the bounding volcanism-related hazard is due to basaltic volcanism (Hackett and Khericha 1993). Impact to the INTEC due to the other volcanism initiators is considered very unlikely due to geologic changes in the region over millions of years, limited impact areas, and the physical distance to the potential sources. When considering volcanism, mitigation measures to either divert the lava flow or cool the lava are likely to be effective, due mainly to the relatively long period of time (up to a month) between the time of an eruption and the time at which the flow reaches the INTEC facilities. The frequency of a basaltic eruption that impacts facilities at INTEC is on the order of 7.0×10^{-7} per year, which places it in the beyond design basis frequency range. This places basaltic eruptions in the same frequency bin as initiators such as external events.

C.4.1.4 Facility Accident Consequences Assessment

In the consequence evaluation discussed in the accident analysis, radiological source terms were used as input for the Radiological Safety Analysis Computer Program (RSAC-5) to estimate human health consequences for radioactive releases (King 1999). DOE used this program to determine the radiation doses at receptor locations from the airborne release and transport of radionuclides from each accident sequence. Meteorological data used in the program were selected to be consistent with previous INEEL EIS analyses (i.e., SNF & INEL EIS) for 95 percent meteorological conditions, that is, the condition which is not exceeded more than 5 percent of the time or is the worst combination of weather stability class and wind speed.

Computed radiological doses to various receptor populations were converted into expected latent cancer fatalities using dose-to-risk conversion factors recommended by the NCRP (NCRP 1993). Conservatively, the NCRP assumes that any amount of radiation carries some risk of inducing cancer. DOE has adopted the NCRP factor of 5×10^{-4} latent cancer fatalities for each person-rem of radiation dose to the general public for doses less than 20 rem. For larger doses, when the rate of exposure would be greater than 10 rad (radiation absorbed dose) per hour, the increased likelihood of a latent cancer fatality is doubled to account for the human body's diminished capability to repair radiation damage. DOE calculated the expected increase in the number of latent cancer fatalities above those expected for the population.

Accident analysis consequences were directly estimated using RSAC for three groups of receptors:

- the maximally exposed individual
- a noninvolved worker
- the offsite population (collective dose)

The approach taken in the accident analysis consequence modeling was to ensure that a "safety envelope" was provided. This approach differs from the approach taken in other EISs, such as the SNF & INEL EIS, where certain mitigation actions were credited up front and other probabilistic arguments were applied to reduce the predicted consequences. As a result of this conservatism, health impacts presented in the accident analysis are larger than the results that would have been obtained by applying the SNF & INEL EIS assumptions (DOE 1995). Thus, consequence evaluations discussed in the accident analysis provide a likely upper bound to the potential consequences for the accidents associated with the candidate alternatives.

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

Selected bounding accidents that resulted in a release only to groundwater were evaluated in the accident analysis using data derived from the environmental restoration Remedial Investigation/Feasibility Study for INTEC (Rodriguez et al. 1997).

Some initiators (i.e., volcanoes) were eliminated from consideration as a source of accidental releases in the accident analysis. These initiators would not provide additional potential for identifying bounding accidents. As an example, based on evaluations in the accident analysis, volcanic activity impacting INTEC was considered a beyond design basis event. This places the event with initiators such as external events and beyond design basis earthquakes. However, based on the phenomena associated with these initiators, volcanic activity-initiated events are considered bounded by other initiators. Lava flow from an eruption (basaltic volcanism) would likely cover the affected structures. Therefore, the amount of material that is released from process vessels and piping due to lava flow would be limited and would be bounded by events such as the external event, where the entire inventory would be impacted and available for release.

The systematic accident analysis process employed identified potentially bounding accidents for each of the identified alternatives and options. The results for radiological releases were expressed in terms of the estimated impacts for the maximally exposed individual, a noninvolved worker, the offsite population, and the latent cancer fatalities for the offsite population. After evaluating the human health consequences associated with these potentially bounding accidents, three bounding accidents (one abnormal, one design basis, and one beyond design basis) were selected for each of the waste processing alternatives and options. Consequences for each of the potentially bounding accident scenarios are given in the tabular summaries associated with each alternative and each frequency category in the accident analysis. Using the process element analogies identified in Table C.4-1, potentially bounding accidents were selected from the accident analysis for inclusion in Section 5.2.14.

C.4.1.4.1 *Methodology for Integrated Analysis of Risk to Involved Workers*

Health and safety risk to involved workers (workers associated with the construction, operation, or decontamination/decommissioning of facilities that implement a process element associated with one of the waste processing alternatives) constitutes a potentially significant impact of implementation. Unlike other receptors of health impacts from HLW treatment implementation, impacts to involved workers could occur as a result of accidents that do not result in radiological releases. Thus the consideration of involved worker impacts for waste processing alternatives requires that risks to involved workers be evaluated in an integrated way. Together with health and safety risk to the public, evaluation of involved worker risk provides a comprehensive basis for comparing waste processing alternatives on the basis of contribution to the implementation risk due to accidents. The following sources of involved workers risk are evaluated in the accident analysis.

- Industrial accident risk to involved workers is the result of accidents that may occur during industrial activities that implement major process elements. Industrial accidents may occur during any of the three major phases of a project; construction, operation, or decontamination/decommissioning.

- Occupational risk to involved workers results from exposure to radioactive materials during normal operations. While occupational risk is not the result of accidents, it is considered along with accident risks as part of the total risk to involved workers during alternative implementation. Occupational exposures occur mainly during the operation and decontamination/decommissioning phases of a project and include unanticipated exposures due to procedural breakdowns or inadequate work planning.

- Facility accident risk to involved workers results from accidents that release radioactive or chemically hazardous materials, accidents that could result in direct exposure to radiation (e.g., criticality), or energetic accidents that can directly harm workers (e.g., explosions). For purposes of this EIS, facility accidents are assumed to occur mainly during the operational phase of a project or during the decontamination/decommissioning phase of project activity. However, an accident analysis of facility disposition alternatives showed that the potential for accidents during the decontamination/decommissioning of existing facilities is several orders of magnitude smaller than for the same facilities during operation. New facilities needed to implement any of the waste processing alternatives are required (DOE 430.1) to make provisions for decontamination and decommissioning in the design process. Such facilities would be expected to pose a substantially lower risk of facility disposition accident than existing facilities. Therefore, consideration of facility accident risk is confined to the operational phase of a project.

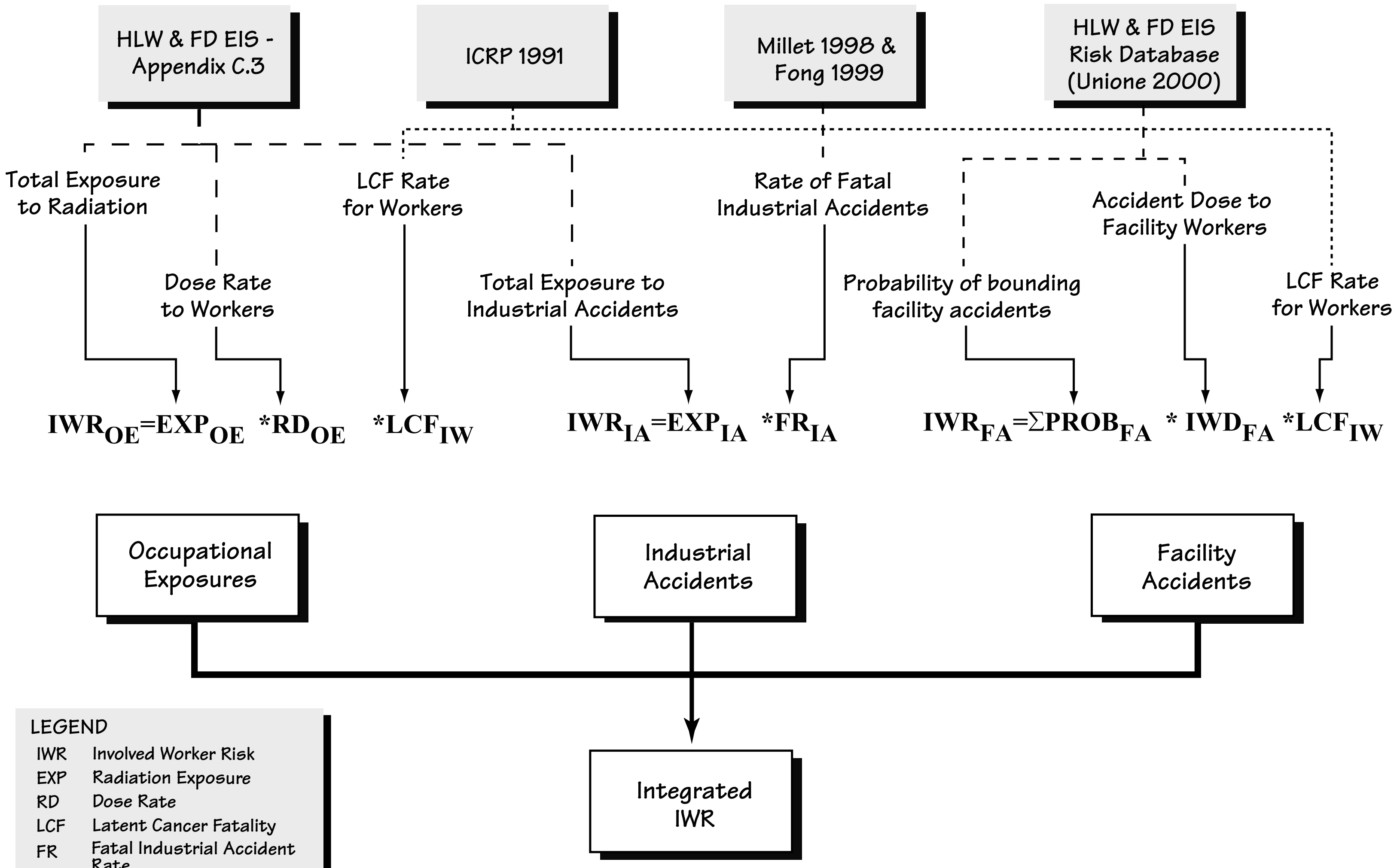
Risk to involved workers from occupational exposures and industrial accidents is appraised as part of the health and safety evaluation in this EIS (Appendix C.3). The evaluations in the accident analysis integrate industrial accidents and occupational exposures with results of the facility accidents evaluation to produce a comprehensive perspective on involved worker risk.

The method used in the accident analysis to evaluate integrated involved worker risk over the life cycle of a waste processing alternative is shown in Figure C.4-4. If the total commitment of risk required to implement a waste processing alternative can be referred to as a life cycle risk, the life cycle risk to involved workers is the sum of worker risks associated with major activities and projects. Figure C.4-4 describes how the three types of risk to involved workers are evaluated.

- Industrial accident risk is the product of total exposure to industrial accidents over the implementation life cycle and the rate of fatalities due to industrial accidents (fatalities per 100 worker years).

- Occupational risk is the product of total life cycle exposure time in a radiation environment (worker-years), the average annual dose to workers (rem per worker-year) for specific activities, and the rate of latent cancer fatalities to workers (4×10^{-4} latent cancer fatalities per person-rem of exposure).

- Facility accident risk to involved workers is estimated as the sum of contributions of potentially bounding accidents identified for that alternative. Over the implementation life cycle, each contribution is the product of the total probability of accident occurrence (anticipated events during the life cycle), dose to a population of workers as a result of the accident, and the rate of latent cancer fatalities. Consequences for involved workers are estimated for potentially bounding accidents identified in the accident analysis. For radioactive releases, doses to involved workers from an accidental release (of radioactivity) are assumed to be equivalent to doses to persons at 100 meters



LEGEND

IWR	Involved Worker Risk
EXP	Radiation Exposure
RD	Dose Rate
LCF	Latent Cancer Fatality
FR	Fatal Industrial Accident Rate
PROB	Probability of Bounding Facility Accidents
OE	Occupational Exposure
FA	Facility Accidents
IA	Industrial Accidents
IW	Involved Workers

FIGURE C.4-4.
Methodology for integrated involved worker risk evaluation.

from the release site [for consistency with the definition of facility worker utilized in the SNF & INEL EIS (DOE 1995)] and proportional to doses to non-involved workers at 640 meters. An evaluation of radionuclide contributors to dose at 100 meters for a select set of potentially bounding accidents identified five radionuclides as responsible for nearly all the dose to workers. On average, the dose at 100 meters was approximately 9 times greater than that at 640 meters. Due to limitations on the accuracy of the consequence code at locations near the origin of a release, a factor of 9 was applied to noninvolved worker doses identified for radiological accidents.

Point estimates of involved worker risk, based on single "best" values of probabilistic parameters in Figure C.4-4, were developed in the accident analysis to compare involved worker risks with facility accident risks to the public for each of the waste processing alternatives. These point estimates are presented in Section C.4.1.8 of this appendix.

C.4.1.4.2 Accidents with Potential Release of Radioactive Materials

Accidents that result in the release of radioactivity are of interest to the general public near nuclear facilities and to both involved workers and non-involved workers in and near those facilities. An individual can be exposed to direct ionizing radiation during an accident and can also be exposed to airborne emissions that are released as a result of the accident. Radiation can cause a variety of ill-health effects to the individual and, in the worst case, may cause death. Generally, the effects of environmental and occupational radiation exposures are depicted in terms of induced latent cancer fatalities. It may take many years for cancer to develop and for death to occur. In addition to latent cancer fatalities, other health effects could result from environmental and occupational exposures to radiation. These effects include nonfatal cancers among the exposed population and genetic effects in subsequent generations. To allow for ready comparison with other health effects, this EIS presents estimated effects of radiation only in terms of latent cancer fatalities.

A systematic review of accidents with the potential for releasing significant radioactivity has been performed. In order to perform this assessment, each waste processing alternative was compared to the process elements associated with the alternative and the process elements were ranked as follows:

- Inventory at risk and frequency of accidental release are likely to produce a bounding accident for the treatment alternative.
- Inventory at risk and frequency of accidental release could credibly produce a bounding accident scenario.
- Process element does not contain sufficient inventory or driving release energy to result in bounding accident scenario.

This ranking led to a determination of the potential severity of the accident.

C.4.1.4.3 Accidents with Potential Release of Toxic Chemicals

Accidents involving the release of toxic and energetic chemical compounds are a significant concern for HLW processing. Accidents could result in significant risks, particularly to involved and noninvolved worker populations. A systematic review of the potential for chemical release accidents has been performed.

Hazardous chemical releases may directly result in offsite injuries, illnesses, or fatalities. Direct impact from a release of a toxic gas such as ammonia in sufficient quantity to form a vapor cloud could endanger involved workers at the facility, noninvolved workers on the site, and members of the general public traveling on or near the site boundaries. Alternatively, such releases may initiate a sequence of unintended events that result in a release of radioactive materials. An example would be an undetected release of a toxic chemical such as chlorine, that finds its way into a building ventilation system and incapacitates operators in the facility, thus preventing the shutdown process for equipment containing radioactive materials. Without operator control, process equipment malfunctions could result in an accidental release of radioactive material. Chemical release accidents could result in groundwater contamination from materials (such as kerosene). In theory, groundwater releases of chemicals can be mitigated, with little ultimate impact on the public. However, both of these accident scenarios are described below.

The accident analysis includes a screening evaluation to identify conditions associated with implementation of the waste processing alternatives, such as the presence of significant hazardous material inventories in or near facilities or use of several incompatible materials in proximity to each other, that could be initiators of accident scenarios.

The accident analysis also provides a systematic review of process elements. This was performed to identify conditions where hazardous chemical inventories were required, processes could result in the formation of hazardous chemicals, or equipment accidents could result in conditions where hazardous chemicals could be produced and released.

The accident analysis review of process elements yielded the following observations:

- Several HLW treatment processes such as separations require additional offgas treatment capabilities not currently in use at the INEEL. Current feasibility studies for several waste processing alternatives identify a need for additional offgas treatment to meet EPA environmental requirements during separation, vitrification, and other functions associated with alternative implementation. These same feasibility studies have identified an ammonia-based treatment process as being most likely to meet the technical requirements of the waste processing alternatives. Thus, ammonia has been identified as a chemical substance posing a potentially significant hazard to workers and the public during waste processing alternative implementation. Recent design studies have identified alternative processes for meeting environmental compliance requirements. However, at this time the ammonia-based process is still considered a potential source of bounding accidents.

- Some batch processes, such as cesium separation, require the use of potentially incompatible chemicals to clean and revitalize equipment.

- Fires in some process equipment could result in the evolution and release of hazardous materials.

Using this screening approach, the accident analysis identified a kerosene leak through failed process connections, an ion exchange toxic release, an explosion from the reaction of incompatible chemicals during TRUEX separations, and an ammonia tank failure as being "abnormal events" with potential hazardous chemical release scenarios. The kerosene leak and ammonia tank failure were also identified as "design basis events" and "beyond design basis" events. These accidents are defined in the accident analysis. The screening approach employed here is considered sufficient to identify accidents resulting from chemical releases in the process.

C.4.1.5 Radiological Impacts of Implementing the Alternatives

This section analyzes the radiological impacts or consequences of implementing the waste processing alternatives. It describes (1) the major processes of each alternative, (2) the bounding accident scenarios applicable to the major processes, and (3) the resulting impact to INEEL workers and the general public. The systematic accident analysis process employed by DOE identified potentially bounding accidents for each waste processing alternative. The results for radiological releases are expressed in terms of the estimated impacts for the maximally exposed individual, noninvolved worker, offsite population, and the latent cancer fatalities for the offsite population. After evaluating the human health consequences associated with these potentially bounding accidents, DOE selected three bounding accidents (one abnormal, one design basis, and one beyond design basis) for each of the processes associated with the particular alternative.

Each waste processing alternative is made up of a number of projects and process elements that are necessary to facilitate the alternative. Each alternative and its processes must be understood to the extent that will allow the analyst to determine potential drivers for accidents. Those processes that have the most significant potential to result in additional health and safety risk to one or another of the major classes of receptors are described below by waste processing alternative.

C.4.1.5.1 *Process Descriptions*

No Action Alternative

Two major risk accruing processes form the basis of the accident analysis for the No Action Alternative.

- **Long-term Storage of Calcine in Bin Sets.** DOE currently stores calcine in a series of bin sets at INTEC. For the No Action Alternative, the facility accident analysis assumes that the stored calcine would continue to be stored in the bin sets and would not be moved for any purpose.
- **Long-term Storage of Mixed Transuranic Waste/SBW.** Mixed transuranic waste/SBW is currently stored in the Tank Farm at INTEC. For the No Action Alternative, the facility accident analysis assumes that 5 tanks identified as pillar and panel tanks would be emptied to their heels by 2003, 5 tanks would be completely filled with mixed transuranic waste/SBW by 2016, and one tank currently empty would remain empty for emergency storage capability. The 5 full tanks would continue to store mixed transuranic waste/SBW indefinitely.

Continued Current Operations Alternative

Seven major risk accruing processes form the basis of the accident analysis for the Continued Current Operations Alternative.

- **Mixed Transuranic Waste/SBW and Newly Generated Liquid Waste Processing.** This process involves the continued calcination of mixed transuranic waste/SBW and newly generated liquid waste in the New Waste Calcining Facility. Liquid waste feed is pumped from the Tank Farm, atomized by air, and sprayed onto a bed of heated spherical particles maintained at a temperature of approximately 500°C by in-bed combustion of kerosene. The calcine product from the bed and the fines removed from the offgas in the cycle are pneumatically transferred to the bin sets for storage. Offgas from the fluidized bed is processed through high-efficiency particulate air filters. From the accident analysis standpoint, the focus for this process element would be on the potential for a kerosene fire in the calciner cell.
- **New Waste Calcining Facility High Temperature and Maximum Achievable Control Technology Modifications (Offgas Treatment Facility Only).** The process involves the continued calcination of mixed transuranic waste/SBW and newly generated liquid waste as described above except that the fluidized bed would potentially operate at 600°C. To meet the Maximum Achievable Control Technology standards, a multi-stage combustion control system is needed to achieve emission goals for carbon monoxide and various nitrogen oxides and a mercury removal system is needed to achieve goals for mercury emissions. The differences in calcining operations using Maximum Achievable

Control Technology are not expected to increase the hazards. This process element takes into consideration the large quantities of kerosene that must be stored in the proximity of the New Waste Calcining Facility. The primary focus from an accident analysis standpoint for this process element would be on the potential for major leaks of kerosene.

- **Cesium Separation (Cesium Ion Exchange Only).** For the Continued Operations Alternative, the process element assumes that cesium separations would be used to process tank heels and newly generated liquid waste. This process takes liquid mixed transuranic waste/SBW and/or tank heel material and feeds this waste into an ion exchange column where cesium would be separated from the actinides and strontium. This separation allows the actinide and strontium waste to be processed for disposal as transuranic waste. The cesium rich resin waste from the ion exchange column would be managed as HLW and transferred to the bin sets for storage in the case of the Continued Current Operations Alternative or vitrified.

- **Liquid Waste Stream Evaporation.** This process would reduce the volume of both mixed transuranic waste/SBW and newly generated liquid waste. It represents the existing Process Equipment Waste and Liquid Effluent Treatment and Disposal Facility evaporators at INTEC but could also consider a new evaporator if current evaporators are insufficient to handle the volumes of newly generated liquid waste expected after the INTEC tanks are closed. Existing mixed transuranic waste/SBW and newly generated liquid waste, currently stored in the Tank Farm, is withdrawn from the tanks and sent to the evaporators. Following evaporation, the liquid waste is sent back to the tanks to await calcination. Following completion of mixed transuranic waste/SBW calcination under this alternative, the existing Tank Farm would be closed and newly generated liquid waste would be sent to Resource Conservation and Recovery Act (RCRA) compliant tanks. The newly generated liquid waste would continue to be generated, stored, and evaporated to reduce the volume, then grouted and disposed.

- **Long-term Storage of Calcine in Bin Sets.** This process element is described under the No Action Alternative.

- **Short-term Storage of Mixed Transuranic Waste/SBW.** Mixed transuranic waste/SBW is currently stored in the Tank Farm at INTEC. For all waste processing alternatives and options except the No Action Alternative, the facility accident analysis assumes that mixed transuranic waste/SBW would be continued to be stored in the Tank Farm until removed for processing (i.e., short-term). The primary focus of the accident analysis is a seismically induced failure of a single tank filled with mixed transuranic waste/SBW.

- **Mixed Transuranic Waste/SBW Retrieval and Transport.** This process involves retrieval of mixed transuranic waste/SBW from the Tank Farm, transportation of the waste onsite, and storage of the waste prior to processing. For the most part, existing retrieval, transport, and storage systems at INTEC would be used (i.e., pumps, transfer tanks, piping, evaporators, etc.). Approximately 1.2 million gallons of mixed transuranic waste/SBW would be retrieved and transported. Liquid waste from other sources also would be transferred by the mixed transuranic waste/SBW retrieval and transport system into storage tanks, blended, characterized, and stored for later processing. Mixed transuranic waste/SBW retrieval includes retrieval of tank "heels" to the extent feasible with the existing waste retrieval equipment.

Separations Alternative - Full Separations Option

Eight major risk accruing processes form the basis of the accident analysis for the Full Separations Option.

- **Calcine Retrieval and Onsite Transport.** This process involves removal of calcine from bin sets 1 through 6 for processing to a road-ready condition. Retrieval of calcine from the bin sets includes four distinct operational functions (1) accessing the existing bin set outer containment and vaults, (2) retrieving the calcine from the bin set structures, (3) transporting the calcine to the processing facility, and (4) storing the calcine in the processing facility for an interim period. The calcine transport subsystem would carry the calcine from the bins to the final destination. An intermediate facility may be required to increase suction if the distance between the bin sets and the processing facility exceeds 1,000 feet.

- **Full Separations (Cesium Ion Exchange, Transuranic and Strontium Extraction).** This process takes liquid mixed transuranic waste/SBW and dissolved calcine, and partitions the liquid waste stream into mixed HLW and mixed low-level waste fractions. The process includes 4 major process elements: (1) dissolution of the calcine and preparation of the waste stream for partitioning, (2) feeding mixed transuranic waste/SBW and dissolved calcine through a cesium ion exchange column to remove cesium, (3) feeding the liquid waste through a TRUEX process to remove actinides, and (4) feeding the remainder of the liquid waste through a SREX process to remove strontium. Since the calcine waste is currently in a solid form, it must be dissolved and filtered prior to feeding to the cesium ion exchange column. The TRUEX process, for removing transuranics from the liquid mixed HLW stream from dissolved calcine, includes use of an organic extractant to separate actinides from the solution. The SREX extraction process uses an organic extractant to separate strontium from the solution with subsequent stripping to remove strontium from the organic phase.

- **Borosilicate Vitrification (Cesium, Transuranic, and Strontium Feedstock).** After separations, the separated mixed HLW fraction and a frit material would be mixed in a melter to form a HLW glass that can be sent to the repository. Mixed transuranic waste/SBW would be processed in the liquid form before calcine is retrieved and processed. Calcine would then be retrieved, dissolved, separated and vitrified. Major borosilicate vitrification facility functions include: (1) receiving the mixed HLW fraction from the waste separations facility, (2) blending the waste, (3) sampling the blended waste, (4) selecting the proper glass frit, (5) delivering the waste and frit mixture to the melter, (6) vitrifying the mixture in the melter, (7) pouring the glass into canisters, (8) welding, leak checking, and decontaminating the canisters, and (9) processing the melter offgas stream.

- **Liquid Waste Stream Evaporation.** An additional evaporation process would be required to handle mixed HLW and mixed low-level waste fractions during the separations process. Mixed low-level waste fractions, produced during the separation of the mixed HLW fraction from the mixed transuranic waste/SBW and dissolved calcine wastes, contain a substantial excess of water and nitric acid that must be removed prior to grouting. These streams would be evaporated to remove excess water and then distilled to concentrate and recycle acid. The estimated flows for the low-level waste fraction are likely to exceed the capacity of current volume reduction facilities, and a new full capacity evaporator would be installed. The facility accident analysis focuses on the mixed HLW evaporator operation due to the high activity in the evaporation process.

- **Additional Offgas Treatment.** An additional offgas treatment process would be required to handle effluents from the mixed HLW and mixed low-level waste fractions. The core activity for offgas treatment design is assumed to involve the use of ammonia to control nitrogen oxide emissions in a selective catalytic reduction process. From the accident analysis standpoint, the focus for this process element would be the use of ammonia in the selective catalytic reduction.

- **Short-term Storage of Calcine in Bin Sets.** DOE currently stores calcine in a series of bin sets at the INTEC. For this option, calcine would be stored in the bin sets for a limited period of time until removed for processing.

- **Short-term Storage of Mixed Transuranic Waste/SBW.** This process element is described under the Continued Current Operations Alternative.

- **Mixed Transuranic Waste/SBW Retrieval and Transport.** This process element is described under the Continued Current Operations Alternative.

Separations Alternative - Planning Basis Option

Ten major risk accruing processes form the basis of the accident analysis for the Planning Basis Option.

- **Mixed Transuranic Waste/SBW and Newly Generated Liquid Waste Processing.** This process element is described under the Continued Current Operations Alternative.

- **New Waste Calcining Facility High Temperature and Maximum Achievable Control Technology Modifications (Offgas Treatment Facility Only).** This process element is described under the Continued Current Operations Alternative.

- **Calcine Retrieval and Onsite Transport.** This process element is described under the Full Separations Option.

- **Full Separations (Cesium Ion Exchange, Transuranic and Strontium Extraction).** This process element is described under the Full Separations Option.

- **Borosilicate Vitrification (Cesium, Transuranic, and Strontium Feedstock).** This process element is described under the Full Separations Option.

- **Liquid Waste Stream Evaporation.** This process element is described under the Full Separations Option.

- **Additional Offgas Treatment.** This process element is described under the Full Separations Option.

- **Short-term Storage of Calcine in Bin Sets.** This process element is described under the Full Separations Option.

- **Short-term Storage of Mixed Transuranic Waste/SBW.** This process element is described under the Continued Current Operations Alternative.

- **Mixed Transuranic Waste/SBW Retrieval and Transport.** This process element is described under the Continued Current Operations Alternative.

Separations Alternative - Transuranic Separations Option

Ten major risk accruing processes form the basis of the accident analysis for the Transuranic Separations Option.

- **Calcine Retrieval and Onsite Transport.** This process element is described under the Full Separations Option.

- **Transuranic Separations (Transuranic Extraction Only).** The transuranic separations process takes liquid mixed transuranic waste/SBW and dissolved calcine material and partitions the actinide waste from the remaining waste stream. The process includes three major steps: (1) retrieval and processing of mixed transuranic waste/SBW to separate the actinides, (2) retrieval and dissolution of calcine in preparation for treatment and partitioning, and (3) processing of liquid HLW from calcine to separate the actinides. The Transuranic Separations Option is assumed to use the TRUEX extraction purification process to separate waste streams. This process includes use of an organic extractant to separate actinides from the solution and acidic stripping to remove actinides from the organic phase. The aqueous raffinate stream would be denitrated and grouted to form a Class C-type grout. The transuranic waste would be packaged for disposal at a suitable repository.

- **Class C Grout.** This process involves converting an aqueous raffinate stream from the Transuranic Separations Option into Class C-type low-level waste grout. The aqueous raffinate stream would be free of actinide elements but would contain the principal fission products associated with waste processing activities. The process involves denitrating and solidification of the mixed low-level waste fraction from the separations process, combining the solids with Portland cement, blast furnace slag, and flyash, and mixing the materials with additives, water, and a plasticizer to form a Class C-type grout. The grout would be placed into canisters for interim storage and ultimate disposal.

- **Liquid Waste Stream Evaporation.** This process element is described under the Full Separations Option.

- **Additional Offgas Treatment.** This process element is described under the Full Separations Option.

- **Class C Grout Disposal.** This process involves separating the mixed low-level waste fraction from the actinides during the transuranic separations process, denitrating the waste, and combining the denitrated waste with cement and other additives to produce a Class C-type grout. The Class C-type grout would be pumped to a container filling facility, containerized, and disposed of at an INEEL landfill or offsite. Because of the presence of cesium and strontium in the waste stream, the grout is much more radioactive and requires additional shielding and remote handling as compared to Class A-type grout. Generally the grout would be loaded into concrete landfill containers with a capacity of about 1 m^3. After filling, these containers are allowed to set, then capped, loaded in a shielded transport cask, and transported to a disposal or interim storage location.

- **Short-term Storage of Calcine in Bin Sets.** This process element is described under the Full Separations Option.

- **Transuranic Waste Stabilization and Preparation for Transport.** This process involves the handling and loading of transport casks with remote-handled transuranic waste destined for the Waste Isolation Pilot Plant. This waste would be generated as a result of the TRUEX separations process. Separated transuranic waste would be evaporated and dried prior to packaging. The transport casks are assumed to be loaded with Waste Isolation Pilot Plant-type half-containers. Handling and loading of casks and containers would be performed in the Waste Separations Facility where limited lag storage would be available. Each half-container produced from mixed transuranic waste/SBW would hold about 0.1 m^3 of remote-handled transuranic waste. Each half-container produced from calcine would hold about 0.2 m^3 of remote-handled transuranic waste material. All containers would be remote handled due to calculated maximum gamma radiation levels.

- **Short-term Storage of Mixed Transuranic Waste/SBW.** This process element is described under the Continued Current Operations Alternative.

- **Mixed Transuranic Waste/SBW Retrieval and Transport.** This process element is described under the Continued Current Operations Alternative.

Non-Separations Alternative - Hot Isostatic Pressed Waste Option

Nine major risk accruing processes form the basis of the accident analysis for the Hot Isostatic Pressed Waste Option.

- **Mixed Transuranic Waste/SBW and Newly Generated Liquid Waste Processing.** This process element is described under the Continued Current Operations Alternative.

- **New Waste Calcining Facility High Temperature and Maximum Achievable Control Technology Modifications (Offgas Treatment Facility Only).** This process element is described under the Continued Current Operations Alternative.

- **Calcine Retrieval and Onsite Transport.** This process element is described under the Full Separations Option.

- **HLW and Mixed Transuranic Waste/SBW Immobilization for Transport (HIP).** The Hot Isostatic Pressed Waste Option would calcine the remaining mixed transuranic waste/SBW, retrieve the calcine from the bin sets, and then immobilize the calcined product. The process involves: (1) receiving calcine from the Calcine Retrieval and Transport System, (2) blending and sizing the calcine in batches, (3) sampling the blended calcine, (4) selecting the proper amorphous silica and titanium powder mixture, (5) mixing the calcine and additives and delivering the mixture to the canning station, (6) devolatilizing the mixture, (7) hot isostatic pressing the cans, (8) welding, leak checking, and decontaminating the cans, and (9) processing the devolatilization offgas. The Hot Isostatic Press facility is designed to process only dry material. The Hot Isostatic Press ovens would operate at about 1050°C and 20,000 psi.

- **Liquid Waste Stream Evaporation.** This process element is described under the Full Separations Option. Although the process is generally adapted to the separations options, it is anticipated that current evaporators will be required to process newly generated liquid waste during Hot Isostatic Press operations.

- **Additional Offgas Treatment.** This process element is described under the Full Separations Option.

- **Short-term Storage of Calcine in Bin Sets.** This process element is described under the Full Separations Option.

- **Short-term Storage of Mixed Transuranic Waste/SBW.** This process element is described under the Continued Current Operations Alternative.

- **Mixed Transuranic Waste/SBW Retrieval and Transport.** This process element is described under the Continued Current Operations Alternative.

Non-Separations Alternative - Direct Cement Waste Option

Nine major risk accruing process form the basis of the accident analysis for the Direct Cement Waste Option.

- **Mixed Transuranic Waste/SBW and Newly Generated Liquid Waste Processing.** This process element is described under the Continued Current Operations Alternative.

- **New Waste Calcining Facility High Temperature and Maximum Achievable Control Technology Modifications (Offgas Treatment Facility Only).** This process element is described under the Continued Current Operations Alternative.

- **Calcine Retrieval and Onsite Transport.** This process element is described under the Full Separations Option.

- **HLW and Mixed Transuranic Waste/SBW Immobilization for Transport (Direct Cement).** The Direct Cement Waste Option would calcine the remaining mixed transuranic waste/SBW, retrieve the calcine from the bin sets and process the calcined waste into HLW grout. The process involves: (1) receiving the calcine from the Calcine Retrieval and Transport System, (2) blending and sampling the calcine, (3) selecting the proper clay, blast furnace slag, and caustic soda mixture, (4) mixing the calcine and additives to form a HLW grout, (5) delivering the mixture to the waste canister fill station and filling the canisters, (6) autoclaving and de-watering the canisters, and (7) sealing the canisters and processing the offgas. Following this process, the canisters would be interim stored awaiting shipment to the geologic repository. Autoclaving would be performed at about 250°C and 1,500 psi.

- **Liquid Waste Stream Evaporation.** This process element is described under the Full Separations Option. Although the process is generally adapted to separations options, it is anticipated that current evaporators will be required to process newly generated liquid waste during Direct Cement Waste Option operations.

- **Additional Offgas Treatment.** This process element is described under the Full Separations Option.

- **Short-term Storage of Calcine in Bin Sets.** This process element is described under the Full Separations Option.

- **Short-term Storage of Mixed Transuranic Waste/SBW.** This process element is described under the Continued Current Operations Alternative.

- **Mixed Transuranic Waste/SBW Retrieval and Transport.** This process element is described under the Continued Current Operations Alternative.

Non-Separations Alternative - Early Vitrification Option

Seven major risk accruing process form the basis of the accident analysis for the Early Vitrification Option.

- **Calcine Retrieval and Onsite Transport.** This process element is described under the Full Separations Option.

- **Borosilicate Vitrification (Calcine and Mixed Transuranic Waste/SBW Feedstock).** The Early Vitrification Option would vitrify mixed transuranic waste/SBW and newly generated liquid waste followed by vitrificaiton of mixed HLW calcine. The process would retrieve the mixed transuranic waste/SBW and newly generated liquid waste from the Tank Farm, filter the liquid waste to remove solids, blend the waste with glass frit, and feed the slurry to a melter for vitrification. Glass from the process would be poured into standard Waste Isolation Pilot Plant remote-handled transuranic waste containers or containers suitable for disposal at a geologic repository. Once mixed transuranic waste/SBW processing is complete, the calcine is retrieved from the bin sets, blended with glass frit, and vitrified. In the melter cell, the waste mixture is fed to a melter that operates at about 1,200°C. The glass product is gravity discharged to the container. Major activities associated with the process element are: (1) receiving the waste in batches and blending the waste with the proper glass frit, (2) sampling the slurry to assure glass quality, (3) delivering the mixture to the melter cell, (4) vitrifying the mixture, (5) pouring the glass into containers, delivering the containers to interim storage to await shipment, and (6) processing the melter offgas.

- **Additional Offgas Treatment.** This process element is described under the Full Separations Option.

- **Short-term Storage of Calcine in Bin Sets.** This process element is described under the Full Separations Option.

- **Short-term Storage of Mixed Transuranic Waste/SBW.** This process element is described under the Continued Current Operations Alternative.

- **Mixed Transuranic Waste/SBW Stabilization and Preparation for Transport.** This process involves the handling and loading of shipping casks with Waste Isolation Pilot Plant-type containers containing remote handled transuranic waste. These containers would be stored in the Interim Storage Facility. From there, the containers would be loaded onto rail cars or truck for shipment to the Waste Isolation Pilot Plant or other geologic repository. All containers would be remote handled using standard techniques since gamma radiation levels would approach 170 R/hr at contact and 73 R/hr at one meter. From an accident standpoint, the issue is a spill of liquid glass from the container during a seismic event. The radiological source term in a container of vitrified mixed transuranic waste/SBW is about twice the source term in a container of vitrified HLW calcine. Therefore, process element Mixed Transuranic Waste/SBW Stabilization and Preparation for Transport is a bounding analysis for a vitrified HLW spill.

- **Mixed Transuranic Waste/SBW Retrieval and Transport.** This process element is described under the Continued Current Operations Alternative.

Non-Separations Alternative - Steam Reforming Option

Eight major risk accruing processes form the basis of the accident analysis for the Steam Reforming Option.

- **Liquid Waste Stream Evaporation.** This process element is described under the Full Separations Option. Although the process is generally adapted to separations options, it is anticipated that current evaporators will be required to process newly generated liquid waste during Steam Reforming Option operations.

- **Short-term Storage of Mixed Transuranic Waste/SBW.** This process element is described under the Continued Current Operations Alternative.

- **Short-term Storage of Calcine in Bin Sets.** This process element is described under the Full Separations Option.

- **Calcine Retrieval and Transport.** This process element is described under the Full Separations Option.

- **Calcine Packaging and Loading.** This process involves retrieving calcine from the bin sets and transporting the calcine to the Waste Packaging Facility where it would be loaded into canisters. The canisters would be sealed and transported to the geologic repository for disposal.

- **Mixed Transuranic Waste/SBW Retrieval and Transport.** This process element is described under the Continued Current Operations Alternative.

- **NGLW Grout Facility.** This process involves grouting all the NGLW generated from 2013 through 2035. The concentrated NGLW would be blended with other materials to form a grouted waste product. Although the radioactive characteristics of such a waste form are uncertain at this time, it is believed that this grouted waste would be classified as mixed, remote-handled transuranic waste. As such, it could only be sent to the Waste Isolation Pilot Plant for disposal. The grout would be loaded into containers, each of which holds 0.4 m^3 of remote-handled transuranic waste.

- **Steam Reforming.** The Steam Reforming Facility would process the liquid SBW from the Tank Farm as well as other newly generated liquid waste. The central feature of the Steam Reforming Facility is the Reformer, a fluidized bed reactor in which steam is used as the fluidizing gas and a refractory oxide material is used as the bed medium. The liquid would be converted into a dry powder that would be canned and shipped to the Waste Isolation Pilot Plant as mixed, remote-handled transuranic waste. The primary focus from an accident standpoint for this process element would be the potential for vessel explosion.

Minimum INEEL Processing Alternative

Eleven major risk accruing processes form the basis of the accident analysis for the Minimum INEEL Processing Alternative.

- **Calcine Retrieval and Onsite Transport.** This process element is described under the Full Separations Option.

- **Cesium Separation (Cesium Ion Exchange Only).** This process element is described under the Continued Current Operations Alternative.

- **Class C Grout.** This process element is described under the Transuranic Separations Option.

- **HLW and Mixed Transuranic Waste/SBW Immobilization for Transport (Calcine and Cesium Ion Exchange Resin Feedstock).** This process involves retrieving calcine from the bin sets and transporting the calcine to the Waste Packaging Facility where it would be loaded into waste containers. The containers would be fitted with a removable lid, sealed, and transported to Hanford for vitrification of the calcined waste. The mixed transuranic waste/SBW would be retrieved, filtered, and transported to an ion exchange facility for processing through an ion exchange column to remove cesium. The waste stream would be grouted and managed as contact-handled transuranic waste. The high-activity waste resins from the ion exchange column would be dried, packaged, and transported to Hanford for vitrification.

- **Additional Offgas Treatment.** This process element is described under the Full Separations Option.

- **HLW Interim Storage for Transport.** This process involves the interim storage of packaged calcine material awaiting shipment to Hanford for vitrification. As containers are filled and the lids secured, they would be moved to an interim storage location and loaded into a transport cask aboard a transport vehicle (nominally a rail car). Shipment to Hanford would take place as soon as the cask is loaded. For each shipment to Hanford, four casks are assumed to be loaded with three waste containers in each cask. The interim storage process is considered an extension of the packaging facility operations and subject to accidents during loading of the transport casks or after the casks are placed on the transport vehicle. Spills or other accidents are capable of releasing calcined material and fines.

- **HLW and HAW Stabilization and Preparation for Transport (Calcine and Cesium Resin Feedstock).** This process involves loading containers with calcine. The loading operation has 5 distinct operations: (1) lowering the container from the main operating floor to the filling cell level, (2) transfer of the container through an airlock into the filling cell where it is raised to mate with the transfer mechanism, (3) attaching a fill spout to the container to receive the calcine, (4) filling the container, and (5) moving the container to a separate location in the filling cell where a cover is attached to the container. Both the cover and the lid must be removable since the containers will be emptied at Hanford and returned for reuse. The calcine will be delivered from the calcine storage bins at the rate of 2,700 kg/hr and will be separated from its airstream by a cyclone separator. The calcine would flow into the container by gravity.

- **Short-term Storage of Calcine in Bin Sets.** This process element is described under the Full Separations Option.

- **Transuranic Waste Stabilization and Preparation for Transport.** This process involves the handling and loading of transport casks with contact-handled transuranic waste destined for the Waste Isolation Pilot Plant. For this alternative, mixed transuranic waste/SBW would be fed to a cesium ion exchange column that would remove the cesium and leave the transuranic and strontium wastes. The transuranic and strontium wastes would be grouted and the grout loaded into 55-gallon drums. The containers would be loaded into transport casks and shipped to the Waste Isolation Pilot Plant. Each container would hold about 0.1 m^3 of contact-handled transuranic waste.

- **Short-term Storage of Mixed Transuranic Waste/SBW.** This process element is described under the Continued Current Operations Alternative.

- **Mixed Transuranic Waste/SBW Retrieval and Transport.** This process element is described under the Continued Current Operations Alternative.

Direct Vitrification Alternative - Vitrification without Calcine Separations Option

Seven major risk accruing processes form the basis of the accident analysis for the Vitrification without Calcine Separations Option.

- **Calcine Retrieval and Onsite Transport.** This process element is described under the Full Separations Option.

- **Borosilicate Vitrification (Calcine and Mixed Transuranic Waste/SBW Feedstock).** This process element is described under the Early Vitrification Option.

- **Additional Offgas Treatment.** This process element is described under the Full Separations Option.

- **Short-term Storage of Calcine in Bin Sets.** This process element is described under the Full Separations Option.

- **Short-term Storage of Mixed Transuranic Waste/SBW.** This process element is described under the Continued Current Operations Alternative.

- **Mixed Transuranic Waste/SBW Stabilization and Preparation for Transport.** This process element is described under the Early Vitrification Option.

- **Mixed Transuranic Waste/SBW Retrieval and Transport.** This process element is described under the Continued Current Operations Alternative.

Direct Vitrification Alternative - Vitrification with Calcine Separations Option

Ten major risk accruing processes form the basis of the accident analysis for the Vitrification with Calcine Separations Option.

- **Calcine Retrieval and Onsite Transport.** This process element is described under the Full Separations Option.
- **Full Separations (Cesium Ion Exchange, Transuranic and Strontium Extraction).** This process element is described under the Full Separations Option.
- **Cesium Separation (Cesium Ion Exchange Only).** This process element is described under the Continued Current Operations Alternative.
- **Borosilicate Vitrification (Cesium, Transuranic, and Strontium Feedstock).** This process element is described under the Full Separations Option.
- **Liquid Waste Stream Evaporation.** This process element is described under the Full Separations Option.
- **Additional Offgas Treatment.** This process element is described under the Full Separations Option.
- **Short-term Storage of Calcine in Bin Sets.** This process element is described under the Full Separations Option.
- **Short-term Storage of Mixed Transuranic Waste/SBW.** This process element is described under the Continued Current Operations Alternative.
- **Mixed Transuranic Waste/SBW Stabilization and Preparation for Transport.** This process element is described under the Early Vitrification Option.
- **Mixed Transuranic Waste/SBW Retrieval and Transport.** This process element is described under the Continued Current Operations Alternative.

C.4.1.5.2 *Bounding Radiological Impacts for Waste Processing Alternatives*

The approach used to evaluate facility accident impacts for this EIS is to utilize evaluations of common process elements from the accident analysis to identify and evaluate potentially bounding accidents. In general, the process used in selecting the bounding accident scenario was to select the scenario with the highest consequence within each frequency bin. In some cases, one scenario had the highest consequence for the maximally exposed individual and noninvolved worker but another scenario had higher consequences for the offsite population and latent cancer fatalities. In these cases, the scenario with the higher consequences for the offsite population/latent cancer fatalities was generally selected. Some exceptions to this rule are:

- **Cross-Cutting Accidents** - Some potential accidents are common to all alternatives. For example, operational failures associated with the removal of calcine from the bin sets and flood-induced failure of bin set 1 are bounding abnormal and design basis events respectively that generally affect all waste processing alternatives. In order to compare waste processing alternatives, cross-cutting accidents are shown separately in the accident analysis as accidents that cross cut alternatives. In many cases, the cross-cutting accidents are the highest risk events. However, in order to provide additional resolution in determining the highest risk alternatives, the scenario with the second highest consequence is also highlighted as a potential "bounding" scenario in the accident analysis database.

- **Highest Risk vs. Highest Consequence Scenario** - Risk is defined as the product of frequency and consequence. In some cases, the scenario with the perceived higher risk was selected even though another scenario may have had higher consequences. The frequency bands considered in the analysis were fairly wide. For instance, the design basis frequency band is from 1.0×10^{-3} per year to 1.0×10^{-6} per year. From a risk standpoint, a scenario that is a 1,000 times more likely (e.g., 1.0×10^{-3} per year vs. 1.0×10^{-6} per year), has a higher risk than another scenario that has a consequence that is 100 times greater. Therefore, the approach taken was to select the higher frequency/lower consequence scenario as the bounding scenario.

Summary tables in the accident analysis describe potentially bounding accidents and their forecasted consequences. The accident analysis also provides additional information with respect to the process used to identify potentially bounding accidents, their source terms, and consequences. Table C.4-2 provides a summary of bounding radiological events for the various waste processing alternatives.

C.4.1.6 Chemical Impacts of Implementing the Alternatives

This section analyzes the impacts or consequences of chemical releases from accidents that could occur as a result of implementing the waste processing alternatives. It identifies (1) the major processes that contribute chemicals to the atmosphere during an accident and (2) the impacts to INEEL workers and the general public in terms of ERPG values at 3,600 meters.

Alternative/Process Data - Two major processes or functions can produce chemical releases from accidents resulting during implementation of waste processing alternatives.

- New Waste Calcining Facility High Temperature and Maximum Achievable Control Technology Modifications.
- Additional Offgas Treatment.

Accident Consequence - Table C.4-3 presents the chemical accidents and the impacts of these accidents.

C.4.1.7 Groundwater Impacts of Implementing the Alternatives

The bounding accident scenarios described in the preceding sections produce human health consequences mainly as a result of inhalation of air releases. In the National Environmental Policy Act accident analysis, it is generally assumed that the inhalation pathway is the predominant source of human health consequences since an air release does not provide an opportunity for intervention and mitigation.

A few potentially bounding accident scenarios from the detailed accident evaluation process produced groundwater releases. Although groundwater releases can sometimes be mitigated with little ultimate impact on the public, significant groundwater releases could produce a substantive risk to the environment. The impact of accident scenarios resulting in groundwater releases is considered in the facility accidents evaluation.

Environmental risk is usually presented in the Remedial Investigation/Feasibility Study process in terms of expected groundwater contamination at the site boundary as a function of time. Therefore, the measures of environmental risk such as the U.S. Environmental Protection Agency (EPA) drinking water standards or maximum contaminant levels can be used to estimate the potential for future adverse human health impacts. Specifically, expected contamination due to a postulated release can be compared with maximum contaminant level values to assess the severity of environmental risk associated with a release. In this way, accident scenarios resulting in a release to groundwater can be appraised for their potential contribution to environmental risk and the overall economic impact of the accident.

Three major process elements or functions can produce groundwater releases from accidents resulting during implementation of waste processing alternatives.

Table C.4-2. Summary of bounding facility accidents for the waste processing alternatives.

Frequency	Process title	Event description	Bounding accident frequency (accidents/ year)	Window of exposure (years)	Probability accident occurs (probability)	Maximally exposed individual dose (millirem)	Noninvolved worker dose (millirem)	Offsite public dose (person-rem/ event)	Offsite public LCFs (LCFs/ event)	Per capita risk to offsite population (LCFs/120,000 person-event)
No Action Alternative										
ABN	Long-term Storage of Calcine in bin sets	Seismic induced failure of a bin set	2.5×10^{-4}	9.5×10^{3}	1.00	8.3×10^{4}	5.7×10^{6}	5.3×10^{5}	270	2.2×10^{-3}
DBE	Short-term Storage of Calcine in bin sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Short-term Storage of Calcine in bin sets	External event causes failure of bin set structure	2.6×10^{-8}	35	5.5×10^{-6}	1.4×10^{4}	9.3×10^{5}	1.2×10^{5}	61	5.1×10^{-4}
Continued Current Operations Alternative										
ABN	Long-term Storage of Calcine in bin sets	Seismic induced failure of a bin set	2.5×10^{-4}	9.5×10^{3}	1.00	8.3×10^{4}	5.7×10^{6}	5.3×10^{5}	270	2.2×10^{-3}
DBE	Short-term Storage of Calcine in bin sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Short-term Storage of Calcine in bin sets	External event causes failure of bin set structure	2.6×10^{-8}	35	5.5×10^{-6}	1.4×10^{4}	9.3×10^{5}	1.2×10^{5}	61	5.1×10^{-4}
Full Separations Option										
ABN	Calcine Retrieval and Onsite Transport	Equipment failure results in release of calcine	3.0×10^{-3}	35	0.11	40	2.7×10^{3}	470	0.23	2.0×10^{-6}
DBE	Short-term Storage of Calcine in Bin Sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Borosilicate Vitrification	External event results in a release (HAW) from borosilicate vitrification facility	2.6×10^{-8}	20	5.3×10^{-7}	1.7×10^{4}	1.2×10^{6}	1.5×10^{5}	76	6.3×10^{-4}

- New Information -

Table C.4-2. Summary of bounding facility accidents for the waste processing alternatives (continued).

Frequency	Process title	Event description	Bounding accident frequency (accidents/ year)	Window of exposure (years)	Probability accident occurs (probability)	Maximally exposed individual dose (millirem)	Noninvolved worker dose (millirem)	Offsite public dose (person-rem/ event)	Offsite public LCFs (LCFs/ event)	Per capita risk to offsite population (LCFs/120,000 person-event)
Planning Basis Option										
ABN	Calcine Retrieval and Onsite Transport	Equipment failure results in release of calcine	3.0×10^{-3}	35	0.11	40	2.7×10^{3}	470	0.23	2.0×10^{-6}
DBE	Short-term Storage of Calcine in Bin Sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Borosilicate Vitrification	External event results in a release (HAW) from borosilicate vitrification facility	2.6×10^{-8}	20	5.3×10^{-7}	1.7×10^{4}	1.2×10^{6}	1.5×10^{5}	76	6.3×10^{-4}
Transuranic Separations Option										
ABN	Calcine Retrieval and Onsite Transport	Equipment failure results in release of calcine	3.0×10^{-3}	35	0.11	40	2.7×10^{3}	470	0.23	2.0×10^{-6}
DBE	Short-term Storage of Calcine in Bin Sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Short-Term Storage of Calcine in Bin Sets	External event causes failure of bin set structure	2.6×10^{-8}	35	5.5×10^{-6}	1.4×10^{4}	9.3×10^{5}	1.2×10^{5}	61	5.7×10^{-4}
Hot Isostatic Pressed Waste Option										
ABN	Calcine Retrieval and Onsite Transport	Equipment failure results in release of calcine	3.0×10^{-3}	35	0.11	40	2.7×10^{3}	470	0.23	2.0×10^{-6}
DBE	Short-term Storage of Calcine in Bin Sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Short-term Storage of Calcine in Bin Sets	External event causes failure of bin set structure	2.6×10^{-8}	35	5.5×10^{-6}	1.4×10^{4}	9.3×10^{5}	1.2×10^{5}	61	5.7×10^{-4}

Table C.4-2. Summary of bounding facility accidents for the waste processing alternatives (continued).

Frequency	Process title	Event description	Bounding accident frequency (accidents/ year)	Window of exposure (years)	Probability accident occurs (probability)	Maximally exposed individual dose (millirem)	Noninvolved worker dose (millirem)	Offsite public dose (person-rem/ event)	Offsite public LCFs (LCFs/ event)	Per capita risk to offsite population (LCFs/120,000 person-event)
Direct Cement Waste Option										
ABN	Calcine Retrieval and Onsite Transport	Equipment failure results in release of calcine	3.0×10^{-3}	35	0.11	40	2.7×10^{3}	470	0.23	2.0×10^{-6}
DBE	Short-term Storage of Calcine in Bin Sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Short-term Storage of Calcine in Bin Sets	External event causes failure of bin set structure	2.6×10^{-8}	35	5.5×10^{-6}	1.4×10^{4}	9.3×10^{5}	1.2×10^{5}	61	5.7×10^{-4}
Early Vitrification Option										
ABN	Calcine Retrieval and Onsite Transport	Equipment failure results in release of calcine	3.0×10^{-3}	35	0.11	40	2.7×10^{3}	470	0.23	2.0×10^{-6}
DBE	Short-term Storage of Calcine in Bin Sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Short-term Storage of Calcine in Bin Sets	External event causes failure of bin set structure	2.6×10^{-8}	35	5.5×10^{-6}	1.4×10^{4}	9.3×10^{5}	1.2×10^{5}	61	5.7×10^{-4}
Steam Reforming Option										
vABN	Calcine Retrieval and Onsite Transport	Equipment failure results in release of calcine	3.0×10^{-3}	35	0.11	40	2.7×10^{3}	470	0.23	2.0×10^{-6}
DBE	Short-term Storage of Calcine in Bin Sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Short-term Storage of Calcine in Bin Sets	External event causes failure of bin set structure	2.6×10^{-8}	35	5.5×10^{-6}	1.4×10^{4}	9.3×10^{5}	1.2×10^{5}	61	5.7×10^{-4}

- New Information -

Table C.4-2. Summary of bounding facility accidents for the waste processing alternatives (continued).

Frequency	Process title	Event description	Bounding accident frequency (accidents/ year)	Window of exposure (years)	Probability accident occurs (probability)	Maximally exposed individual dose (millirem)	Noninvolved worker dose (millirem)	Offsite public dose (person-rem/ event)	Offsite public LCFs (LCFs/ event)	Per capita risk to offsite population (LCFs/120,000 person-event)
			Minimum INEEL Processing Alternative							
ABN	Calcine Retrieval and Onsite Transport	Equipment failure results in release of calcine	3.0×10^{-3}	35	0.11	40	2.7×10^{3}	470	0.23	2.0×10^{-6}
DBE	Short-term Storage of Calcine in Bin Sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Short-term Storage of Calcine in Bin Sets	External event causes failure of bin set structure	2.6×10^{-8}	35	5.5×10^{-6}	1.4×10^{4}	9.3×10^{5}	1.2×10^{5}	61	5.1×10^{-4}
			Vitrification without Calcine Separations Option							
ABN	Calcine Retrieval and Onsite Transport	Equipment failure results in release of calcine	3.0×10^{-3}	35	0.11	40	2.7×10^{3}	470	0.23	2.0×10^{-6}
DBE	Short-term Storage of Calcine in Bin Sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Short-term Storage of Calcine in Bin Sets	External event causes failure of bin set structure	2.6×10^{-8}	35	5.5×10^{-6}	1.4×10^{4}	9.3×10^{5}	1.2×10^{5}	61	5.1×10^{-4}
			Vitrification with Calcine Separations Option							
ABN	Calcine Retrieval and Onsite Transport	Equipment failure results in release of calcine	3.0×10^{-3}	35	0.11	40	2.7×10^{3}	470	0.23	2.0×10^{-6}
DBE	Short-term Storage of Calcine in Bin Sets	Short-term flood induced failure of a bin set structure	1.3×10^{-4}	35	5.8×10^{-3}	880	5.9×10^{4}	5.7×10^{4}	29	2.4×10^{-4}
BDB	Borosilicate Vitrification	External event results in a release (HAW) from borosilicate vitrification facility	2.6×10^{-8}	20	5.3×10^{-7}	1.7×10^{4}	1.2×10^{6}	1.5×10^{5}	76	6.3×10^{-4}

ABN = abnormal; BDB = beyond design basis; DBE = design basis; HAW = high-activity waste; LCF = latent cancer fatality

Table C.4-3. Summary of events that produce chemical impacts.

Process title	Event description	Contaminant	Peak atmospheric concentration (ERPG)
	Abnormal Events		
Additional Offgas Treatment	Failure of ammonia tank connections results in a spill of 150 pounds per minute of liquid ammonia for 10 minutes. A fraction of the ammonia would flash to vapor as it escapes the tank. The remainder would settle and form a boiling pool.	Ammonia	Less than ERPG-2 at 3,600 meters
	Design Basis Events		
New Waste Calcining Facility High Temperature & Maximum Achievable Control Technology Modifications	A carbon filter bed fire. Inadequate nitrous oxide destruction in the reduction chamber of the multi-stage combustion system leads to exothermic reactions in the filter bed. The heat buildup could result in a carbon bed fire and a release of radioactive material (iodine-129) and mercury embedded in the filter bed and corresponding HEPA filter fire.[a]	Mercury	Greater than ERPG-2[b] at 3,600 meters.
Additional Offgas Treatment	Failure of ammonia tank connections results in a spill of 1,500 pounds per minute of liquid ammonia for 10 minutes. A fraction of the ammonia would flash to vapor as it escapes the tank. The remainder would settle and form a boiling pool.	Ammonia	Greater than ERPG-2 at 3,600 meters
	Beyond Design Basis Events		
Additional Offgas Treatment	Failure of ammonia tank connections results in a spill of 15,000 pounds per minute of liquid ammonia for one minute. A fraction of the ammonia would flash to vapor as it escapes the tank. The remainder would settle and form a boiling pool.	Ammonia	Greater than ERPG-2 at 3,600 meters

a. This accident also results in a chemical release to the atmosphere. This accident has been evaluated as a potential atmospheric release to assess its potential as an additional source of human health and environmental risk.

b. There is no standard ERPG value for mercury vapor. However, there is a standard method to calculate an ERPG using the Threshold Limit Value – Time Weighted Average (TLV-TWA). In this case the equivalent ERPG-2 value is [(3) (TLV-TWA)] = 0.1 ppm.

ERPG = Emergency Response Planning Guideline; HEPA = high efficiency particulate air.

- New Waste Calcining Facility High Temperature and Maximum Achievable Control Technology Modifications.
- Storage of Mixed Transuranic Waste/SBW.
- Storage of Calcine in Bin Sets.

For the purposes of this EIS, the complex subsurface transport calculations used to negotiate performance requirements for the INEEL Environmental Management Program are not needed. Potential impacts that could result from previous spills have already been evaluated for Waste Area Group 3 using subsurface modeling at INTEC as well as a simple screening model approach.

DOE calculated the groundwater impacts beneath the mixed transuranic waste/SBW tanks at INTEC. These impacts are provided for comparison purposes between alternatives under accident conditions and are not meant to fulfill the needs of or replace a performance assessment or INEEL-wide composite analysis as required by DOE Order 435.1. Facilities disposition and closure activities would eventually require such assessments but it is premature to attempt performance assessments until the waste processing technology is selected and the facilities to implement the selected technology are chosen.

The migration of the contaminants from the top of the soil column to the aquifer was evaluated using the same approach for assessing the potential risk via groundwater ingestion as outlined in Rodriguez et al. (1997). This approach evaluates risk via ingestion of groundwater based on modeling of geologic and hydrologic conditions, natural and anthropogenic sources of water, contaminant source locations, contaminant masses and concentrations, as well as release history and geochemical characteristics of existing contaminants. Numerical models were utilized to predict peak groundwater concentrations resulting from bin set failure and mixed transuranic waste/SBW tank failures. Detailed explanations of models and parameters are provided in Schafer (2001) and Rodriguez et al. (1997). A screening analysis was performed to assess the impact of the modeled peak groundwater concentrations by comparing the modeled concentrations to maximum contaminent levels. The results of the groundwater analysis are provided below.

New Waste Calcining Facility High Temperature and MACT Modifications

The New Waste Calcining Facility requires large quantities of kerosene to support the fluidized bed burner. Abnormal and beyond design basis events for calcining is a leak of kerosene to the environment due to equipment failures. This is assumed to result in the release of 15,000 gallons and 30,000 gallons, respectively, of kerosene to the surface soil and subsequent infiltration through the vadose zone to groundwater. The primary concern is the migration of the toxic constituents of the kerosene. A primary toxic constituent of kerosene is benzene, a carcinogen, which has an EPA maximum contaminant level of 5 micrograms/liter. The expected peak groundwater concentration of benzene for the 15,000-gallon spill is approximately 120 micrograms/liter at the edge of the spill when assuming infiltration from normal precipitation. For the beyond design basis event, an external event is assumed to rupture both kerosene tanks and cause a fire. The expected peak groundwater concentration of benzene for the beyond design basis 30,000-gallon spill is approximately 180 micrograms/liter at the edge of the spill when assuming infiltration from normal precipitation. The groundwater impact from such spills would exceed the maximum contaminant level for benzene by a factor of 24 for the 15,000-gallon spill and a factor of 36 for the 30,000-gallon spill. Both accidents assume that the kerosene would form a pool about 3 inches deep before seeping into the subsurface. The benzene component of the kerosene may require about 200 years to reach the groundwater under normal precipitation conditions. Since INTEC would be operational during a kerosene spill, emergency crews would be available to stop the spill, halt the spread of the kerosene, and dispose of contaminated soil. The minimum volume of soil that would be contaminated due to a 15,000 gallon spill is estimated to be 250 cubic yards (Jenkins 2001a). The 30,000 gallon spill would at least double the estimated contaminated soil volume. The results of the abnormal and beyond design basis events are shown in Table C.4-4.

For the abnormal and beyond design basis kerosene spill accidents, DOE analyzed the risk to a resident drinking 2 liters per day of the benzene contaminated groundwater from beneath the INTEC Tank Farm. The additional risk for developing cancer over a 30-year lifetime due to these accidents is 1.9×10^{-4} for the abnormal event and 2.9×10^{-4} for the beyond design basis event (Jenkins 2001b). Cancer fatalities were not estimated for either event.

Storage of Mixed Transuranic Waste/SBW

Three accidents are associated with storage of mixed transuranic waste/SBW. These are:

- Failure of a full mixed transuranic waste/SBW tank vault in the year 2001 with subsequent tank rupture and a release of liquid waste directly to the soil column due to an earthquake. This is considered a design basis event and is assumed to occur in the next 35 years.
- The accidental intrusion by unauthorized persons into a full mixed transuranic waste/SBW tank. This is considered an abnormal event, which cannot take place until after 2095 when it is assumed INEEL institutional control is lost. The results of this scenario are bounded by the failure of a single

tank in 2001 and therefore not analyzed further.

- Degradation and eventual simultaneous failure of 5 full mixed transuranic waste/SBW tanks and their vaults after 500 years with a release of liquid waste directly to the soil column. Although not a true "accident", this event is considered to be an abnormal event under the No Action alternative since it is assumed that the tanks break after 500 years.

The results for the accidents associated with storage of mixed transuranic/SBW are shown in Table C.4-4.

Failure of a full mixed transuranic waste/SBW tank in the year 2001. The rupture of a full mixed transuranic waste/SBW tank in the year 2001 due to a seismic event is assumed to release liquid waste directly to the soil column, where it infiltrates and disperses through the vadose zone and migrates in the groundwater. The impacts for this accident were analyzed using similar modeling assumptions to those considered for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) analyses in the *Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL, Part A, RI/BRA Report* (Rodriguez et al. 1997). Under these assumptions, the predicted peak groundwater concentration for iodine-129 is 0.13 pCi/L, which is 13 percent of the maximum contaminant level of 1.0 pCi/L. The peak iodine-129 concentration would occur in the year 2075. The predicted groundwater concentration for total plutonium (plutonium-239, plutonium-240, and plutonium-242) is 1.1 pCi/L, which does not exceed the maximum contaminant level of 15 pCi/L for alpha-particle emitters such as plutonium. The peak plutonium concentration would occur in the year 6000. The predicted groundwater concentrations for technetium-99 and neptunium-237 are 100 pCi/L and 0.030 pCi/L, respectively, well below their maximum contaminant levels of 900 pCi/L and 15 pCi/L. The peak concentration for these radionuclides would occur in the years 2075 and 3500, respectively (Bowman 2001a).

Table C.4-4. Summary of accidents resulting in groundwater impacts.

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

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a. Based on benzene component.

MCL = maximum contaminant level; μg/L=micrograms per liter; pCi/L= picocuries per liter;
SBW = mixed transuranic waste/SBW

Degradation and simultaneous failure of 5 full mixed transuranic waste/SBW tanks after 500 years. For the No Action Alternative, mixed transuranic waste/SBW would be stored in the below grade tanks indefinitely. The impact of the tank failures has been analyzed under the assumptions that (a) all five tanks fail simultaneously and (b) prior to failure all other tank contents and tank heels have been pumped into the five tanks. Although five times more mixed transuranic waste/SBW would be released to the soil column (relative to the single tank failure described above), many of the radionuclides would have decayed to very low activities over the 500 years. The impacts for this accident were analyzed using similar modeling assumptions to those considered for the CERCLA analyses in Rodriguez et al. (1997). Under these assumptions, the analysis shows that the impact from the tank failures would result in peak concentrations of iodine-129 at 0.47 pCi/L in the year 2575, technetium-99 at 380 pCi/L in the year 2595, neptunium-237 at 0.34 pCi/L in the year 4000, and total plutonium at 8.6 pCi/L in the year 6500. Thus, the peak concentrations for these key radionuclides would be less than current drinking water standards (Bowman 2001b).

The risk to an assumed long-term resident drinking the groundwater from beneath the INTEC Tank Farm was analyzed for this accident. Using the concentration-to-dose conversion factor from DOE (1998), and assuming 72 years of water ingestion at 2 liters per day, DOE estimated a lifetime whole-body dose equivalent to 420 millirem due to total plutonium for this accident. This equates to a 210 per million increase in the probability of a fatal cancer. As for the single tank failure, these results could be non-conservative depending on the assumed mass release time for the 5-tank failure. Since doses are directly related to concentrations, a faster release time would be expected to increase concentration and doses accordingly.

This accident would release at least 5 times more source term to the soil column than considered for the single tank failure. Nevertheless, the concentrations of nonradionuclide contaminants in the aquifer would be less than the drinking water standards. The analysis for the 5-tank failure shows the greatest impact would be due to cadmium which would be about 41 percent of its maximum contaminent level. The next most impacting contaminant, uranium, would be about 0.5 percent of its maximum contaminant level based on the CERCLA model.

Storage of Calcine in Bin Sets

For this accident a seismic event is assumed to damage a degraded bin set facility structure and equipment such that a release occurs with a direct pathway to the environment. Bin set 5 was analyzed for this event since it has the largest bin set source term. A seismic event that exceeds the design capacity of the structure would be powerful enough to breach passive berms thus providing a direct leakage pathway to the environment. Although the frequency of the seismically induced failure involving the bin set would be less than 1×10^{-4}, the accident is assumed to occur within 500 years and is treated as an abnormal event. The bin set breach is assumed to release calcine directly to the environment and would result in both air and groundwater impacts. The impacts to the environment are much larger for the air releases, however, all calcine would be subjected to gradual dissolution with subsequent infiltration directly to the soil column.

The accident analysis conservatively assumed that all calcine is released from the stainless-steel bin sets and deposited on the floor of the calcine solids storage facility. It is further conservatively assumed that the calcine is subjected to normal precipitation and that all leachate dissolved from the calcine is deposited directly to the soil column with no holdup in the basemat (Jenkins 2001c). Even under these very conservative conditions, the inventory of key radionuclides and nonradionuclides deposited to the soil column is a fraction of the inventory due to the 5 full mixed transuranic waste/SBW tanks failure accident discussed for storage of mixed transuranic waste/SBW. For the bin set failure in 500 years, the percent of the radionuclide inventory released the first year compared to the inventory released from the 5-tank failure is: I-129 (1 percent); Tc-99 (11 percent); Np-237 (7 percent); and total plutonium (< 1 percent). For the nonradionuclides, the percentage of the inventory released the first year compared to the 5-tank failure for the most impacting species is: beryllium (8 percent) and molybdenum (4 percent). All other nonradionuclides are less than 1 percent of the inventory released from the 5-tank failure. Therefore, this accident is bounded by the 5-tank failure accident at 500 years described under storage of mixed transuranic waste/SBW.

C.4.1.8 Integrated Risk to Involved Workers

In accordance with the methodology described in Section C.4.1.4.1, point estimates for involved worker risk have been derived and are depicted on Table C.4-5. This table presents the relative contributions from industrial accidents, occupational exposures, and facility accidents for each waste processing alternative. The involved worker risks do not include risks posed by transportation or facility disposition. From Table C.4-5 several conclusions can be drawn:

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

- Estimates of involved worker risk due to industrial accidents do not favor alternatives that require large amounts of manpower during implementation. Thus, alternatives such as the Planning Basis Option that encompass the largest requirements for facility construction as well as the longest facility operation campaigns, could pose risk to involved workers from industrial accidents that is a full order of magnitude higher than that posed by less ambitious alternatives.

- Industrial accidents are, for most of the alternatives, the largest contributors to involved worker risk. Therefore, estimates of integrated involved worker risk (including all sources) typically favor the Minimum INEEL Processing Alternative, Steam Reforming Option, and Vitrification without Calcine Separations Option that involve less site activity over time. However, the risks posed by transportation and activities at the Hanford site are not included in the estimates of involved worker risk for the Minimum INEEL Processing Alternative.

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

Example of Methodology - The Integrated Involved Worker Risk (IWR) calculation includes three separate components and two separate time periods. The three components are the risks from (1) industrial accidents, (2) occupational radiation doses, and (3) facility accidents. The two time periods are the construction period, which includes systems operations and startup testing, and the operations period. Summing the appropriate components for the two time periods produces the Integrated IWR. Mathematically, this is shown below:

Construction Period (sum of Occupational Risk + Industrial Risk) + Operations Period
(sum of Occupational Risk + Industrial Risk + Facility Accident Risk) = Integrated IWR

Table C.4-5. Point estimates of integrated involved worker risk for the waste processing alternatives.

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

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

b. Fatalities over life of activities.

c. Does not include activities at the Hanford Site.

To calculate the Integrated IWR one needs both alternative specific information as well as generic information. The alternative specific information includes the number of projects, the number of total worker hours for each project, the number of total radiation worker hours for each of the project, and the duration of the projects. This information is needed for both construction and operations phases. Also needed are the estimated fatalities associated with facility accidents. The generic information includes the average radiation exposure during construction and operations, the industrial accident rate, and the exposure risk factor, which translates the person-rem doses to latent cancer fatalities.

As an example, consider the Direct Cement Waste Option. This option consists of eight separate projects:

P1A	Calcine SBW Including New Waste Calcining Facility Upgrades
P1B	Newly Generated Liquid Waste and Tank Farm Heel Waste Management
P18	New Analytical Laboratory
P59A	Calcine Retrieval and Transport
P80	Direct Cement Process
P81	Unseparated Cementitious HLW Interim Storage
P83A	Packaging and Loading Cementitous Waste at INTEC for Shipment to a Geologic Repository
P133	Waste Treatment Pilot Plant

Considering one of the projects, P1A, the project data sheet in Section C.6.2.1 of Appendix C.6, indicates that there are 96 construction workers per year for 5 years. In this total of 96 construction workers, there are 48 radiation workers per year. With respect to operations, the project data sheet indicates there will be 148 total workers for 6 years. Of the 148 operations workers, there are 96 radiation workers.

To calculate the occupational risks, DOE summed the risks from radiation exposure during construction and during operations. The total number of radiation worker hours for both time periods was multiplied by the average exposure rate for each period and then summed to get the total exposure. For Project P1A, there are 48 radiation workers per year times 5 years for the construction period (a total of 240 worker-years) and 96 radiation workers per year times 6 years for the operations period (a total of 576 worker-years). For this EIS, DOE assumed an average radiation worker exposure of 0.25 rem/year for the construction period and 0.19 rem/year for operations. Multiplying these two factors times the associated radiation worker-years and summing the two products will give the total worker exposure. In the P1A example, there are 240 radiation worker-years at 0.25 rem/year for a total construction exposure of 60 person-rem and 576 radiation worker-years at 0.19 rem/year for a total operations exposure of 109 person-rem. Summing the two yields a total exposure of 169 person-rem. To calculate the occupational exposure risk, DOE converted the total worker exposure to the number of latent cancer fatalities by multiplying by a dose-to risk conversion factor of 4×10^{-4} latent cancer fatalities per person-rem of exposure. In the P1A example, 169 person-rem at 4×10^{-4} latent cancer fatalities per person-rem results in 0.068 latent cancer fatalities.

To calculate the industrial risks, DOE summed the risks from industrial accidents during the construction and operations phases. To do this, DOE took the total number of worker-hours for both time periods and multiplied by the industrial accident rate for the INEEL. In Project P1A, there are 96 workers per year times 5 years for the construction period (a total of 480 worker-years), and 148 workers per year times 6 years for operations (a total of 888 worker-years) for a grand total of 1,370 worker-years. This EIS uses an accident rate of 0.011 fatalities per 100 worker-years or 0.00011 fatalities per worker-year. Multiplying this accident rate by the total number of worker-years provides the number of fatalities for this task from industrial accidents. For Project P1A, there are 1,370 worker-years at 0.00011 fatalities per worker-year, which results in 0.150 fatalities.

The third component of Integrated IWR is the risk from facility accidents. The methodology for determining facility accident risk is described in Section C.4.1.4.1.

If the alternative consisted of just this one project, the three risk components described above would be summed to calculate the Integrated IWR. For the Direct Cement Waste Option, DOE performed the risk calculations for all eight projects and then summed the results. A straightforward way to perform these multiple calculations is with a spreadsheet. A sample spreadsheet to show how one might be constructed is shown in Figure C.4-5. Project specific information for each of the projects comprising the Direct Cement Waste Option has been included in this spreadsheet. The data described above for Project P1A appears in Step 1 of the spreadsheet.

DOE identified all of the projects for the Direct Cement Waste Option, and determined the associated worker and radiation worker hours. The next step was to sum these values for the two time periods as follows. As was done for Project P1A, the radiation worker subtotals for the Direct Cement Waste Option (see Step 2 in Figure C.4-5) were used to calculate the occupational risks. The total radiation worker-years for construction (780) were multiplied by 0.25 rem/yr to get the total radiation exposure during construction of 195 person-rem. Similarly, the total radiation worker exposure during operations was determined by multiplying the total radiation worker-years (5,664.5) by 0.19 rem/yr to get 1,076 person-rem. To determine the occupational risk, DOE added the exposures for construction (195) and operations (1,076) to get 1,271 person-rem. This total worker exposure was multiplied by the dose-to risk conversion factor (4×10^{-4} latent cancer fatalities per person-rem) to determine the risk from radiation exposure. For the Direct Cement Waste Option, this occupational exposure risk is 0.509 latent cancer fatality.

To calculate the industrial risks, DOE used the total worker years (12,293) and multiplied by the industrial accident rate of 0.00011 fatalities per worker-year to determine the total number of fatalities from industrial accidents. For the Direct Cement Waste Option, this industrial accident risk is 1.352 fatalities.

The last component of the Integrated IWR calculation is the risk from facility accidents. This risk is not only a function of the type of accidents, but also the probability of the accidents and the consequences thereof. The methodology is described in detail in Section C.4.1.4.1. Basically, it is sum of the probability of the bounding accident occurring for each of three time periods multiplied by the consequences of those accidents and a conversion factor. Mathematically, this can be shown as:

Σ Probability x Consequences x Dose to Fatality Conversion Factor = Facility Accident Risk

For the Direct Cement Waste Option, the risk from facility accidents is 0.002 fatalities.

The last step is to add the components of the Integrated IWR to get the final result, which is 1.863 fatalities as shown in Step 3 of Figure C.4-5.

C.4.1.9 Comparison of Waste Processing Alternatives Based on Facility Accidents

Bounding accident scenarios in this EIS bound the consequences of accidents that could occur as a result of implementing a waste processing alternative. Bounding accident scenarios contribute much but not all of the risk associated with implementation of an alternative. In order to compare the risk of implementing a waste processing alternative based on facility accidents, it is appropriate to construct a basis for estimating the total risk of implementation rather than simply comparing the largest accidents posed by an alternative. As a prelude to this comparison, an understanding of the relationship between risk due to bounding accident scenarios and the total risk of implementation must be developed.

The process used to compare health and safety risk to the public as a result of implementing each of the waste processing alternatives is shown in Table C.4-2 and its accompanying descriptive information. This table provides an integrated perspective on risk to the public as a result of bounding facility accidents for all the waste processing alternatives. In Table C.4-2, the contribution to public risk (in latent cancer fatalities) from identified bounding accident sce-

DIRECT CEMENT WASTE OPTION

①

PROJECT P1A	CONSTRUCTION	OPERATIONS
workers/year	96	148
radiation workers/year	48	96
duration	5	6
total worker-years	480	888
total radiation worker-years	240	576
average exposure rem/yr	0.25	0.19

PROJECT P1B	CONSTRUCTION	OPERATIONS
workers/year	20	76
radiation workers/year	0	60
duration	4	21
total worker-years	80	1596
total radiation worker-years	0	1260
average exposure rem/yr	0	0.19

PROJECT P18	CONSTRUCTION	OPERATIONS
workers/year	59	105
radiation workers/year	0	30
duration	4	21
total worker-years	236	2205
total radiation worker-years	0	630
average exposure rem/yr	0	0.19

PROJECT P59A	CONSTRUCTION	OPERATIONS
workers/year	100	11.25
radiation workers/year	90	10
duration	6	21
total worker-years	600	236.25
total radiation worker-years	540	210
average exposure rem/yr	0.25	0.19

PROJECT P80	CONSTRUCTION	OPERATIONS
workers/year	100	140
radiation workers/year	0	93
duration	7	21
total worker-years	700	2940
total radiation worker-years	0	1953
average exposure rem/yr	0	0.19

FIGURE C.4-5. (1 of 2) Sample integrated involved worker risk calculation.

PROJECT P81	CONSTRUCTION	OPERATIONS
workers/year	134	6.5
radiation workers/year	0	4.5
duration	5	21
total worker-years	670	136.5
total radiation worker-years	0	94.5
average exposure rem/yr	0	0.19

PROJECT P83A	CONSTRUCTION	OPERATIONS
workers/year	0	11
radiation workers/year	0	2.5
duration	0	20
total worker-years	0	220
total radiation worker-years	0	50
average exposure rem/yr	0	0.19

PROJECT P133	CONSTRUCTION	OPERATIONS
workers/year	63	39
radiation workers/year	0	33
duration	4	27
total worker-years	252	1053
total radiation worker-years	0	891
average exposure rem/yr	0	0.19

②

SUBTOTALS	CONSTRUCTION	OPERATIONS
total worker-years	3018	9274.75
total radiation worker-years	780	5664.5

GRAND TOTALS	
worker-years	12292.75
radiation worker-years	6444.5

FACILITY ACCIDENTS	Abnormal	Design Basis	Beyond Design Basis
Accident ID	ABN03	DBE20A	BDB20A
Probability Accident Occurs	0.11	5.80E-03	5.50E-06
Noninvolved Worker Dose - rem	2.7	59	930
Involved Worker Dose - rem	24.3	531	8370
Accident Risk	0.001069	1.23E-03	1.84E-05
Total Facility Accident Risk		2.32E-03	

③

Life Cycle Integrated Worker Risk (IWR), Point Estimate (fatalities)

Industrial Accidents		Occupational Exposures		Facility Accidents		Integrated Worker Risk
1.352	+	0.509	+	0.002	=	1.863

FIGURE C.4-5. (2 of 2) Sample integrated involved worker risk calculation.

narios is presented as a fractional increase over the background cancer rates for the total affected population analyzed.

The information in Table C.4-2 supports comparison of waste processing alternatives based on the risk of facility accidents and shows:

- Alternatives that are vulnerable to bounding accident scenarios with the highest probabilities of occurrence and estimated consequences exhibit the highest potential for risk due to facility accidents. Those alternatives that do not address the basic issue of reducing releasable material inventories have the highest predicted combinations of likelihood and consequences for bounding accidents, thus posing risk to the public several orders of magnitude greater than alternatives that actively reduce risk over time.
- Alternatives requiring the use of separation and vitrification technologies could pose relatively high risk from facility accidents. Historical experience indicates that such processes could have a relatively high likelihood of accidents that result in significant and energetic release of materials.

C.4.2 FACILITY DISPOSITION ACCIDENTS

C.4.2.1 Derivation of Facility Disposition Accidents

The accident analysis provides a systematic review of alternatives for the disposition of INTEC facilities. Each facility disposition alternative requires an analysis of potential facility accidents as one of the environmental impacts, particularly to human health and safety, associated with its implementation. DOE has performed an accident analysis to identify environmental impacts associated with accidents that would not necessarily occur, but which are reasonably foreseeable and could result in significant impacts. Since the potential for accidents and their consequences varies among different facility disposition options, accidents provide a discriminator among the facility disposition alternatives. Accidents were defined according to the National Environmental Policy Act as undesired events that could occur during or as a result of implementing an alternative and that would have the potential to result in human health impacts or indirect environmental impacts.

Potential facility disposition accidents pose health risk to several groups of candidate recipients. Along with workers performing disposition activities at each facility (involved workers), workers at nearby INEEL facilities (noninvolved workers) and the offsite population could be exposed to hazardous materials released during some accident scenarios. Potential facility disposition impacts to human health arise from the presence of radiological, chemical, and industrial (physical) hazards. Clean closure, performance-based closure, and closure to landfill standards were the three major alternatives considered in the accident analysis for disposition of existing INTEC HLW management facilities.

The approach for evaluation of facility disposition accidents in the accident analysis is illustrated in Figure C.4-6. Potential facility disposition impacts for noninvolved workers and members of the offsite population are analyzed differently than for involved workers. Only involved workers are subject to industrial accident hazards, such as falls or electrical shocks; however, all three groups could be exposed to radioactivity and/or hazardous chemicals released in a severe accident.

For noninvolved workers and the offsite population, a maximum reasonably foreseeable accident for facility disposition activities was identified in the accident analysis. The maximum reasonably foreseeable disposition accident for each facility was compared to the maximum credible accident postulated for normal operation of that facility. The comparative approach was adequate for National Environmental Policy Act purposes, since the facilities currently manage nuclear and chemical risks through the safety authorization basis. If the maximum credible accident during facility operation bounds the maximum reasonably foreseeable accident during facility disposition, then facility disposition activities would not be

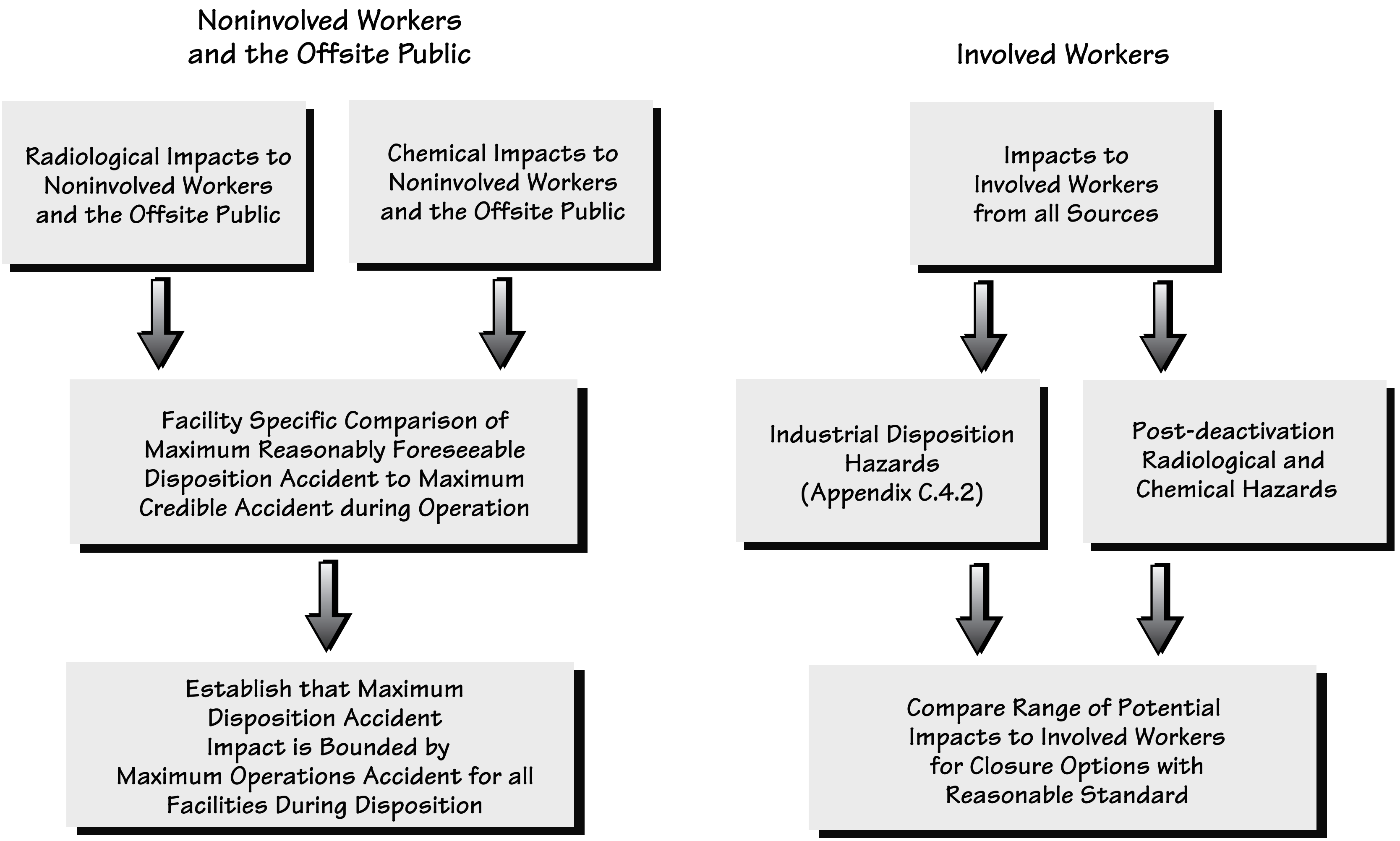

FIGURE C.4-6.
Impact assessment methodology for hypothetical disposition accidents in INTEC facilities.

expected to introduce new or previously undisclosed sources of risk to noninvolved workers and the offsite population.

Data sources used to establish maximum reasonably forseeable facility accidents during facility operation included safety assurance documents and EIS estimates for bounding facility accidents. Comparisons between disposition events and corresponding operations accidents were based on relative differences in inventories of radioactive materials and hazardous chemicals, changes in mobility of these substances, and changes in the energy available for accident initiation and propagation. For individual facilities, the combination of inventory reductions, immobilization of residues, and removal of energy sources resulted in a significantly reduced potential for health impacts when compared to current operations, inferring that risk to noninvolved workers and the offsite public would not be increased by prospective actions taken to implement the facility disposition alternatives.

Involved workers could be exposed to industrial hazards, and hazards from residual chemicals and radioactive materials during deactivation. These hazards to involved workers would not necessarily diminish when major inventories of chemicals and radioactive substances are removed or immobilized. The likelihood of industrial accidents could increase during facility disposition because more industrial labor is required during active phases of disposition. Likewise, the potential for inadvertent exposure to excessive radioactivity or chemical hazards may increase due to loss of monitoring capabilities and relaxation of mechanisms to control exposure during operation

For these reasons the strategy for evaluating the facility disposition alternatives in the accident analysis was to compare the potential for health impacts to involved workers from disposition activities with a standard of acceptability used to validate facility operations. Industrial hazards were estimated using the disposition health and safety information from Appendix C.3. Impacts of radiological hazards were estimated on the basis of hours worked in a radiation environment, the dose rate, and the correlation between exposure and latent cancer fatalities for workers. Impacts of inadvertent exposure to residual radioactive or chemically hazardous materials were estimated based on assumptions regarding the potential for human errors and breakdowns during facility disposition activities.

C.4.2.2 Scope of the Analysis

This analysis postulates accidents that could occur during disposition of INTEC facilities and have the potential to harm workers, the offsite population, and the environment. This analysis of facility disposition accidents was applied only to those existing INTEC facilities that are significant to the treatment, storage, or generation of HLW. New facilities required for the waste processing alternatives are not considered in the analysis because the design of these facilities has not been finalized, and the designs would include features to facilitate dispositioning (DOE 1989). Thus, new HLW management facilities are assumed to have minimal radioactive and hazardous material inventories remaining at the time of disposition and a low potential for significant accidents.

As described in Section 3.2.2 of this EIS, DOE used a systematic process to identify which existing INTEC facilities would be analyzed in detail for this EIS. Facilities that pose short-term radiological and chemical hazards to noninvolved workers and the offsite population are presented in Table C.4-6; the emphasis was on those facilities where potential accidents could rapidly disperse radionuclides and/or hazardous chemicals beyond the immediate working area. Selection guidance was obtained from a prior study, the *Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL Part A, RI/BRA Report* (Rodriguez et al. 1997), which identified those facilities with airborne release and direct exposure pathways.

For purposes of the facility disposition accident analysis, HLW management facilities that have only "groundwater pathways" for hazardous material releases were not assessed for potential impacts to noninvolved workers and the offsite population. Facility disposition accident releases to the groundwater pathway would not be expected to produce a short-term health impact to the public because DOE could remediate the affected media or restrict public access to it. Also, due to limitations on material, accessibility, and available energy for release, the possi-

Table C.4-6. Existing INTEC HLW management facilities with significant risk of accidental impacts to noninvolved workers and to the offsite population.[a]

Tank Farm	
CPP-713	Vault containing Tanks VES-WM-187, 188, 189, and 190 with supporting equipment and facilities
CPP-780	Vault containing Tank VES-WM-180 with supporting equipment and facilities
CPP-781	Vault containing Tank VES-WM-181 with supporting equipment and facilities
CPP-782	Vault containing Tank VES-WM-182 with supporting equipment and facilities
CPP-783	Vault containing Tank VES-WM-183 with supporting equipment and facilities
CPP-784	Vault containing Tank VES-WM-184 with supporting equipment and facilities
CPP-785	Vault containing Tank VES-WM-185 with supporting equipment and facilities
CPP-786	Vault containing Tank VES-WM-186 with supporting equipment and facilities
Bin Sets	
CPP-729	Calcined Solids Storage Facility 1 with supporting equipment and facilities
CPP-742	Calcined Solids Storage Facility 2 with supporting equipment and facilities
CPP-746	Calcined Solids Storage Facility 3 with supporting equipment and facilities
CPP-760	Calcined Solids Storage Facility 4 with supporting equipment and facilities
CPP-765	Calcined Solids Storage Facility 5 with supporting equipment and facilities
CPP-791	Calcined Solids Storage Facility 6 with supporting equipment and facilities
CPP-795	Calcined Solids Storage Facility 7 with supporting equipment and facilities
Process Equipment Waste Evaporator and Related Facilities	
CPP-604	Process Equipment Waste Evaporator
CPP-605	Blower Building
CPP-649	Atmospheric Protection Building
CPP-708	Main Exhaust Stack
CPP-756	Prefilter Vault
CPP-1618	Liquid Effluent Treatment and Disposal Facility
Fuel Processing Building and Related Facilities	
CPP-601	Fuel Processing Building
CPP-627	Remote Analytical Facility
CPP-640	Head End Process Plant
Other Facilities	
CPP-659	New Waste Calcining Facility
CPP-666/767	Fluorinel Dissolution Process and Fuel Storage (FAST) Facility and Stack
CPP-684	Remote Analytical Laboratory

a. Derived from Harrell (1999) and Rodriguez et al. (1997).

bility of such large events can be categorically eliminated or assumed to be bounded by the facility accidents already considered.

Because current facility data on the type and quantities of miscellaneous hazardous materials were not available, no definitive analysis was done with respect to the chemical content and potential impact of incidental hazardous materials at the facilities. Hazardous materials expected to be present during facility disposition activities include kerosene, gasoline, nitric acid, decontamination fluids, and paints. The assumption was made that closure activities would include the disposal and cleanup of hazardous materials to the maximum extent practicable in accordance with the current decommissioning manuals and regulations. In any event, during INTEC-wide operations, the bounding release scenario for hazardous chemicals with the greatest potential consequences to noninvolved workers and the offsite population is a catastrophic failure of a 3,000-gallon ammonia tank. This scenario results in ammonia releases greater than ERPG-2 concentrations at 3,600 meters and would require immediate evacuation of nearby personnel. This accident scenario would also bound potential chemical releases for the facility disposition analysis cases thus negating the necessity to analyze specific chemical releases facility by facility.

There are two end products of this HLW management facility disposition analysis: (1) for potential impacts to noninvolved workers and to members of the offsite population, a comparison of "Maximum Plausible Accident Scenarios" for each applicable facility disposition activity and closure option with impacts anticipated during facility operation and (2) for involved workers, estimates of relative health and safety risk among the facility closure options. In both cases risks will not be estimated in terms of absolute impact on the health and the environment but can be used for comparison purposes.

C.4.2.3 Facility Disposition Alternatives

The three facility disposition alternatives considered by DOE and included in this analysis are defined below.

Clean Closure

Hazardous wastes and radiological and chemical contaminants, including contaminated equipment, would be removed from the facility or treated so that residual radiological and chemical contamination is indistinguishable from background concentrations. Use of facilities (or the facility sites) after clean closure would present no risk to workers or the public from radiological or chemical hazards. Clean closure may require total dismantlement and removal of facilities.

Performance-Based Closure

For radiological and chemical hazards, performance-based closure would be in accordance with risk-based criteria. The facilities would be decontaminated so that residual waste and contaminants no longer pose any unacceptable exposure (or risk) to workers or to the public. Post-closure monitoring may be required on a case-by-case basis. Closure methods would be dictated on a case-by-case basis depending on risk.

Closure to Landfill Standards

The facilities would be closed in accordance with Federal, state, and/or DOE requirements for closure of landfills. Closure to landfill standards is intended to protect the health and safety of the workers and the public from releases of contaminants. This could be accomplished by installing an engineered cap; establishing a groundwater monitoring system; and providing post-closure monitoring and care of the waste containment system, depending on the type of contaminants.

C.4.2.4 Analysis Methodology for Noninvolved Workers and the Offsite Population

For the facility disposition options, DOE performed a systematic review of available data from applicable INTEC safety analysis reports, safety reviews, HLW management facility closure studies, and EIS technical requirements data that were presented in the accident analysis. The maximum plausible accident scenario, selected for the HLW management facilities with airborne release and direct exposure pathways, is compared to a bounding accident scenario that was postulated during normal facility operations in safety analysis reports or in the accident analysis. In some cases, references have not been updated to reflect cessation of fuel processing operations at INTEC. Criticality may still be cited as the maximum postulated operations accident as a result of previous processing or storage operations at the facility. Although such an event would no longer be possible, its potential for occurrence has been evaluated and "accepted" as part of the facility safety management requirements by DOE.

A seven-step process, as described in the accident analysis, was used to select and compare the bounding accident scenarios for facility disposition activities. This process included:

- Review of facility descriptions including material inventories.
- Facility closure condition and type of closure expected to be implemented.
- Material at risk and likelihood of significant material remaining in the facility.
- Contaminant mobility at closure and likelihood of contaminants being available for release during disposition activities.
- Available energy during the accident at closure including accidents involving fires, explosions, spills, nuclear criticality, natural phenomena, and external events.
- Maximum plausible accident at closure, which is the largest credible accident during facility closure that could be hypothesized using available information.
- Comparison to maximum credible accident during facility operation.

Table C.4-7 summarizes the results of the analyses of facility disposition accidents

C.4.2.5 Industrial Hazards to Involved Workers During Facility Disposition

The risk of impacts to noninvolved workers and the public as a result of radiological and chemical release accidents during facility disposition is small. However the risk to involved workers is important and can be a discriminator among facility disposition alternatives. Involved workers may incur health effects from three sources during the implementation of facility disposition alternatives.

- Industrial accidents, particularly those occurring in the course of decontamination, construction, and demolition activities.
- Increased occupational doses as a result of exposure to contaminated ground and facilities, under conditions where exposures are unplanned for or the level of shielding and protection is reduced.
- Chemical release accidents that impact involved workers but not uninvolved workers or the public.

Specific hazards and their relative contributions to involved worker risk will vary among facilities and the closure options selected for them. In general, clean closure requires more interaction between workers and hazards than a performance-based closure, while a closure to landfill standards requires the least interaction.

Nonradiological Hazards. This section analyzes the potential impacts to involved workers from these hazards during disposition of the HLW management facilities pertinent to this EIS. Industrial impacts are estimated in terms of injuries, illnesses, and fatalities that are sustained on the job and reported according to Occupational Safety and Health Administration regulations. The total number of injuries/illness and fatalities that could occur at each of the existing HLW management facilities during the facility disposition period are estimated according to total labor hours. This provides an additional discriminator, a relative assessment of the total number of reportable injuries/illness and fatalities for disposition of the existing HLW management facilities. The absolute numbers of calculated industrial incidents are dependent on preliminary estimates of disposition labor for each facility, which are uncertain given the preliminary nature of facility disposition plans. For example, the estimates do not include disposition of transport lines between individual facilities, for which projection of labor are not yet available. Nevertheless, the relative numbers of injuries/illnesses and fatalities among facility

Table C.4-7. Facility disposition accidents summary.

Facility number	Facility title	Clean closure	Performance-based	Landfill Stds	Material at risk at closure	Contaminant mobility at closure	Energy for accident at closure	Maximum plausible accident	Bounding operations accident[a]
CPP-601	Fuel Processing Building		●		Low levels of radioactive and hazardous material residue after cease-use removal activities	Low mobility potential for contaminants affixed to surfaces or trapped in inaccessible locations	Low energy sources due to routine closure activities and removal of combustible materials	Accidental fire during demolition activities could release contaminants beyond the working area	Radiological: criticality event of 4.0×10^{19} fissions that released 3.0×10^{5} curies to the atmosphere
CPP-604	Waste Treatment Building			●	Low levels of radioactive and hazardous material residue after cease-use removal activities	Low mobility potential for contaminants affixed to surfaces or trapped in inaccessible locations	Low energy sources due to routine closure activities and removal of combustible materials	Accidental fire during demolition activities could release contaminants beyond the working area	Radiological: criticality event of 4.0×10^{19} fissions that released 3.0×10^{5} curies to the atmosphere
CPP-605	Blower Building			●	Low levels of radioactive and hazardous material residue after cease-use removal activities	Low mobility potential for contaminants affixed to surfaces or trapped in inaccessible locations	Low energy sources due to routine closure activities and removal of combustible materials	Accidental fire during demolition activities could release contaminants beyond the working area	Chemical release due to ammonia gas explosion in the former NO_x Pilot Plant during New Waste Calcining Facility testing
CPP-627	Remote Analytical Facility		●		Low levels of radioactive and hazardous material residue after cease-use removal activities	Low mobility potential for contaminants affixed to surfaces or trapped in inaccessible locations	Low energy sources due to routine closure activities and removal of combustible materials	Accidental fire during demolition activities could release contaminants beyond the working area	Radionuclide spill in the CPP-627 cave that resulted in 0.23 rem (MEI) and 7.4×10^{-6} rem (OSP).
CPP-640	Head End Process Plant		●		Low levels of radioactive and hazardous material residue after cease-use removal activities	Low mobility potential for contaminants affixed to surfaces or trapped in inaccessible locations	Low energy sources due to routine closure activities and removal of combustible materials	Accidental fire during demolition activities could release contaminants beyond the working area	Cask criticality initiated by a flood that resulted in 0.051 rem (MEI) and 1.2×10^{-3} rem (OSP).
CPP-659	New Waste Calcining Facility		●		Low levels of radioactive and hazardous material residue after cease-use removal activities	Low mobility potential for contaminants affixed to surfaces or trapped in inaccessible locations	Low energy sources due to routine closure activities and removal of combustible materials	Crane drops or equipment malfunctions during decontamination or demolition activities	An external event results in 0.34 rem (MEI), 23 rem (NIW), 5,700 rem (OSP), and 2.9 LCF.

Table C.4-7. Facility disposition accidents summary (continued).

Facility number	Facility title	Clean closure	Performance-based	Landfill Stds	Material at risk at closure	Contaminant mobility at closure	Energy for accident at closure	Maximum plausible accident	Bounding operations accident[a]
CPP-666 and 767	Fluorinel Storage Facility and Stack	●	●		Low levels of radioactive and hazardous material residue after cease-use removal activities	Low mobility potential for contaminants affixed to surfaces or trapped in inaccessible locations	Low energy sources due to routine closure activities and removal of combustible materials	Accidental fire during demolition activities could release contaminants beyond the working area	Radiological: criticality event in the SNF Storage Area of 3.0×10^{19} fissions resulted in 2.4 rem (MEI); 0.033 rem (OSP).
CPP-684	Remote Analytical Laboratory		●		Low levels of radioactive and hazardous material residue after cease-use removal activities	Low mobility potential for contaminants affixed to surfaces or trapped in inaccessible locations	Low energy sources due to routine closure activities and removal of combustible materials	High winds disperse residual contaminants freed during routine demolition activities	Failure of CPP-684 containment releasing contents of Analytical Cell.
CPP-1618	Liquid Effluent Treatment & Disposal Building	●			Low levels of radioactive and hazardous material residue after cease-use removal activities	Low mobility potential for contaminants affixed to surfaces or trapped in inaccessible locations	Low energy sources due to routine closure activities and removal of combustible materials	Accidental fire during demolition activities could release contaminants beyond the working area	Fractionator explosion: 50 curies of tritium; doses of 1.0×10^{-3} rem (MEI) and 3.0×10^{-4} rem (OSP).
CPP-708	Main Stack			●	Low levels of radioactive and hazardous material	Low mobility potential for contaminants affixed to surfaces or trapped in inaccessible locations	Low energy sources due to gradual disassembly of stack	Accidental drop of stack segment during disassembly	Main stack toppled westward by earthquake, crushing CPP-756 prefilters and CPP-604 offgas filter
CPP-713	Vault for Tanks VES-WM-187, 188, 189, and 190	●	●	●	Low levels of radioactive and hazardous material	Low mobility ensured by pipe capping and filling the tanks with Class C-type grout or clean fill material	Low energy sources during mixed transuranic waste/SBW retrieval, removal of combustible materials, and routine decontamination	Rupture or break in the mixed transuranic waste/SBW transfer lines during retrieval operations	An external event results in 0.34 rem (MEI), 23 rem (NIW), 3,500 rem (OSP), and 1.8 LCF.
CPP-729	Bin set 1	●	●	●	Low levels of radioactive and hazardous material	Low mobility ensured by pipe capping and filling the bin sets with Class C-type grout or clean fill material	Low energy sources during Calcine Retrieval and Transport Project, removal of combustible materials, and routine decontamination	Rupture or break in the calcine transfer lines during Calcine Retrieval and Transport operations	An external event results in 0.50 rem (MEI), 34 rem (NIW), 5,900 rem (OSP), and 3.0 LCF.

Table C.4-7. Facility disposition accidents summary (continued).

Facility number	Facility title	Clean closure	Performance -based	Landfill Stds	Material at risk at closure	Contaminant mobility at closure	Energy for accident at closure	Maximum plausible accident	Bounding operations accident[a]
CPP-742	Bin set 2	●	●	●	Low levels of radioactive and hazardous material	Low mobility ensured by pipe capping and filling the bin sets with Class C-type grout or clean fill material	Low energy sources during Calcine Retrieval and Transport Project, removal of combustible materials, and routine dispositioning	Rupture or break in the calcine transfer lines during Calcine Retrieval and Transport operations	An external event results in 0.50 rem (MEI), 34 rem (NIW), 5,900 rem (OSP), and 3.0 LCF.
CPP-746	Bin sets 3	●	●	●	Low levels of radioactive and hazardous material	Low mobility ensured by pipe capping and filling the bin sets with Class C-type grout or clean fill material	Low energy sources during Calcine Retrieval and Transport Project, removal of combustible materials, and routine dispositioning	Rupture or break in the calcine transfer lines during Calcine Retrieval and Transport operations	An external event results in 0.50 rem (MEI), 34 rem (NIW), 5,900 rem (OSP), and 3.0 LCF.
CPP-756 and 649	Prefilter Vault and Atmospheric Protection System Building			●	Low levels of radioactive and hazardous material residue after cease-use removal activities	Low mobility ensured by pipe capping and installation of a site protective cover during closure activities	Low energy sources due to routine closure activities and removal of combustible materials	Accidental fire during demolition activities could release contaminants beyond the working area	Prefilter fire that results in 43 curies of radioactivity; doses of 6.69 rem (MEI) and 0.042 rem (OSP).
CPP-760	Bin set 4	●	●	●	Low levels of radioactive and hazardous material	Low mobility ensured by pipe capping and filling the bin sets with Class C-type grout or clean fill material	Low energy sources during Calcine Retrieval and Transport Project, removal of combustible materials, and routine dispositioning	Rupture or break in the calcine transfer lines during Calcine Retrieval and Transport operations	An external event results in 0.50 rem (MEI), 34 rem (NIW), 5,900 rem (OSP), and 3.0 LCF.
CPP-765	Bin set 5	●	●	●	Low levels of radioactive and hazardous material	Low mobility ensured by pipe capping and filling the bin sets with Class C-type grout or clean fill material	Low energy sources during Calcine Retrieval and Transport Project, removal of combustible materials, and routine dispositioning	Rupture or break in the calcine transfer lines during Calcine Retrieval and Transport operations	An external event results in 0.50 rem (MEI), 34 rem (NIW), 5,900 rem (OSP), and 3.0 LCF.

Table C.4-7. Facility disposition accidents summary (continued).

Facility number	Facility title	Clean closure	Performance-based	Landfill Stds	Material at risk at closure	Contaminant mobility at closure	Energy for accident at closure	Maximum plausible accident	Bounding operations accident[a]
CPP-780 through CPP-786	Vaults for Tanks VES-WM-180-186	●	●	●	Low levels of radioactive and hazardous material	Low mobility ensured by pipe capping and filling the tanks with Class C-type grout or clean fill material	Low energy sources during SBW retrieval, removal of combustible materials, and routine dispositioning	Rupture or break in the SBW transfer lines during SBW retrieval operations	An external event results in 0.34 rem (MEI), 23 rem (NIW), 3,500 rem (OSP), and 1.8 LCF.
CPP-791	Bin set 6	●	●	●	Low levels of radioactive and hazardous material	Low mobility ensured by pipe capping and filling the bin sets with Class C-type grout or clean fill material	Low energy sources during Calcine Retrieval and Transport Project, removal of combustible materials, and routine dispositioning	Rupture or break in the calcine transfer lines during Calcine Retrieval and Transport operations	An external event results in 0.50 rem (MEI), 34 rem (NIW), 5,900 rem (OSP), and 3.0 LCF.
CPP-795	Bin set 7	●	●	●	Very low levels of radioactive and hazardous material; bin sets did not contain calcine	Low mobility ensured by pipe capping and filling the bin sets with Class C-type grout or clean fill material	Low energy sources during Calcine Retrieval and Transport Project, removal of combustible materials, and routine dispositioning	Rupture or break in the calcine transfer lines during Calcine Retrieval and Transport operations	An external event results in 0.50 rem (MEI), 34 rem (NIW), 5,900 rem (OSP), and 3.0 LCF.

a. In addition to the "bounding operational scenario" for *radiological and hazardous material releases* shown in the last column of this table for all the facilities, the following bounding accident scenario for *hazardous chemical releases* should be included for all facilities, except CPP-605. As described in the introduction of this facility analysis, the bounding accident scenario for *hazardous chemical releases* is a catastrophic failure of a 3,000-gallon ammonia tank and formation of cloud of toxic vapor. This chemical accident postulated during INTEC-wide operations has the greatest potential consequences to workers and the offsite population.

LCF = latent cancer fatality; MEI = maximally exposed individual; NIW = noninvolved worker; OSP = offsite population; SBW = mixed transuranic waste/SBW; SNF = spent nuclear fuel.

disposition options offers a valuable perspective on the potential impacts to involved workers.

For this analysis the total number of injury/illnesses and fatality cases for each existing facility is determined by multiplying the estimated total worker hours during facility disposition times an assumed incident rate for injuries/illnesses and fatalities. The exact frequency of injuries/illnesses and fatalities is less critical than the consistency with which these rates are applied to different facility disposition alternatives, so that the impact of facility disposition to involved workers can be put in perspective as a potential discriminating factor for evaluating EIS alternatives.

The estimated total worker hours for each facility disposition were obtained from Lockheed Martin Idaho Technologies Company Engineering Design Files and Project Data Sheets performed for the existing facility closures associated with this EIS.

The average hazard incident rates were obtained by reviewing several historical DOE and U.S. Government records for actual injury/illness and fatality rates during construction work in the recent past. The average INEEL and private industry injury/illnesses and fatality incident rates were extracted from the SNF & INEL EIS (DOE 1995), from the Computerized Accident Incident Reporting System industrial accident database from 1993 through 1997, and from a Bayesian update to include 1998 data (Fong 1999).

The incident rates are per 100 man-years or 200,000 construction hours, which is a common benchmark used by DOE, Occupational Safety and Health Administration, and the Bureau of Labor Statistics. These selected rates are 6.2 and 13.0 injuries/illnesses per 200,000 worker hours, and 0.011 and 0.034 fatalities per 200,000 worker hours for INEEL and private industry, respectively. Actual rates for INTEC HLW management facility disposition activities likely would be equal to or greater than the DOE construction rates but less than the private industry construction rates. Thus, the lower and upper estimates of expected incidents were averaged for calculating the results.

Table C.4-8 presents the analysis results for industrial impacts to involved workers. The available DOE data do not consistently disclose the type of facility closure assumed for the "Other Facilities." Therefore, for purposes of this table, the estimated total labor hours and resultant incidents for the "Other Facilities" are assumed to be equal for all three types of closure.

This table shows that the estimated number of incidents varies considerably with the facility disposition alternative. The Clean Closure Alternative has by far the greatest number of injuries/illnesses and fatalities; the Performance-Based Closure Alternative has fewer incidents and the Closure to Landfill Standards Alternative has the least number of estimated incidents. This result can be attributed to the large number of disposition man-hours and project years required by the Clean Closure Alternative. This option also involves more demolition and heavy equipment operation than the other two facility disposition alternatives. The total number of incidents for the Performance-Based and Landfill Closure Alternatives are nearly equal, within the limitations on the data currently available for the "Other Facilities."

Radiological Hazards. In addition to estimating the nonradiological impacts of occupational hazards to the INTEC involved worker, it is impor-

Table C.4-8. Industrial hazard impacts during disposition of existing HLW management facility groups using "average DOE-private industry incident rates" (per 200,000 hours).

Facility groups	Clean closure		Performance-based closure/clean fill		Closure to landfill standards/clean fill	
	Injuries/illnesses	Fatalities	Injuries/illnesses	Fatalities	Injuries/illnesses	Fatalities
Tank Farm	770	1.8	30	0.07	16	0.04
Bin sets	130	0.32	100	0.24	48	0.11
Other facilities	150	0.33	150	0.33	150	0.33
Total incidents	1,100	2.4	280	0.64	210	0.48

tant to estimate the radiological impacts that could be sustained during facility disposition. For this purpose, estimates for the total radiation dosage sustained by the involved workers during the facility disposition period were used for this analysis. Data for this radiological parameter were obtained from Engineering Design Files and Project Data Sheets referenced in the accident analysis and provide the EIS analyst additional inputs for relative comparisons among the EIS alternatives. As for industrial hazards, specific information is not currently available for transport lines that are not associated with any individual facility. This omission could be significant if any contamination has leaked from transport lines to the surrounding soil, which could pose a distinct risk of accidental radiation exposure to unsuspecting involved workers.

Facility totals for worker radiation dosage are assumed to be directly proportional to the total number of radiation worker-years needed for each facility disposition alternative. Radiation worker-years are defined as the product of the number of workers working in radiation areas times the number of closure years for each facility. Thus, to determine the total radiation dosage per facility, the number of radiation man-years was multiplied by the dosage rate, i.e. total rem per worker per year.

Table C.3-8 presents the total radiation dosage to the exposed radiation workers for each facility group by closure type. An average dosage rate for each facility closure was obtained from the Engineering Design Files and Project Data Sheets mentioned previously. The available DOE data do not disclose the type of facility closure assumed for the "Other Facilities." Therefore, for purposes of this table, the estimated total labor hours and resultant incidents for the "Other Facilities" are assumed to be equal for all three types of closure. The latent cancer fatalities that result from this population exposure can be estimated by multiplying the total dosage (person-rem) by 4×10^{-4} latent cancer fatalities per person-rem. This dose-to-risk factor is based on the 1990 Recommendations of the International Commission on Radiation Protection (ICRP 1991).

Appendix C.4 References

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