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Document Title: Environmental Restoration Disposal Facility (Project W-296) Safety

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**This document was reviewed following the
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7. Abstract The Safety Assessment for the Environmental Restoration Disposal Facility (Project W-296) is based on the Conceptual Design Report and ancillary documentation developed during the conceptual design phase of Project W-296. The Safety Assessment supports the Solid Waste Burial Grounds Interim Safety Basis, WHC-SD-WM-1SB-002, Rev. 0. Accident safety analysis scenarios have been analyzed based on events identified in the hazards analysis. Radiological and hazardous material exposures have been analyzed to determine if exposure levels are acceptable from an overall health and safety standpoint to the worker, onsite personnel, the public, and the environment.		
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ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (PROJECT W-296) SAFETY ASSESSMENT

August 1994

Prepared for the U.S. Department of Energy

Westinghouse Hanford Company
Richland, Washington

APPROVED FOR
PUBLIC RELEASE
W. Burkland
8/19/94

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**ENVIRONMENTAL RESTORATION DISPOSAL FACILITY
(PROJECT W-296)
SAFETY ASSESSMENT**

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**ENVIRONMENTAL RESTORATION DISPOSAL FACILITY
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**_WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

CHAPTER 1

INTRODUCTION

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LIST OF TERMS

DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy - Richland Operations Office
ERDF	Environmental Restoration Disposal Facility
U.S.	United States
USACE	U.S. Army Corps of Engineers
WHC	Westinghouse Hanford Company

1.0 INTRODUCTION

This Safety Assessment is based on information derived from the *Conceptual Design Report for the Environmental Restoration Disposal Facility* (DOE/RL 1994) and ancillary documentation developed during the conceptual design phase of Project W-296. The Safety Assessment has been prepared to support the Solid Waste Burial Ground Interim Safety Basis document. The purpose of the Safety Assessment is to provide an evaluation of the design to determine if the process, as proposed, will comply with U.S. Department of Energy (DOE) Limits for radioactive and hazardous material exposures and be acceptable from an overall health and safety standpoint. The evaluation considered affects on the worker, onsite personnel, the public, and the environment.

1.1 OVERVIEW OF THE FACILITY

The Environmental Restoration Disposal Facility (ERDF), Project W-296, will provide a *Resource Conservation and Recovery Act of 1976*, 42 USC 6901 et seq., compliant burial space for consolidating low-level radioactive and low-level mixed wastes from Hanford Site burial grounds and liquid waste disposal facilities throughout the Hanford Site into a single location above the Columbia River maximum flood elevation. The facility will support remediation activities at the Hanford Site and minimize potential for contamination migration.

In all, approximately 21,400,000 m³ (28,000,000 yd³) of bulk contaminated soils and containerized waste are scheduled for transfer to the site. Approximately 4,600,000 m³ (6,010,000 yd³) of this waste volume will be included in Project W-296, which covers trench operation through the year 2001. This waste has been classified as contact-handled and remote-handled low-level; transuranic waste will not be accepted for disposal in this trench.

Project W-296 includes construction of the support buildings, excavation of the first quarter of the trench, placement of the liner, and receipt and placement of waste in the disposal trench through the first five years of facility operation. Disposal functions through the remaining three-fourths of the trench volume, construction of the closure cap, and decontamination and decommissioning of support buildings for final facility closure will be performed and funded under other projects. These projects will require additional safety documentation.

The ERDF will be located between the 200 West and 200 East Areas of the Hanford Site approximately 14.5 kilometers (9 miles) east and north of the nearest Hanford Site boundaries. The Hanford Site is a 1,450 square-kilometer (560 square-mile) tract of semiarid land owned by the U.S. Government and set aside for U.S. Department of Energy (DOE) and other federal agency activities. The Hanford Site has supported nuclear reactor operations; special nuclear material production, separation, and manufacturing; fast breeder reactor operations; and nuclear power reactor operations during the past 50 years. The facility location is central to the Hanford Site and is well above the Columbia River maximum flood plain.

- Operations in the 200 Areas consist primarily of nuclear material separations and processing, waste treatment and storage, and decontamination and decommissioning. High level radioactive mixed waste tanks and radioactive waste burial trenches are located in both the 200 East and West Areas. In addition, a commercial low-level mixed waste burial trench operated by U.S. Ecology, Inc. is located adjacent to the ERDF site on the east.

1.2 FACILITY HAZARD CLASSIFICATION

Hazard categorization for ERDF radiological hazards was performed in accordance with DOE-STD-1027-92 (DOE 1992), *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. The ERDF has been designated as a Nuclear Facility, exceeding Hazard Category 3 inventory thresholds, which represent the potential for significant localized consequences but not for significant onsite or offsite consequences. Facilities designated as Hazard Category 3 are required to comply with the requirements of DOE Order 5480.23, *Nuclear Safety Analysis Reports* (DOE 1992a), for preparation of safety analysis documentation. Hazard classification for nonradiological material hazards was performed in accordance with the guidance of WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992), Section 4.0, "Hazard Classification" and DOE Order 5481.1B, *Safety Analysis and Review* (DOE 1987), resulting in classification of the facility as Low Hazard.

1.3 SUMMARY OF THE SAFETY ANALYSIS

The ERDF will provide disposal for large volumes of bulk soil and treatment for contaminated wastewaters including leachate containing low concentrations of contamination. The most significant hazards associated with ERDF operation are radiation and hazardous chemical exposure to facility workers, industrial accidents involving transport vehicles, and industrial accidents related to heavy equipment operation and maintenance. Soil column migration is not anticipated to be a significant concern based on information from the ERDF Remedial Investigation/Feasibility Study (DOE 1994b).

The primary preventive/mitigative features provided by the conceptual design (DOE/RL 1994) are: control of inventory by verification of waste containers as they are received; application of fixants to waste soils to preclude fugitive dust generation; application of a clean daily soil cover in areas where vehicles or equipment will operate; halting waste soil placement during windy conditions; and monitoring airborne concentrations of dust and contaminants in the vicinity of the trench.

The qualitative and quantitative analyses performed in support of this Safety Assessment demonstrate that normal operation of the facility will result in significant radiological exposures to facility workers, exposures which are below the DOE Annual Limits given in DOE Order 5480.11, *Radiation Protection for Occupational Workers* (DOE 1988) and DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (DOE 1990), but above the DOE Annual Dose Guidance Values given in DOE/EH-0256T, Rev. 1, *Radiological Control Manual* (April 1994), as shown in Table 1-1. Vehicle accidents which

cause release of radioactive materials will result in consequences below DOE Annual Limits and DOE annual Dose Guidance Values, as shown in Table 1-2. Dispersion of waste soil due to windstorm conditions also results in consequences below DOE Annual Limits and DOE Annual Dose Guidance Values, as shown in Table 1-3. Acute exposures during the windstorm scenario analyzed reach levels as high as six times the Derived Air Concentrations (DOE 1988).

Calculation of consequences using the values given in the *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (WHC 1994) results in concentrations of hazardous materials (Chrysene and Iron) above the WHC risk acceptance criteria and dose rates above the 2,000 mrem/y DOE guidance limits for onsite and facility workers. These potential exposures may be lowered through implementation of engineered features or administrative controls. Reduction of waste acceptance limit concentrations for Iron to $7.44\text{E}+03$ mg/kg, and Chrysene to $1.49\text{E}+03$ mg/kg could result in reduction of airborne concentrations of these constituents to limits below the WHC risk acceptance criteria for these constituents. Reducing the allowable concentration of Ra-226 to $9.4\text{E}-09$ Ci/g would lower the overall annual uptake dose for facility workers from 1,940 mrem/y to 1,080 mrem/y. This reduces the maximum potential total dose for the facility worker from 2,400 mrem/y to 1,540 mrem/y, which will not require DOE approval for normal operations. Where the Tables 1-1, 1-4, and 1-5 indicate conditional compliance, this is contingent upon reduction of waste acceptance limits to the values given above.

Normal facility operations and windstorm conditions result in localized and onsite concentrations of hazardous materials which are in excess of the WHC risk acceptance criteria given in WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992), as shown in Tables 1-4 and 1-5. The results of vehicle accidents which cause release of radioactive materials will result in concentrations of hazardous materials within the risk acceptance criteria. All facility operations and accident conditions will result in exposure of personnel at the facility and onsite to measurable concentrations or respirable carcinogens.

1.4 FACILITY MANAGEMENT AND ORGANIZATION

The ERDF is a U.S. Department of Energy - Richland Operations Office (DOE-RL) project. The DOE-RL has contracted a design team consisting of the United States Army Corps of Engineers (USACE) acting as the primary Architect/Engineer with subcontracts to Montgomery-Watson, Golder Associates, Inc., and Wastren, Inc. for engineering support. The USACE is also the construction manager. WHC is the lead for safety analysis, and has subcontracted with M.H. Chew & Associates, Inc. for completion of this safety documentation. Construction will be performed by USACE and WHC, USACE providing the major excavation functions and building construction, and WHC providing liner installation in an ongoing manner.

Table 1-1. Estimated Annual Doses Due to Normal Operations

Receptor Location	Effective Dose Equivalent [Sv (rem)]	DOE Annual Limit [Sv (rem)]	DOE Annual Dose Guidance Value [Sv (rem)]	Compliant
Facility Worker	2.40E-02 (2.40E+00)	5.0E-02 (5.0E+00)*	2.0E-02*** (2.0E+00)	Yes - Limit Yes Conditional - Guidance
Onsite Worker	8.24E-04 (8.24E-02)	5.0E-02 (5.0E+00)*	2.0E-02*** (2.0E+00)	Yes
Site Boundary	9.47E-06 (9.47E-04)	1.0E-03 (1.0E-01)**	1.0E-04**** (1.0E-02)	Yes

* Annual occupational limit (DOE 1988)

** Annual public limit (DOE 1990)

*** Annual guidance values (DOE 1992b)

**** Annual reporting value (DOE 1990)

Table 1-2. Estimated Doses Due to Container Spill

Receptor Location	Effective Dose Equivalent [Sv (rem)]	DOE Annual Limit [Sv (rem)]	DOE Annual Dose Guidance Value [Sv (rem)]	Compliant
Facility Worker	4.27E-09 (4.27E-07)	5.0E-02 (5.0E+00)*	2.0E-02*** (2.0E+00)	Yes
Onsite Worker	2.24E-10 (2.24E-08)	5.0E-02 (5.0E+00)*	2.0E-02*** (2.0E+00)	Yes
Site Boundary	4.04E-12 (4.04E-10)	1.0E-03 (1.0E-01)**	1.0E-04**** (1.0E-02)	Yes

* Annual occupational limit (DOE 1988)

** Annual public limit (DOE 1990)

*** Annual guidance values (DOE 1992b)

**** Annual reporting value (DOE 1990)

Table 1-3. Estimated Doses Due to a Windstorm Event

Receptor Location	Effective Dose Equivalent Sv (rem)]	DOE Annual Limit [Sv (rem)]	DOE Annual Dose Guidance Value [Sv (rem)]	Compliant
Facility Worker	2.07E-03 (2.07E-01)	5.0E-02 (5.0E+00)*	2.0E-02*** (2.0E+00)	Yes
Onsite Worker	1.02E-04 (1.02E-02)	5.0E-02 (5.0E+00)*	2.0E-02*** (2.0E+00)	Yes
Site Boundary	2.19E-06 (2.19E-04)	1.0E-03 (1.0E-01)**	1.0E-04**** (1.0E-02)	Yes

* Annual occupational limit (DOE 1988)

** Annual public limit (DOE 1990)

*** Annual guidance values (DOE 1992b)

**** Annual reporting value (DOE 1990)

Table 1-4. Estimated Hazardous Chemical Concentrations in Excess of Risk Acceptance Criteria Due to Normal Operations

Element or Compound	Airborne Conc. at (100 m Site) (mg/m ³)	Airborne Conc. at (550 m E) (mg/m ³)	Airborne Conc. at (15,100 m W) (mg/m ³)	Permissible Exposure Limits (mg/m ³)	Compliant
Iron	1.32E+01	7.13E-01	4.87E-03	1.00E+00	Yes Conditional - worker Yes - onsite Yes - offsite
Chrysene	5.09E+01	2.75E+00	1.88E-02	2.00E-01	Yes Conditional - worker Yes Conditional - onsite Yes - offsite

Table 1-5. Estimated Hazardous Chemical Concentrations in Excess of Risk Acceptance Criteria Due to a Windstorm Event

Element or Compound	Airborne Conc. at (100 m ESE) (mg/m ³)	Airborne Conc. at (550 m E) (mg/m ³)	Airborne Conc. at (13,300 m E) (mg/m ³)	Permissible Exposure Limits (mg/m ³)	Compliant
Chrysene	1.67E+01	8.21E-01	5.89E-03	2.00E-01	Yes Conditional - worker Yes Conditional - onsite Yes - offsite
Iron	4.33E+00	2.13E-01	1.52E-03	1.00E+00	Yes Conditional - worker Yes - onsite Yes - offsite

Upon completion of construction, the resulting facilities will be operated by WHC, the Management and Operating contractor for the Hanford Site. During operation, WHC will utilize the Hanford Environmental Health Foundation for occupational, medical, and industrial hygiene support, Pacific Northwest Laboratory for dosimetry and radiological instrument calibration, and ICF Kaiser Hanford Company for engineering and operations support.

1.5 APPLICABILITY OF THE AUTHORIZATION BASIS

This Safety Assessment provides an evaluation of the facility conceptual design and proposed operations as defined in documentation issued as of 6 June 1994. A Final Safety Analysis Report prepared in accordance with DOE Order 5480.23, *Nuclear Safety Analysis Reports* (DOE 1992a), will be required to authorize operation of the facility.

1.5.1 Limitations on Operations

ERDF interim Operational Safety Requirements have been identified in the form of administrative and operating limits. Each of these interim Operational Safety Requirements provide controls to limit releases with potential offsite consequences. They consist of the following operating limits and administrative controls:

Operating Limits

- Hazardous Material/Radioactive Material Concentration Limit Requirement
- Soil Fixant Application
- Trench Air Monitoring
- Trailer Tipper Water Spray System Operation
- Dozer Water Spray Mister System Operation
- Halting Waste Placement During Windstorm Conditions
- Interim Cover Installation

- Administrative Controls
 - Organization and Responsibilities Requirements
 - Operating Procedures Control
 - Programmatic Requirements
 - Staffing Requirements
 - Qualification and Training Requirements

1.5.2 Items for Providing Additional Refinement

This section contains the most significant items identified in this assessment that may impact the safe operation facility. More information on these items is included in the supporting documentation for Project W-296 referenced in this document.

Because the proposed facility site is co-located with identified historical and archeological sites (Roeck 1994), a plan for preservation of discovered artifacts must be in place before the start of site grading or grubbing. Because the proposed facility location is a nesting area for avian species of concern (Roeck 1994), a plan should be prepared for scheduling of site preparation and construction activities for minimum interference with the nesting season. In particular, if activities are planned to commence during the season, some measure should be taken to prevent nesting in areas in which birds might be disturbed to such an extent that they would abandon the eggs or young.

A Criticality Safety Evaluation Report must be prepared as required by WHC-CM-4-29, *Nuclear Criticality Safety Manual* (WHC 1991a), prior to construction of any portion of the facility that will handle or contain fissionable material. The evaluation report is the mechanism for formal identification of required criticality control systems and instrumentation. The facility has been preliminarily classified a limited control facility. A separate evaluation report may not be required for ERDF if the Solid Waste Burial Grounds Criticality Safety Evaluation Report is modified to address ERDF design and operations.

A Memorandum of Understanding must be developed with U.S. Ecology, Inc. to provide a level of protection for U.S. Ecology, Inc. employees in emergency response equal to that provided for all Hanford Site employees (DOE/RL 1994a), in order to ensure these personnel remain defined as "onsite" for the purposes of risk acceptance evaluation.

An engineering study should be performed to determine whether additional engineering controls may be implemented to reduce the level of occupational exposure. If implementation of such controls is not practicable, administrative exposure controls must be developed prior to facility operation (WHC 1992a and 1993).

Project W-296 specific plans and procedures related to quality assurance in design, procurement, and construction (WHC 1991b) must be complete prior to beginning facility construction. These plans and procedures must be in place for all contractors involved.

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- The ERDF conceptual design should be reviewed for development of a radiological and hazardous material control strategy (WHC 1990 and 1993) prior to the start of construction to ensure that the design of support buildings will allow installation of required equipment and establishment of required control areas.

The designation of Safety Class items must be documented and finalized. Discrepancies between the *Project Specific Quality Assurance Program Plan* (WHC 1994a) for Project W-296 and the *Conceptual Design Report for the Environmental Restoration Disposal Facility* (DOE/RL 1994) must be resolved in the area of definition of Safety Class items.

1.6 REFERENCES

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1.6.3 Legal Documents

Resource Conservation and Recovery Act of 1976, 42 USC 6901 et seq.

1.6.4 Controlled Manuals

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WHC, 1991b, *Quality Assurance Manual*, WHC-CM-4-2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992, *Nonreactor Facility Safety Analysis Manual*, WHC-CM-4-46, Westinghouse Hanford Company, Richland, Washington

WHC, 1992a, *Industrial Hygiene Manual*, WHC-CM-4-40, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993, *WHC Radiological Control Manual*, WHC-CM-1-6, Westinghouse Hanford Company, Richland, Washington.

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**_ WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

APPENDIX A1

**UNIT RELEASES FOR THE ENVIRONMENTAL RESTORATION DISPOSAL
FACILITY ACCIDENT ANALYSIS**

CCCC01

WHC-SD-W296-SAD-001, REV 0

**WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

APPENDIX A2

**CONSEQUENCE CALCULATIONS FOR THE ENVIRONMENTAL RESTORATION
DISPOSAL FACILITY ACCIDENT ANALYSIS**

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WHC-SD-W296-SAD-001, REV 0

**_ WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

APPENDIX B1

PROJECT W296

TECHNICAL SAFETY REQUIREMENTS

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WHC-SD-W296-SA-001, REV 0

**_ WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

APPENDIX B2

**TECHNICAL SAFETY REQUIREMENTS ADMINISTRATIVE CONTROLS
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000004

WHC-SD-W296-SAD-001, REV 0

**WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

CHAPTER 2.0

DESCRIPTION OF FACILITY

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LIST OF TERMS

CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act</i>
CFR	<i>Code of Federal Regulations</i>
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy - Richland Operations Office
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
HDPE	High-density polyethylene
HEPA	High-efficiency Particulate Air
HVAC	Heating, Ventilation, and Air Conditioning
NRC	Nuclear Regulatory Commission
PCM	Process Control Module
U.S.	United States
WAC	<i>Washington Administrative Code</i>
WHC	Westinghouse Hanford Company
WSDOE	Washington State Department of Ecology

2.0 FACILITY DESCRIPTION

The proposed Project W-296 will consist of the design, construction, and first five years of operation of the Environmental Restoration Disposal Facility (ERDF). The ERDF will be used for the disposal of waste resulting from remediation activities throughout the Hanford Site. The planned operating life of the ERDF is 22 years; the component facilities are designed to support this requirement. These facilities consist of an Operations Building, Decontamination Building, Wastewater Treatment Facility, disposal trench, leachate collection system, heavy equipment for bulk waste and waste container handling, utilities, fencing, roads, inventory and access control systems, communications, and ancillary systems necessary to support facility operations and ensure personnel safety.

2.1 INTRODUCTION

This chapter provides a description of the ERDF component facilities and operations in sufficient detail to support the assessment of design and operational safety contained in the remainder of this document. Because the level of hazard associated with facility operations is low, the facility is not operationally complex, and much of the process and operational equipment is standardized and commercially available, the facility and operations description is not extensive. The information in this chapter is taken from the *Conceptual Design Report for the Environmental Restoration Disposal Facility* (DOE/RL 1994) unless otherwise referenced.

2.2 REQUIREMENTS

Design criteria and requirements can generally be divided into two categories: those related to efficiently achieving the programmatic mission of the facility, and those related to safety, health, and environmental protection. The following sections identify and discuss the safety-, health-, and environmental-related design criteria applicable to the ERDF.

2.2.1 U.S. Department of Energy Orders

The design criteria for the buildings and equipment will conform to the requirements of U.S. Department of Energy (DOE) Order 6430.1A, *General Design Criteria* (DOE 1989). Division 1300 of this Order, "Special Facilities," contains design requirements for nonreactor nuclear facilities including radioactive solid and liquid waste facilities. Constituent portions of the ERDF structures will be required to comply with this section and various other portions of the Order. The DOE Order 6430.1A, *General Design Criteria* (DOE 1989), incorporates by reference the requirements of applicable standards and codes such as the *Uniform Building Code* (ICBO 1991) and the publications of the American National Standards Institute.

The DOE Order 5480.28, *Natural Phenomena Hazards Mitigation* (DOE 1993), defines facility performance categories based on the level of hazard and type of facility operations. For systems, structures, and components designated Performance Category 1 the

primary concern is preventing major structural damage or collapse that would endanger personnel. The Order specifies a performance goal of probability less than 1×10^{-3} annually for significant damage to Category 1 items. The failure of a Performance Category 2 item is considered to pose a greater danger to onsite personnel than the failure of a Performance Category 1 item because of the potential for hazardous materials release upon failure. Only relatively minor structural damage to Category 2 items should be allowed as a result of natural phenomena hazards. The Category 2 performance goal is an annual probability of less than 5×10^{-4} for structure, system, or component damage. The ERDF Operations Building design shall comply with the standards for Performance Category 1 facilities. The Operations Building Control Room, the Decontamination Building, and the Wastewater Treatment Facility shall comply with the standards for Performance Category 2 facilities.

The Hanford Plant Standard SDC-4.1, *Standard Arch-Civil Design Criteria, Design Loads for Facilities* (DOE/RL 1989), defines four safety classifications for nonreactor nuclear facilities. The ERDF has been designated a Safety Class 3 facility - Low Hazard/Important (see Chapter 3 of this document). This Standard specifies the values given in Table 2-1 for design basis winds, and the values given in Table 2-2 for seismic evaluation.

Table 2-1. Design Basis Wind Load Criteria

	Safety Class		
	2	3	4
Fastest Mile Windspeed	128 km/h	113 km/h	113 km/h
Exposure Category	C*	C*	C*
Importance Factor	1.0	1.07	1.0

*Exposure Category C: Flat and generally open terrain extending >0.5 mile from the building.

Table 2-2. Design Basis Seismic Evaluation Criteria

	Safety Class		
	2	3	4
Free Field Horizontal Acceleration	0.12 G	0.12 G	0.09 G
Critical Damping	UCRL-15910	5%	5%
Importance Factor	2.0	1.25	1.0

2.2.2 Codes and Standards

The U.S. Environmental Protection Agency (EPA) Office of Solid Waste and Emergency Response, and the U.S. Nuclear Regulatory Commission (NRC) Office of

Nuclear Material Safety and Safeguards have issued two joint guidance documents on the design of low-level mixed waste disposal facilities. The publication of these documents was announced in the *Federal Register*, although the guidance itself has not been incorporated into the Code of Federal Regulations.

The document *Conceptual Design Approach for Commercial Mixed Low-Level Radioactive and Hazardous Waste Disposal Facilities* (NRC/EPA 1987) presents basic design concepts that are acceptable to both EPA and NRC as satisfying technical standards for disposal facility design and construction. These design criteria require:

- Installation of a double liner with leachate collection and removal systems above the primary liner, and in the interstitial space between the primary and secondary liners, and a perimeter berm for leachate control.
- Emplacement of waste only above the level of highest water table fluctuation and above the drainage layers where leachate will collect.
- Use of stable, high-integrity waste containers with the spaces between the containers filled with a cohesionless, low-compressibility fill material, or placement of the waste in an engineered structure such as a reinforced concrete vault.
- Installation of a cover system in the closure process that consists of an outer rock or vegetative layer to minimize erosion and provide long-term stability; a filter and drainage layer that transmits infiltrating water away from the facility; an impervious flexible membrane layer overlying a compacted low-permeability clay layer; and a filter and drainage layer beneath the compacted clay layer.
- For low-level mixed waste that contains waste designated as Class C, the cover materials must be of sufficient thickness or an engineered intruder barrier provided to protect against inadvertent intrusion.

[Note: WHC-EP-0063-4 (Willis and Triner 1991) uses different terminology; wastes designated as Class C are designated by Westinghouse Hanford Company (WHC) as greater than Class 3.]

The joint guidance document *Guidance on the Land Disposal Restrictions' Effect on Storage and Disposal of Commercial Mixed Waste* (NRC/EPA 1990) confirms that for land disposal, low-level mixed wastes must meet the treatment standards promulgated under the *Resource Conservation and Recovery Act of 1976*, 42 USC 6901 et seq., of 40 CFR 268, "Land Disposal Restriction," *Code of Federal Regulations*, as amended.

2.2.3 Federal and State Regulations

The ERDF has been defined by WHC as a part of the 100-B/C Areas Large Scale Remediation Activity under the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA). The CERCLA National Contingency Plan allows a disposal facility located on a CERCLA remediation site and in very close proximity to the defined area of

contamination to receive waste from predesignated CERCLA remediation sites for disposal. Such a facility may only receive wastes generated in CERCLA remediation activities as designated in the Record of Decision for the site Remedial Investigation/Feasibility Study and is required under the National Contingency Plan to comply with all Federal and State requirements determined to be applicable or relevant and appropriate. Applicable requirements are defined as cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Relevant and appropriate requirements are defined as substantive environmental protection requirements which address situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. While the determination of applicability is primarily a legal one, the determination of relevance and appropriateness is site-specific and based on best professional judgement, taking into account the circumstances of the release or potential release. The facility will not be required to comply with the administrative portions of any applicable, relevant, or appropriate requirement, including requirements for approval of or consultation with administrative bodies, documentation, permit issuances, reporting, and recordkeeping.

The primary substantive requirements applicable to the design of the ERDF trench are found in the WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended, which implement the requirements of the *Resource Conservation and Recovery Act of 1976*, 42 USC 6901 et seq. Specific design requirements for landfills found in WAC 173-303-664, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended, include:

- A liner that is designed, constructed, and installed to prevent any migration of wastes out of the landfill at any time during the active life of the facility.
- A leachate collection and removal system immediately above the liner designed to collect and remove leachate from the landfill.
- A runoff control system capable of preventing flow into the active portion of the landfill during peak discharge from at least a 25-year storm.
- A runoff management system to collect and control at least the water volume resulting from a 24-hour, 25-year storm.
- A cover or other management practices to prevent wind dispersal of particulate matter.
- A groundwater monitoring program capable of detecting, characterizing, and responding to any release from the landfill to the uppermost aquifer.

The facility is exempted from the requirement for groundwater monitoring of a double-liner, interstitial leak detection, and a system for leachate collection and removal from between the liners is implemented.

The *Dangerous Waste Regulations* (Chapter 173-303-640) also provide requirements for design of tank systems for waste storage. Tanks used for storage of dangerous wastes containing free liquids must be:

- Assessed by an independent, qualified, registered professional engineer for adequacy in foundation, structural support, seams, connections, compatibility, and corrosion protection to ensure that they will not collapse, rupture, or fail.
- Equipped with a secondary containment system for the tank and any underground piping designed, installed, and operated to prevent any migration of wastes or accumulated liquid out of the system to the environment, and capable of collecting releases and accumulated liquids until those liquids are removed.
- Equipped with a leak detection system that is designed and operated so that it will detect the failure of either the primary or secondary containment structure or detect the presence of any accumulated liquid within 24 hours.

These requirements will apply to decontamination wastewater, storm water, and leachate tanks if these liquid wastes are determined to be regulated as dangerous waste in accordance with the *Dangerous Waste Regulations*.

The ERDF operations will be required to comply with the requirements promulgated by the EPA the *Resource Conservation and Recovery Act of 1976*, 42 USC 6901 et seq., of 40 CFR 268, "Land Disposal Restriction," *Code of Federal Regulations*, as amended. These regulations establish prohibitions on the disposal of hazardous waste in landfills and other land disposal units by requiring advance treatment of many regulated wastes. All radioactive mixed waste intended for disposal at the ERDF must be characterized to identify all hazardous constituents, and these constituents compared with the appendices to 40 CFR 268, "Land Disposal Restriction," *Code of Federal Regulations*, as amended, to determine the required treatment or concentration limits for disposal. The waste must be treated at the generator sites before transport to the ERDF; no treatment capacity is provided at the facility.

2.3 FACILITY OVERVIEW

The ERDF site will be located on a 15.5 km² (6 mi²) tract of land beginning at the southeast corner of the 200 West Area and extending south and east towards the Army Loop Road and the U.S. Ecology, Inc. commercial low-level radioactive waste disposal site. The disposal trench will eventually extend to a point about 550 m (1800 ft) west of the U.S. Ecology, Inc. perimeter fence line; at the completion of Project W-296 the separation between the trench and the U.S. Ecology, Inc. fence line will be about 2300 m (7500 ft). The general facility location is shown in Figure 2-1. The locations of the principle component facilities described in the following sections are shown in Figure 2-2. ERDF is designated a limited control facility for criticality safety so that criticality safety requirements are commensurate with the low-level amounts of fissionable material anticipated in the waste matrix.

2.3.1 Buildings and Facilities

Three main support buildings will be constructed to accommodate approximately 167 full-time employees working two shifts per day and Hanford site-wide services personnel (part-time). The Operations Building is a two story structure that will provide working areas for the operations personnel on the first floor and will accommodate managerial, engineering, and administrative staff on the second floor. The shops in this building are expected to handle decontaminated equipment only, thereby minimizing potential hazardous material and radioactive material inventories in the building. The Decontamination Building will provide container decontamination, surveying operations, and working areas for personnel involved in container decontamination. This building decontaminates container exteriors with a wet rinse process that minimizes the potential for hazardous material and radioactive material inventories at risk within the building. The Wastewater Treatment Facility will house equipment for treatment of combined leachate, decontamination wastewater, and stormwater streams. This building contains a closed piping system which minimize hazardous materials and radioactive materials at risk within the building.

2.3.1.1 Operations Building The Operations Building is located approximately 280 m (910 ft) west of the disposal trench as shown in Figure 2-2. This location places the building upwind of the trench based on the prevailing wind direction. The structure is designed as an offset double rectangle providing approximately 1490 m² (16,000 ft²) of usable space. The building will consist of a two-story administrative area and a single-story, high-ceiling shop and hot shop area. The administrative area will contain a lobby and reception area, visitor center, offices, restrooms, change rooms, lunch room, and conference room. The facility support area will include a control/computer room, janitor closet, mechanical room, electrical spaces, clean and dedicated maintenance rooms, personnel decontamination area, and miscellaneous storage rooms. The plans for the first and second floors are shown in Figures 2-3 and 2-4, respectively. The structure is designed as a pre-engineered rigid beam-column type frame installed on a reinforced concrete floor and foundation with the second floor a composite of wide-span metal decking and concrete.

2.3.1.2 Decontamination Building The Decontamination Building will provide a wash, rinse, dry, and radiological survey process for decontamination of containers, operations vehicles, and emergency response vehicles that leave the facility. The Decontamination Building is located on the northwest corner of the site approximately 80 m (260 ft) from the trench, as shown in Figure 2-2. The building structure will be a rectangle approximately 30 m (100 ft) wide and 67 m (220 ft) long, with an attached covered container storage area approximately 4.6 m (15 ft) wide by 137 m (450 ft) long (Figure 2-5). There will be four 6 m (20 ft) wide wash bays and one 6 m (20 ft) wide bay which will serve as a combination control and equipment room. Each container wash bay consists of a conveyor loading area, an 18 m (60 ft) long wash room, a 15 m (50 ft) long drying room, and a 15 m (50 ft) long radiation survey room. The rooms will be separated from each other by automatically-actuated electric-powered doors. The facility is designed to handle 215 containers per shift. In addition to the automatic wash bays, the Decontamination Building will include vehicle and equipment wash pad, restrooms, and a small personnel decontamination room (Figure 2-6).

The washwater in each wash unit will be collected and treated so that it may be recycled. The water and contaminants will flow into a sand trap where heavy materials will be captured. The sand trap will be cleaned daily using a vacuum truck. The overflow water will be pumped through a cyclone separator to remove the remaining heavy materials and into a settling tank for removal of the remaining suspended particles. The overflow will be pumped through a filter to remove materials larger than 40 microns and then into a storage tank for reuse. The solids removed in the cyclone, settling tank, and filters will be transferred to the blowdown storage tank in the wastewater treatment facility (Figure 2-7). Provisions are included for adding a reverse osmosis treatment system if needed.

A single liner and leak collection system equipped with a sump pump will be installed under both the Decontamination Building and the Wastewater Treatment Facility. The outline of this liner is shown with a dotted line in Figure 2-5. This liner system is designed to prevent any release of contaminated wastewater to the environment.

2.3.1.3 Wastewater Treatment Facility The Wastewater Treatment Facility will provide the capacity for treatment of storm water, Decontamination Building wastewater, and leachate collected from the trench for removal of radionuclides and hazardous constituents. The treatment process will be housed in a rectangular building 15 m (50 ft) wide by 30 m (100 ft) long, located adjacent to the Decontamination Building. A 3 m (10 ft) by 6 m (20 ft) control room is provided; the remainder of the building will house process equipment (Figure 2-8). This facility may require permitting under the *Resource Conservation and Recovery Act of 1976*, 42 USC 6901 et seq., if the facility feed is determined to be a newly generated waste.

Decontamination wastewater will be combined with potentially contaminated stormwater runoff and leachate from the in-trench collection system in a 1,300 l (350 gal) fiberglass blowdown tank. This tank will feed to a package wastewater treatment plant utilizing a reverse osmosis process. The treated water will be pumped to eight evaporation tanks.

2.3.2 Disposal Trench

The ERDF will provide a single trench for disposal of low-level radioactive mixed waste with a double liner and leachate collection system. The trench and liner design is segmented to allow for phased construction. The finished trench will provide disposal capacity for 21.8 million m³ (28.5 million yd³) of bulk waste, 4.6 million m³ (6 million yd³) of which will be emplaced in the trench under Project W-296.

2.3.2.1 Layout The ERDF trench will be approximately 430 m (1420 ft) wide and 890 m (2920 ft) long at the surface and 21 m (70 ft) deep. The long axis of the trench will be oriented west to east as shown in Figure 2-2. Access ramps graded at an 8 percent slope will be provided leading to the interim operating level [-10.6 m (-35 ft)] and the trench floor [-21 m (-70 ft)]. The trench will be constructed entirely below grade, except for a 3 m (10 ft) high berm along the southeast side where the existing topography is lower than on the north side. The berm will be constructed as a structural fill using excavated soil. The sides

of the trench will be graded at a 3:1 slope to preclude bank sloughing or cave-in. The trench layout and cross section are shown in Figures 2-9 and 2-10.

2.3.2.2 Construction Trench excavation will be conducted using standard earthmoving equipment and techniques including cut and fill excavation, grading, and construction of embankments. Excavation will start on the west end of the trench site. Four cells (Figure 2-9) will be excavated in the first year of operation (1996) and six in the second year (1997). Three cells will be lined in the first year (1996); three in the second year (1997); and the remaining four as needed over the remaining three years. This phased approach to construction is designed to limit the amount of open, lined trench which will collect precipitation.

Clean soil excavated in construction of the trench will be stockpiled on-site for beneficial use. This material will be used for grading of the area around the trench to prevent run-on of storm water into the facility. A layer of clean fill will be placed on top of the liner to preclude damage from heavy equipment operations (trucks and bulldozers). Additional layers of clean fill will be used to form the daily operational cover for waste materials. A portion of the stockpiled material will be set aside for use in construction of the facility cap and cover. The remainder may be transported to remediation areas throughout the Hanford Site to be used in restoration activities.

Trench excavation areas will be accessed from the east side. Construction equipment materials, stockpiles, and personnel will operate on the south side of the facility. This approach isolates ongoing construction operations from waste placement activities, which will access the trench from the northwest side. A physical barrier will be temporarily installed between the construction area and the waste placement activities to prevent inadvertent entry into the waste area.

2.3.2.3 Liner System The trench will employ a double liner system that satisfies the requirements of Subtitle C of the *Resource Conservation and Recovery Act of 1976*, 42 USC 6901 et seq., for design and construction of low-level radioactive mixed waste disposal facilities. This liner will be essentially the same system as implemented for the Project W-025 Low-Level Mixed Waste Landfill, for which construction on one trench has been completed. Test results for the effects of radiation and chemical leachate constituents on both the geosynthetic and soil components of the liner are included in the *Geosynthetic Liner/Leachate Compatibility Testing in the Support of Project W-025, Radioactive Mixed Waste Disposal Facility* (WHC 1992) and the Hanford Grout Technology Program document the compatibility of various polymeric liner and pipe materials with simulated double-shell slurry feed at 90°C (PNL 1989). The preliminary draft of the *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (WHC 1994) limits acceptance of any constituents shown by these test results to have any adverse effect on the liner materials.

The multilayer liner design is shown in Figure 2-11. The bottom layer on the trench floor will consist of 0.9 m (3 ft) of low-permeability bentonite-soil mixture. This will be overlain by a 1.5 millimeter (0.060 in.) thick high-density polyethylene (HDPE) geomembrane (the secondary liner) on the trench floor and sideslopes. On the trench floor, the secondary liner will be overlain by a gravel leak detection layer. On the sideslopes, the

secondary liner will be overlain by a geocomposite leak detection layer consisting of a nonwoven geotextile thermally bonded to each side of an HDPE geonet. The leak detection layer will be overlain on the trench floor and sideslopes by the primary HDPE geomembrane. On the trench floor, this primary liner will be overlain by a gravel layer for leachate collection, which may include piping to aid in leachate removal. On the sideslopes, the primary liner will be overlain by a geocomposite drainage layer for leachate collection. A 0.9 m (3 ft) layer of clean fill will cover the liner on the trench floor and sideslopes to preclude damage by equipment during waste unloading and emplacement.

2.3.2.4 Leachate Management The trench floor will be divided into 36 leachate collection cells arranged in a 2 x 18 array. Project W-296 will construct and utilize only a portion of the trench as designed, consisting of 10 leachate collection cells (facility operation through 1999). The cells are arranged in a 2 x 5 array as shown in Figure 2-9. Each cell measures 152 m (500 ft) on each side, providing a collection area of 23,100 m² (250,000 ft²). Each cell will be equipped with two separate sumps for leachate collection, located on the cell edge nearest to the trench sideslope. One sump will be located above the primary liner; the second sump will be located between the two liners and will provide leak detection. The sump systems for each cell will be physically and hydraulically independent. Drainage will be provided by a one to two percent slope into the sump from the rest of the cell. Leachate will be removed by submersible pumps through riser pipes designed to follow the trench sideslope. These pumps will be automatically activated by the presence of liquid in the sumps. Leachate pumped from the trench will be stored in three 1,514,000 L (400,000 gal) storage tanks located above grade at the southwest corner of the trench. This tank capacity is sufficient to store rainfall from a 25-year storm that falls on one empty cell and two cells half filled with waste. The design allows for two tanks in use and one tank in reserve during normal operations. Two 76 L/min (20 gal/min) pumps will be used to transfer leachate from the storage tanks to the Wastewater Treatment Facility.

2.3.2.5 Daily Operational Cover The upper, horizontal waste surfaces located at the top of the trench and at the interim level on the working face will be covered each shift with a 0.6 m (2 ft) thick layer of clean soil. This daily operational cover will provide a clean surface for operation of equipment in additional waste placement.

2.3.2.6 Interim Cover An interim cover designed to limit leachate production and biointrusion will be constructed annually over filled portions of the trench. The interim cover components will be determined during final design.

2.3.2.7 Final Closure Closure of the facility will be accomplished through installation of a trench cap and cover as described in the ERDF conceptual design (DOE/RL 1994) which will meet the requirements of the *Resource Conservation and Recovery Act of 1976*, 42 USC 6901 et seq. The final closure barrier will be designed to prevent inadvertent intrusion or infiltration of precipitation into the facility. The conceptual design of the trench cap and cover proposes that the upper layers of the barrier be predominantly silt, intended to provide high water storage capacity and evapotranspiration to limit infiltration. Below the silt will be granular layers that function as a capillary break to further reduce infiltration. The underlying thick layer of crushed basalt fragments is intended to provide a barrier to intrusion from humans and large animals. The lower layer of the barrier will be constructed

of asphalt; this layer serves as a third barrier to moisture. The conceptual configuration of the trench cap and cover is shown in Figure 2-11. Construction of the final cover is not included in Project W-296 for any portion of the trench.

2.3.3 Contaminated Wastewater Management Systems

All contaminated wastewater will be collected and treated onsite for compliance with the *Functional Design Criteria, Environmental Restoration Storage and Disposal Facility, Project W-296* (WHC 1993), which states that no liquid effluent will leave the ERDF site. Wastewater from the Decontamination Building and collected leachate from the trench will be pumped to the Wastewater Treatment Facility, combined, treated, and released to eight evaporation tanks located adjacent to the Decontamination Building. Water may be recycled from these tanks for use in dust control applications, grout make-up, or decontamination. Stormwater runoff from non-radiologically controlled areas of the facility will be collected, metered, and discharged to an existing drainage channel (Figure 2-12). Stormwater runoff from radiologically controlled areas of the facility will be separately collected and routed to *Resource Conservation and Recovery Act of 1976*, 42 USC 6901 et seq., compliant tanks for retention. The contents of the tanks will be sampled and analyzed for radiological and chemical constituents. Uncontaminated stormwater will be released to the existing drainage channel. Contaminated stormwater will be treated by addition of lime or processed through the Wastewater Treatment Facility.

2.3.4 Heating, Ventilation, and Air Conditioning

The Operations Building will be equipped with two separate heating, ventilation, and air conditioning (HVAC) systems: a clean system for office and administrative areas, and a potentially contaminated system for radiologically controlled areas including the personnel decontamination room, a dedicated shop, and storage areas. The clean system will provide a dust free and comfortable working environment at a pressure maintained positive with respect to ambient air to preclude infiltration of contaminants. The radiologically controlled area system will maintain negative pressure with respect to ambient air to preclude escape of contaminants to the area serviced by the clean ventilation system or to the outside environment. This ventilation system will be provided with a backup power supply and will employ high-efficiency particulate air (HEPA) filtration systems on the ventilation exhaust.

The HVAC systems for the Decontamination Building and the Wastewater Treatment Facility will be similar in design to the system serving the radiologically controlled areas of the Operations Building. All portions of these facilities will be maintained at a negative pressure with respect to ambient air. Ventilation exhaust systems will be equipped with HEPA filtration systems and, where required, dehumidifiers. These systems will not be provided with backup power supplies.

Air intake systems for heavy equipment and vehicles used in trench operations will be equipped with HEPA and dust filtration to preclude introduction of contamination and nuisance dust into the breathing space of the equipment operators. These filtration systems may be installed on the equipment as procured, or may be added after receipt of the

equipment onsite. The design or procurement specifications for these systems will be developed during the detailed phase of design.

2.3.5 Security

Personnel and vehicular entry to the ERDF will be restricted by the use of perimeter fencing and controlled access gates. No unauthorized personnel will be permitted beyond the visitors center in the Operations Building. Because the facility is designed to handle chemical and hazardous radioactive wastes, security is paramount to public safety and worker protection.

2.4 PROCESS DESCRIPTIONS

The ERDF operations will consist of the following primary activities: receipt of low level radioactive and low level mixed waste in containers; placement of waste in the disposal trench; and decontamination of containers for reuse. It is estimated that up to 4,600,000 m³ (6,010,000 yd³) of waste will be emplaced in the trench in the first five years. The facility is designed to process 215 waste containers per shift and to operate a maximum of two shifts a day for five days a week throughout the year. Proposed facility operations are described in the following sections.

2.4.1 Loading and Unloading Sequences

Incoming waste containers will arrive at the ERDF from the generating sites via transportation tractor/trailers. The transportation tractor/trailers will enter the facility by turning south from 16th Avenue and then turning west onto the incoming container offloading siding and pad (Figure 2-13). Pneumatic wheeled container handlers will offload incoming waste containers from the transportation tractor/trailers onto dedicated facility tractor/trailers. The container offloading pad will be used for container transfer only, and not for staging or storage of waste containers. The empty transportation tractor/trailers will continue west to the Decontamination Building where another pneumatic wheeled container handler will onload an empty decontaminated container. The transportation tractor/trailer will continue west from the Decontamination Building making two right hand turns and exit the site to return to the generating facility or proceed to the backhaul siding for unloading of clean soil for delivery to the remediation site. Container transfer areas will be lighted to permit operations during nondaylight hours.

Dedicated facility tractor/trailers will transport the waste containers from the off-loading area to the northwest end of the open trench, where access to the interim working level and trench floor is provided. Waste bulk soils will be unloaded from reusable containers via two hydraulic tipper trailers located at the edge of the working face and at the interim working level. Solid wastes other than bulk soils will be unloaded at the trench floor using hydraulic tip beds on dedicated tractor/trailers. Wastes to be buried in containers will be off-loaded at the trench floor via a dedicated crane using conventional hoisting and rigging equipment. Support roads and trailer tippers will be lighted to permit operations during non-daylight hours.

Following unloading, the exterior and interior of each container will be visually inspected for residual waste before leaving the unloading point. Any residual waste volume greater than 0.3 percent [0.07 m^3 (0.10 yd^3)] of the rated container capacity [24.5 m^3 (32 yd^3)] will be removed at the unloading point. A second dump will first be attempted; if unacceptable amounts of residue are still present these will be dislodged using a portable high pressure wash.

Empty containers will be transported by dedicated facility tractor/trailers to the Decontamination Building. The tractor/trailers will exit the trench operations area via the same road used for entry access and proceed to the southwest corner of the Decontamination Building. There the containers will be offloaded by pneumatic wheeled container handlers and placed on the decontamination conveyor feed. The contaminated container transfer pad at the Decontamination Building will be sized to allow simultaneous offloading of contaminated containers from two dedicated tractor/trailers and to provide a staging area for 30 contaminated containers.

2.4.2 Decontamination Process

Empty containers will be loaded onto conveyors at the Decontamination Building for transport through the wash rooms for detergent-pressure wash, recycled water rinse, and clean water rinse of the container exterior; the drying rooms for cool air and hot air drying; and the radiation survey rooms for surveillance by fixed detectors and with hand-held instrumentation. A separate, single conveyor system will transport clean containers to the covered container storage area where they will be loaded onto offsite tractor/trailers for return to the generating site. Containers with residual contamination will be returned to the cycle conveyors for rewash. The conveyors will be designed to move containers at a speed of 4.6 m/min (15 ft/min). Containers will be transferred to and from the decontamination conveyors by means of pneumatic-wheeled container handlers. An overall process flow diagram is shown in Figure 2-13. Heavy equipment will be decontaminated on wash pads at the Decontamination Building and by use of mobile decontamination units in the trench.

2.4.3 Disposal Activities in the Trench

Disposal activities will be conducted using conventional earthmoving techniques and systems commonly employed in the construction and mining industries. Bulldozers with push blades suitable for movement of soil rubble will be used to level and spread the waste as it is unloaded into the trench. This equipment may be fitted with controls for both manual and remote controlled operations. The cabs will be enclosed and fitted with dust and HEPA filters for operator protection from airborne dust and thermal stress. The bulldozers are also used to pull vibratory compactors for compaction of bulk soils. Heavy equipment will be provided with lighting for non daylight operations.

Generation of fugitive dust will be mitigated by using water sprayers on the tipper trailers during dumping operations and by periodic operation of water trucks with spray hoses along the exposed waste face. These measures will maintain the bulk waste soils in a moist condition to minimize dust generation without adding an amount of liquid sufficient to constitute free liquid. Dust generation will also be minimized by application of physical

fixants to the exposed trench operations face at the end of each shift. As the trench is filled, a daily operational cover of clean fill approximately 0.7 m (2 ft) thick will be placed on top of the waste material to prevent vehicle dispersion of contamination.

2.5 EQUIPMENT

2.5.1 General ERDF Use

The following equipment will be required for general operational use at the ERDF:

- Five (5) administrative vehicles (cars and pickup trucks) will be provided for transportation of personnel within the site.
- One (1) personnel shuttle vehicle (van) will be provided for transportation of operations crews on regular shift schedules.
- Two (2) preventive maintenance trucks will be provided for transportation of fuel, filters, coolants, small parts, and service tools to service the heavy equipment, site vehicles, and portable lighting facilities.
- One (1) tire maintenance truck equipped with an air compressor, tools, lifting hoist, truck jack, and lights for nondaylight operations will be provided for service on all types of on-site, rubber-tired vehicles.
- One (1) electronics/instrument service vehicle equipped with spare parts and electricians' tools will be provided for service of onsite electronic systems.
- Two (2) mobile decontamination vehicles equipped with high-pressure, low-volume water spray mechanisms will be provided for use in decontaminating dedicated on-site equipment in the field to allow for servicing.
- One (1) clean vacuum truck will be provided for cleanup of spilled clean soils and other nonhazardous and nonradioactive materials.
- One (1) motor grader will be provided for maintaining gravel roads within the facility boundaries.
- One (1) water truck equipped with a light pressurized spray mechanism will be provided for maintaining gravel roads and granular interim cover material.

2.5.2 Transportation

The following equipment will be required for operational transportation at ERDF:

- Eighteen (18) truck tractors equipped with self-tipping flat-bed trailers will be provided for on-site transfer of waste containers between the offloading area, burial trench, and container decontamination area.

- Four (4) truck tractors equipped with end-dump trailers will be provided for dedicated on-site transfer of clean cover and grout material from the clean spoils pile and batch plant to the burial trench.
- Six (6) 4,550 kg (10,000 lb) lifting capacity wheeled container handlers will be provided for transfer of empty containers to and from truck tractor-trailers at the Decontamination Building.
- Four (4) 45,450 kg (100,000 lb) lifting capacity wheeled container handlers will be provided for transfer of full containers to truck tractor-trailers at the offloading area.

2.5.3 Waste Handling

The following equipment will be required for waste handling operations at ERDF:

- Four (4) hydraulic trailer tippers equipped with water spray mechanisms will be provided for unloading the contents of reusable containers from truck trailers into the disposal trench (three tippers will be continuously in use; one will be provided for a down-time replacement).
- One (1) 45,450 kg (100,000 lb) capacity crane will be provided for offloading of containerized waste from truck trailers on the trench floor.
- Eight (8) bulldozers will be provided for moving waste bulk soil in the trench.
- One (1) vibratory compactor with a rating of 18,000 kg (40,000 lb) will be provided for surface grading of waste soils in the disposal trench.
- One (1) contaminated vacuum truck will be provided for cleanup of contaminated soil and hazardous or radioactive material spills.
- One (1) spray truck will be provided for application of fixant or surfactant material over exposed waste materials at the end of each shift.

2.5.4 Miscellaneous Trench Management

The following equipment will be required for ancillary operations at ERDF:

- Two (2) grout transport vehicles will be provided for filling void spaces around irregularly shaped debris and containerized waste in the trench.
- One (1) vehicle will be provided to house the control unit for remotely controlled waste handling equipment.
- Two (2) vehicles will be provided for transportation of the working face supervisor and the grout crew supervisor within and around the trench.

- Portable lighting will be provided to allow nondaylight operations.
- One (1) bulldozer will be provided to move and spread clean interim cover material.
- One (1) vibratory compactor will be provided for surface grading of clean interim cover material.
- One (1) front end loader will be provided for loading of clean interim cover material.
- One (1) front end loader will be provided for loading contaminated materials.
- One (1) street sweeper will be provided for general housekeeping.
- Two (2) trucks will be provided for transport of bulk cement and grout aggregate.

2.6 CONFINEMENT SYSTEMS

2.6.1 Reusable Waste Transport Container

The waste container to be used for management of bulk soils in transport to the ERDF will be designed for reusable packaging and will provide the primary and only containment for bulk soils at ERDF. The container will be top loading; the removable lid will be attached by the waste generator after loading. For unloading, the container will be designed with a gasketed, full area, end-gate mechanism that will allow the contents to be completely emptied when tilted. Both the end-gate and the lid will incorporate design features that allow for remote operations. The container will be equipped with a mechanism designed to support the container for lifting by the wheeled container handlers and a tiedown system for attaching the container to the transport vehicles. The container (Figure 2-14) will be 2.4 m (8 ft) wide by 1.8 m (6 ft) high by 6.1 m (20 ft) long for a capacity of 24.5 m³ (32 yd³). A fully loaded container may weigh up to 45,500 kg (100,000 lb). The design life of the container shall be a minimum of 1,150 transport cycles. A cycle is defined as the operation of container filling, loading for transport, transport to the ERDF, unloading for transport into the trench, dumping, decontamination, and return to the remediation site. Details of the container design are contained in *Packaging Design Criteria, 100 B/C Retrieval Package*, (WHC 1993a).

Because the container will be used to transport radioactive materials, the safety of the container design, construction and operations will be evaluated and documented separately in a Safety Evaluation for Packaging to ensure compliance with WHC-CM-2-14, *Hazardous Material Packaging and Shipping* (WHC 1994). The container design and utilization must also comply with the requirements of WHC-CM-7-5, *Environmental Compliance Manual* (WHC 1994a).

2.6.2 Nonreusable Waste Container

Containers will be used for waste disposal at ERDF only when waste materials cannot be handled in a radiologically safe manner without some level of shielding. Single use

containers will be designed specifically for ERDF use. At present, these containers are planned to have a capacity of approximately 17 yd³, and to meet Department of Transportation requirements for "Type B" shipping containers as outlined in the *Hanford Site Solid Waste Acceptance Criteria* (Willis and Triner 1993).

2.7 UTILITY DISTRIBUTION SYSTEMS

Electricity will be provided from an existing 13.8 kVA line that runs north to south along the east border of the 200 West Area. Backup power for the Operations Building will be provided by a 500 kVA diesel fueled generator. Backup power will only be provided for ventilation, computer equipment, and alarm/communications systems.

Two types of water will be utilized at the ERDF. Sanitary (potable) water will be used for all sanitary uses such as drinking water, showers, toilets, and laundry. Raw water will be used for fire protection, landscape irrigation, decontamination make-up, and batch plant operations. Sanitary water will be supplied from the 200 West Area sanitary water system to the Operations Building, Decontamination Building, and the Wastewater Treatment Facility.

Sanitary wastewater from the Operations Building and Decontamination Building will be collected and treated in new septic tanks located near each facility in noncontaminated areas. The liquid from the septic tanks will be diverted to new drain field systems. Solids that accumulate in the septic tanks will be periodically removed for disposal.

Sanitary wastewater facilities will be required to comply with the requirements of the WAC, Chapters 173-221, 173-240, and 246-272 for the design of domestic wastewater facilities, including septic tank systems with design capacities of less than 14,500 gallons per day, and discharges from such systems.

2.8 AUXILIARY SYSTEMS AND SUPPORT FACILITIES

2.8.1 Grout Plant

A portable batch plant will be permanently located north of the trench to supply grout for filling voids left by the burial of irregularly shaped and containerized debris. Mitigation of void space is required to prevent long-term subsidence or differential settlement in the landfill which might threaten the integrity of the final cover. The plant will be sized to produce a maximum of 107 m³ (140 yd³) of grout per day, and to be capable of operating at a minimum capacity of 22.9 m³ (30 yd³) per day. The facility will require between 7600 L (2000 gal) and 38,000 L (10,000 gal) of make-up water per day, depending upon the production level. This water will be recycled from the Wastewater Treatment Facility effluent. Grout transport trucks will be provided to haul the batch plant product to the trench floor, where grouting operations will be conducted. The batch plant will be provided with a washdown for the grout trucks, and will be placed over a buried leak collection liner. Any leakage will be pumped and returned as grout makeup water or routed to the Wastewater Treatment Facility.

2.8.2 Fuel Storage and Dispensing Area

A fuel storage and dispensing area will be provided south of the Operations Building. This area will consist of a containment system with a 57,000 L (15,000 gal) diesel tank, a 1900 L (500 gal) gasoline tank, and two 950 L (250 gal) bulk lubricating oil tanks. The tanks will be located above ground and provided with off-site access for delivery of fuels and oils. The tanks will be equipped to dispense bulk fuels to the on-site fuel truck and to individual vehicles operating within the security fence. The capacity is sufficient for one week of two-shift operations. The tanks as currently sized are not compliant with NFPA 30A requirements.

2.8.3 Bulk Chemical Storage and Dispensing Area

The bulk chemical storage and dispensing area will be located near the fuel storage and dispensing area. This area will consist of a 425 m³ (15,000 ft³) silo for storage of bulk cement to be used in grout mixing, above ground tanks for storage of surfactant chemicals to be used in stabilization of bulk soils in the trench, and a pad for storage of decontamination chemicals in 208 L (55 gal) drums. Tanks containing hazardous materials will be constructed to provide double containment. The facility will have off-site access for delivery of chemical products, and will be equipped to dispense materials to vehicles within the security fence. The reserve capacity will be sufficient for one week of two-shift operations. Further assessment of applicable requirements will be needed when the chemicals to be used are identified.

2.8.4 Communications

The communication systems will be connected to existing fiber optic network in the 200 West Area and will include telephone, public address, computer networking [Hanford Local Area Network], and emergency systems.

2.8.5 Alarm Systems

A local fire alarm system will be installed within each building. This system will be comprised of a fire alarm control panel, standby battery power, and auxiliary relays which activate an alarm panel at the 200 Area Hanford Fire Department. Each fire suppression system will individually annunciate.

2.8.6 Automated Data Processing

The ERDF will be equipped with an electronic waste tracking system to record information on each container including contents, generating facility, and the location of waste placement within the burial trench. A process control module (PCM) at the container off loading area will be used to collect data associated with each incoming container. An automatic bar code reader, or a similar device, will be used to scan the container and record arrival time and container weight. An operator terminal will also be provided for manual entry of data such as the results of visual inspections for container integrity or radiologic

monitoring information. The PCM will transmit this information to the facility host computers where it will be compared to information recorded by the waste generator on the Hanford Solid Waste Information Tracking System.

The PCM at the offloading area will also receive information from each trailer tipper, via radio communication, to record the location of waste emplacement. This location will be automatically entered in the database using the global positioning system mounted on each trailer tipper. A similar radio communication device to record the location of emplacement for single use containers and other waste offloaded at the trench floor will be provided on the unloading crane. This information will be provided as update to the Solid Waste Information Tracking System.

In a similar manner, a PCM located on the northwest corner of the Decontamination Building will collect all data associated with the empty containers including the results of automatic and manual inspections and radiological surveys. The capability for automatic and/or manual scanning and data entry will be provided.

Figure 2-1. General Facility Location

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Figure 2-2. Principle Facility Plan

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Figure 2-3. Operations Building Plan - First Floor

Figure 2-4. Operations Building Plan - Second Floor

Figure 2-5. Decontamination Building Plan

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Figure 2-6. Decontamination Building Plan Closeup

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Figure 2-7. Wastewater Treatment Facility Tankage

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79405040.16a

Figure 2-8. Wastewater Treatment Process Flow Diagram

Wastewater Treatment System

Note: M = Motor

79405040.14

Figure 2-9. Trench Layout Plan

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Figure 2-10. Trench Layout Elevation

79405040.5

Figure 2-11. Liner Cross-Section

79405040.6

Figure 2-12. Site Stormwater System

79405040.22

Figure 2-13. Operating Sequence

79405040.3

Figure 2-14. Container Illustration

2.9 REFERENCES

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WHC, 1994, *Environmental Restoration Disposal Facility Waste Acceptance Criteria, Preliminary Draft*, WHC-SD-W296-WAC-001, Westinghouse Hanford Company, Richland, Washington.

Willis and Triner, 1993, *Hanford Site Solid Waste Acceptance Criteria*, WHC-EP-0063-4, Westinghouse Hanford Company, Richland, Washington.

2.9.2 DOE Orders

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DOE, 1993, *Natural Phenomena Hazards Mitigation*, DOE Order 5480.28, U.S. Department of Energy, Washington D.C.

DOE/RL, 1989, *Standard Arch-Civil Design Criteria, Design Loads for Facilities*, Hanford Plant Standard SDC-4.1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

2.9.3 Legal Documents.

40 CFR 268, "Land Disposal Restriction," *Code of Federal Regulations*, as amended.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended,

Resource Conservation and Recovery Act of 1976, 42 USC 6901 et seq

2.9.4 Controlled Manuals

WHC, 1994, *Hazardous Material Packaging and Shipping*, WHC-CM-2-14, Westinghouse Hanford Company, Richland, Washington.

WHC, 1994a, *Environmental Compliance Manual*, WHC-CM-7-5, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-W296-SAD-001, REV 0

**WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

CHAPTER 3.0

IDENTIFICATION OF HAZARDS

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3.0 IDENTIFICATION OF HAZARDS

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LIST OF TERMS

DOE	U.S. Department of Energy
DOE	U.S. Department of Energy - Richland Operations Office
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facilities
MDA	Minimum Detectable Activity
SNL	Sandia National Laboratories
TBD	To Be Determined
TLV-C	Threshold Limit Value-Ceiling
TLV-TWA	Threshold Limit Value-Time Weighted Average
U.S.	United States
WHC	Westinghouse Hanford Company
WSDOE	Washington State Department of Ecology

3.0 HAZARDS AND ACCIDENT ANALYSIS

3.1 INTRODUCTION

This chapter identifies the hazards and their potential consequences associated with Environmental Restoration Disposal Facility (ERDF) operations. These consequences are estimated to determine the level of risk associated with proposed operations. The operation of ERDF will involve the handling of hazardous materials and radioactive mixed waste using heavy equipment of the type normally associated with construction activities. The operations conducted at the ERDF in support of radioactive mixed waste disposal have the potential to present industrial safety, industrial hygiene, and radiological safety hazards to facility workers. Handling of flammable liquids poses the potential for fire. Other nearby onsite workers, the public, and the environment are expected to be subjected to only minor hazards from operations.

3.2 REQUIREMENTS

The Safety Assessment is the second step in the formal safety analysis documentation process as defined in WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992). This manual implements the requirements of U.S. Department of Energy (DOE) Order 4700.1, *Project Management System* (DOE 1987), DOE Order 5481.1B, *Safety Analysis and Review System* (DOE 1986), and DOE Order 5480.23, *Nuclear Safety Analysis Reports* (DOE 1992) to prepare documentation of the risks associated with facility operation. The Safety Assessment was preceded by the Preliminary Safety Evaluation which identifies design uncertainties related to the safe operation of the facility, and will be followed by the Final Safety Analysis Report which provides the safety basis for justifying operation.

Hazard categorization for the ERDF has been performed in accordance with DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, (DOE 1992a). Application of this standard results in designation of the ERDF as a Hazard Category 3 Nuclear Facility. This designation represents the potential for significant localized radiological consequences but not for significant onsite or offsite radiological consequences. Facilities designated Hazard Category 3 are required to comply with the requirements of DOE Order 5480.23 (DOE 1992) for preparation of safety analysis documentation. Because of the relatively low hazard associated with operations, only qualitative risk analysis is required for a Hazard Category 3 facility.

The primary function of the accident analysis is to determine the potential risk associated with operations. The WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992) Section 7.0, "Risk," defines the level of risk, expressed as a function of both probability and consequence, which may be considered acceptable while still providing reasonable assurance that operations can be conducted in a manner that ensures the health and safety of the public and employees, and provides adequate protection for the environment. The risk acceptance guidelines defined in WHC-CM-4-46, *Nonreactor Facility*

Safety Analysis Manual (WHC 1992), have been applied in this chapter to determine risk acceptability.

3.3 METHODOLOGY

The hazard identification process for ERDF was conducted in two parts: identification of energy sources, and identification of hazardous material inventory. The results of this process are documented in Tables 3-1 through 3-8.

Identification of energy sources was accomplished through a review of proposed facility operations. Standard industrial hazards were considered only where they can be considered accident initiators or significant contributors. Information was derived from the *Conceptual Design Report for the Environmental Restoration Disposal Facility* (DOE/RL 1994) and the *Preliminary Operations Plan and Waste Treatment Evaluation for the Hanford ERDF* (DOE/RL 1993).

Identification of hazardous material inventory was accomplished through a review of the *Source Inventory Development Engineering Study for the Environmental Restoration Disposal Facility* (DOE/RL 1994a). For each material determined to be present, the form, quantity, and major hazards were identified.

3.4 HAZARD IDENTIFICATION

3.4.1 Physical Characteristics of Waste Soils

Bulk soils contaminated with radioactive and chemically hazardous materials will account for approximately 70% of the waste volume anticipated for disposal at the ERDF. The average density of these bulk soils is 1.6 g/cm^3 [$1,600 \text{ kg/m}^3$ (110 lb/ft^3)] based on field measurements documented in the *Dust Mitigation Study for the Environmental Restoration Disposal Facility* (DOE/RL 1994b). The remaining 30% of the waste volume will consist of radioactive materials in nondispersible solid forms including irradiated metal objects from 100-B/C Area remediation and decontamination and decommissioning work. Less than 10% of the waste matrix will be composed of soft wastes (paper, wood, plastics) in soil, as documented in the *Source Inventory Development Engineering Study for the Environmental Restoration Disposal Facility* (DOE/RL 1994a). The majority of waste materials will be emplaced in the trench in bulk form. Containers will be used for disposal only when waste materials cannot be handled in a radiologically safe manner without some level of additional protection (e.g., shielding). Containerized waste is projected to comprise less than 15% of the total volume of waste for disposal.

The contaminated bulk soils are composed of surficial deposits of aeolian material ranging from 0 to 3 m (0 to 10 ft) in depth and the underlying soils of the Hanford Formation. Typical Hanford Formation soils consist primarily of nonuniform sandy gravels with localities of cobble to boulder sized particles and localities of fine sized particles. The cobbles and boulders tend to concentrate near the river and the finer sized particles tend to concentrate away from the river. The *Physical Treatment of Hanford Waste Sites Engineering Study* (WHC 1990) identifies the average amount of cobble-sized material in

Hanford Formation soils as varying from 18 to 32%. This study also establishes a standard soil description based on drilling logs from 12 locations in the 100 and 300 Areas in order to simplify the analysis of accident scenarios, which has been used consistently in permit documentation, safety documentation, and engineering studies for Project W-296 and in support of 100-B/C remediation activities. The standard soil is defined as being composed of approximately 50% pebbles and sand, 45% cobbles, and 5% boulders with the approximate particle size distribution given in Table 3-1.

Contaminated bulk soils will present a potentially significant exposure hazard because these wastes can be readily dispersed by disposal activities and wind. The radionuclides from liquid waste disposal in soil have been determined to attach to the smallest particles in the soil matrix, which are the particles most likely to be dispersed. These fine particles (less than 10 μm in diameter) are also of concern because they can be readily inhaled. Because the standard soil description (Table 3-1) does not provide a percentage composition for respirable or dispersible fines, the analysis conservatively assumes that the entire fraction of fines less than 63 μm is dispersible, and that the entire fraction less than 31 μm is respirable. The site soil is composed of approximately 12.2% fines (particles less than 70 μm in diameter), 68% of which are considered respirable (less than 30 μm in diameter).

Table 3-1. Soil Composition

Description	Size	Weight Percent
boulders	305 to 610 mm (12 to 24 in)	5.0
large cobbles	152 to 305 mm (6 to 12 in)	13.5
small cobbles	8.6 to 152 mm (0.33 to 6 in)	31.5
fine pebbles	2 to 8.4 mm (0.079 to 0.33 in)	5.7
very fine pebbles	1 to 2 mm (0.039 to 0.079 in)	3.7
very coarse sand	0.5 to 1 mm (0.02 to 0.039 in)	7.8
coarse sand	0.25 to 0.5 mm (9.8 E-3 to 2.0 E-2 in)	6.6
medium sand	0.125 to 0.25 mm (4.9 E-3 to 9.8 E-3 in)	9.0
fine sand	0.0625 to 0.125 mm (2.5 E-3 to 4.9 E-3 in)	5.0
very fine sand	0.0313 to 0.0625 mm (1.2 E-3 to 2.5 E-3 in)	3.9
silt	0.0038 to 0.0313 mm (1.5 E-4 to 1.2 E-3 in)	2.9
pan	less than 0.0038 mm (1.5 E-4 in)	5.4

3.4.2 Radiological and Hazardous Material Inventories

Liquid waste disposal sites proposed for remediation received acids including hydrofluoric, sulfuric, and nitric; acid solutions of metal salts; sodium compounds including sodium chromate, sodium oxalate, and sodium sulfamate; and organic solvents and volatile organic compounds. Solid waste disposal sites received contaminated trash (paper and plastic) and contaminated reactor hardware, including irradiated lead-cadmium pieces, boron splines, graphite, lead bricks and sheets, gunbarrels, fuel-element spacers, thimbles and step plugs, aluminum tritiated target cans, lead tritiated target melting pots, and control rods.

Bulk solid wastes will be containerized for disposal only when handling of the wastes without shielding is radiologically unsafe.

The radionuclide inventory of waste proposed for disposal at the ERDF is listed in Table 3-2. The inorganic and organic toxicological inventories are given in Tables 3-3 and 3-4. The estimated concentration information listed was taken from the *Source Inventory Development Engineering Study for the Environmental Restoration Disposal Facility* (DOE/RL 1994a). This information was developed through sampling and analysis of proposed remediation sites and through review of available process records. For some sites where neither analysis data nor process records were available, the study assumed similar composition to an analogous characterized site. The concentrations listed as "overall average" were calculated based on the total activity of each contaminant expected to result from all remediation activities and the total mass of excavated soil, rubble, and debris expected to result from all remediation activities. The concentrations listed as "maximum average" were calculated based on the average concentration of each contaminant at the individual remediation site which contained the highest concentration of that contaminant.

Tables 3-2, 3-3, and 3-4 also include the proposed waste acceptance limit for each contaminant taken from the *Environmental Restoration Disposal Facility (ERDF) Waste Acceptance Criteria*, Preliminary Draft (WHC 1994a). These concentration limits were developed based on performance criteria for the trench liner and the performance assessment requirements for infiltration of contaminants to groundwater after closure of the facility. Limits for radionuclides are intended to be applied using a "sum of fractions" method, in which the sum of the ratio of actual activity to activity limit for each radionuclide may not be greater than unity. These limits are based on the assumption that the ERDF disposal trench will provide a permanent repository for 21,000,000 m³ (27,437,000 yd³) of radioactive mixed waste during the 22-year facility lifetime. The total volume of waste to be received at the facility during the first five years of operation (Project W-296) is 4,600,000 m³ (6,010,000 yd³), according to the *Conceptual Design Report for the Environmental Restoration Disposal Facility* (DOE/RL 1994).

The consequence calculations performed for this document used the waste acceptance limits except that: 1) where the limit was listed as minimum detectable activity or "to be determined" a value of zero was substituted, which means that the estimates of consequences in the remainder of this Chapter include no contribution from that constituent; and 2) where the limit was listed as "unlimited" the maximum average soil concentration value was substituted. The resultant values are listed on the extreme right of Tables 3-2, 3-3, and 3-4. It should be noted that some waste acceptance limits are lower than estimated inventories.

Table 3-2. Radionuclide Inventory for the ERDF

Isotope	Maximum Average Soil Concentration (Ci/g)	Overall Average Soil Concentration (Ci/g)	Waste Acceptance Limits (Ci/g)	Consequence Calculation Values (Ci/g)
¹⁴ C	1.99E-10	1.34E-11	7.00E-12	7.00E-12
²² Na	5.40E-12	6.00E-14	<MDA	--
⁴⁰ K	1.60E-11	7.21E-12	2.30E-07	2.30E-07
⁶⁰ Co	1.58E-10	1.10E-11	2.00E-06	2.00E-06
⁹⁰ Sr	2.67E-10	1.58E-11	3.00E-07	3.00E-07
⁹⁹ Tc	5.00E-13	6.10E-14	8.60E-12	8.60E-12
¹³⁷ Cs	4.49E-10	3.23E-12	1.00E-05	1.00E-05
¹⁵² Eu	9.25E-10	7.43E-11	3.50E-08	3.50E-08
¹⁵⁴ Eu	2.08E-10	1.52E-11	5.50E-07	5.50E-07
¹⁵⁵ Eu	1.80E-11	1.09E-12	<MDA	--
²²⁶ Ra	9.40E-12	4.50E-13	2.40E-08	2.40E-08
²²⁸ Th	1.10E-12	4.80E-13	<MDA	--
²³² Th	1.74E-12	3.90E-13	8.00E-11	8.00E-11
²³³ U/ ²³⁴ U	3.60E-10	2.29E-11	<MDA	--
²³⁵ U	5.00E-12	9.50E-13	<MDA	--
²³⁸ U	4.51E-10	2.07E-11	2.50E-13	2.50E-13
²³⁸ Pu	2.90E-12	1.50E-13	5.00E-10	5.00E-10
²³⁹ Pu/ ²⁴⁰ Pu	6.22E-11	3.29E-12	3.00E-10	3.00E-10
²⁴¹ Am	1.56E-11	8.50E-13	3.00E-10	3.00E-10

MDA - Minimum Detectable Activity

Table 3-3. Organic Inventory for ERDF

Chemical	Maximum Average Soil Concentration ($\mu\text{g/kg}$)	Overall Average Soil Concentration ($\mu\text{g/kg}$)	Waste Acceptance Criteria ($\mu\text{g/kg}$)	Consequence Calculation Values ($\mu\text{g/kg}$)
Acetone	2800	2.25	28000	28000
Benzene	190	0.01	0	0
2-Butanone	5	0.07	33000	33000
Carbondisulfide	36	0.02	TBD	0
1,2-Dichloroethane (Ethylene	0	0	10000	10000
4-Methyl-2-Pentanone	5	0.05	278000	278000
Methylene Chloride	18	0.6	20800	20800
Tetrachloroethene	29	0.91	112800	112800
Toluene	30	2.90	185600	185600
Trichloroethene	36	1.23	57800	57800
Vinyl Chloride	120	1.01	30800	30800
Acenaphthene	81	0.15	2805000	2805000
Aroclor-1248	159	23.7	1000	1000
Aroclor-1254	678	91.7	1000	1000
Aroclor-1260	600	0.54	1000	1000
Anthracene	6300	2.24	14000000	14000000
Benzo(a)anthracene	900	3	unlimited	900
Benzo(a)pyrene (Coal tar pitch)	470	1.74	TBD	0
Benzo(b)fluoranthene	1200	3.85	unlimited	1200
Benzo(ghi)perylene	230	1.26	500000000	500000000
Benzo(k)fluoranthene	190	3.61	850000000	850000000
Benzoic Acid	850	1.8	unlimited	850
Bis (2-ethylhexyl) phthalate	16780	618	15000000	15000000
Butylbenzylphthalate	1300	233	206000	206000
Carbazole	170	0.12	500	500
Carbon Tetrachloride	3	0.05	0	0
4-Chloro-3-Methylphenol	170	0.11	TBD	0
2-Chlorophenol	170	0.11	601000	601000
Chloroform	1	0.02	700	700
4-Chloroaniline	3150	69.60	unlimited	3150
Chrysene	460	3.38	380000000	380000000
Di-n-octyl-phthalate	170	0.09	TBD	0
Di-n-butyl-phthalate	1472	257	unlimited	1472

TBD - To Be Determined

Table 3-3 (continued). Organic Inventory for ERDF

Chemical	Maximum Average Soil Concentration (µg/kg)	Overall Average Soil Concentration (µg/kg)	Waste Acceptance Criteria (µg/kg)	Consequence Calculation Values (µg/kg)
Dibenzofuran	60	0	TBD	0
1,3 Dichlorobenzene	170	0.10	400	400
1,4 Dichlorobenzene	170	0.11	101400	101400
Diethyl phthalate	170	0.66	325000	325000
Ethylbenzene	330	0.013	70000	70000
Fluoranthene	1450	5.12	16500000	16500000
Fluorene	1700	0.83	1251000	1251000
Indeno(1,2,3-cd)pyrene	240	1.20	20000000	20000000
2-Hexanone	0	0.0002	TBD	0
2-Methylnaphthalene	13000	0.49	unlimited	13000
4-Methylphenol	500	11.10	unlimited	500
Naphthalene	4100	0.16	1400000	1400000
2-Nitrophenol	170	4.08	unlimited	170
N-Nitrosodiphenylamine	37	0.68	unlimited	37
Pentachlorophenol	850	11.20	unlimited	850
Phenathrene	2500	0.81	24000000	24000000
Phenol	170	5.93	71600	71600
1,1,1-Trichloroethane	0	0.00002	unlimited	0
Pyrene	1350	12.10	12000000	12000000
Xylenes	1300	0.05	unlimited	1300
2,4-D	0	0	unlimited	0
4,4'-DDD	6	0.002	20500000	20500000
4,4'-DDE	41	0.90	12500000	12500000
Aldrin	4	0.002	unlimited	4
Beta-BHC-Lindane	4	0.002	1500000	1500000
Dieldrin	8	0.004	0.5	0.5
Endrin	8	0.005	unlimited	8
gamma-Chlordane	9	0.0003	0	0
Heptachlor	4	0.003	unlimited	4
Methoxychlor	none listed	none listed	10000	10000
Dibenzo(a,h)anthracene	none listed	none listed	TBD	0
1,1,2,2-Tetrachloroethane	none listed	none listed	unlimited	0

TBD - To Be Determined

Table 3-4. Inorganic Inventory for ERDF

Chemical	Maximum Average Soil Concentration (mg/kg)	Overall Average Soil Concentration (mg/kg)	Waste Acceptance Criteria (mg/kg)	Consequence Calculation Values (mg/kg)
Aluminum	20470.5	3708	unlimited	20470.5
Antimony	18.6	0.272	0.6	0.6
Arsenic	11.8	3.155	0.005	0.005
Barium	3095	92.22	unlimited	3095
Beryllium	0.900	0.052	0.4	0.4
Cadmium	25.5	0.329	0.5	0.5
Chromium	1765	37.7	10	10
Cobalt	12.2	5.074	41	41
Copper	2853.7	521.3	100	100
Iron	98316.7	7692	unlimited	98316.7
Lead	250	50	unlimited	250
Magnesium	3630	905	unlimited	3630
Manganese	462	219	5	5
Mercury	35.55	1.2	0.2	0.2
Nickel	83.1	21.6	10	10
Potassium	2965	112	unlimited	2965
Selenium	3.9	0.281	1	1
Silver	169.2	6.39	10	10
Sodium	274	19	unlimited	274
Thallium	4.5	0.001	0.078	0.078
Vanadium	119	17.9	7.8	7.8
Zinc	5120	89.5	500	500

Toxicological hazards are also presented by the hazardous materials to be used in operation of the facility, particularly those materials to be used in mobile equipment operations. These materials are listed in Table 3-5.

Table 3-5. Toxicological Inventory for Trench Operations

Hazardous Material	Mass Available for Release kg (lb)
Diesel Fuel (Storage Tank)	45,000 (100,000)
Diesel Fuel (Vehicle)*	400 (880)
Glycol Antifreeze*	100 (220)
Motor Oil*	40 (88)
Hydraulic Fluid*	40 (88)
Gasoline (Maintenance Truck Tankage)	1400 (3000)
Oil (Maintenance Truck Tankage)	680 (1500)

*Estimated based on single vehicle capacities.

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3.4.3 Hazardous Energy Sources

In order for hazardous or radioactive materials from the ERDF to pose a hazard to personnel or the environment, some energy source must provide a mechanism for dispersal of the material. An energy source is also necessary for occurrence of an industrial accident. This energy source may be kinetic, as for moving equipment; potential, as for elevated equipment; pressure-related, as for gas cylinders; or thermal, as for sources of ignition. Energy sources inherent to trench operations and their hazardous characteristics are listed in Table 3-6. These hazards should be further considered when equipment is selected and operations are detailed (e.g., vehicle safety, traffic flow analysis, heavy equipment/worker safety) to control industrial hazards.

Table 3-6. Energy Source Inventory for the Trench Operations

Source	Characteristics
Loaded Container (paved roads)	maximum 51,800 kg (120,000 lb) at 48 km/h (30 mi/h)
Loaded Container (unpaved roads)	maximum 51,800 kg (120,000 lb) at 24 km/h (15 mi/h)
Moving Equipment (paved roads)	36,400 kg (80,000 lb) at 48 km/h (30 mi/h)
Moving Equipment (unpaved roads)	36,400 kg (80,000 lb) at 24 km/h (15 mi/h)
Trench Depth	21 m (70 ft)
Crane Lifted Loads	45,400 kg (100,000 lb) from less than 3 m (less than 10 ft)
Welding Gas Cylinders	6230 l at 140 kg/cm ² (220 cf at 2000 psi)
Container Dumping	45,400 kg (100,000 lb) from less than 3 m (less than 10 ft)
Soil Leveling	841 m ³ /h (1100 yd ³ /h) moved 23 m (75 ft)
Soil Compaction	841 m ³ /hr (1100 yd ³) compacted to 30.5 cm (1 ft)
Diesel Fuel (Tank)	45,000 kg (100,000 lb) at 46 MJ/kg (2.0 x 10 ⁴ BTU/lb)
Gasoline (Tank)	1,400 kg (3,000 lb) at 47 MJ/kg (2.0 x 10 ⁴ BTU/lb)
Oil (Tank)	680 kg (1,500 lb) at 46 MJ/kg (2.0 x 10 ⁴ BTU/lb)

3.4.4 Natural Phenomena Hazards

Natural phenomena such as earthquakes, winds, precipitation, volcanic activity, and flooding represent potential energy sources for the dispersal of radioactive and hazardous materials. Parameters for maximum and average occurrences of these events have been well characterized for the Hanford Site and are given in Chapter 1 of this document. Natural phenomena energy sources that may affect trench operations are listed in Table 3-7. Seismic events and volcanic activity do not have significant ERDF operational consequences and were not included in the analysis.

Table 3-7. Natural Phenomena Inventory for the Trench Operations

Source	Characteristics
Straight Winds	112 km/h (70 mi/h) for 24 h
Precipitation (25-y storm)	5.08 cm (2 in) within 24 h

3.5 HAZARD CLASSIFICATION AND HAZARD CATEGORIZATION

The facility hazard class and hazard category are determined in order to qualitatively and quantitatively express the level of hazard associated with facility operations. This level of hazard is then used for determination of the level of detail appropriate for safety analysis, and the required level of review and approval for safety analysis documentation.

3.5.1 Facility Hazard Classification

The requirements for hazard classification are established in DOE Order 5481.1B, *Safety Analysis and Review System* (DOE 1986), and WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992), Chapter 4, "Hazard Classification." The purpose of hazard classification is to (1) establish the review and authorization level of the safety analysis, and (2) provide a basis for applying a graded approach to the level of analysis and documentation for facility safety analysis reports.

The hazard classification methodology established in WHC-CM-4-46 has been applied only to the nonradioactive hazardous materials aspects of ERDF operations, for the hazardous material inventory given in the *Hazard Classification, Environmental Restoration Storage and Disposal Facility* (Cain 1993). This application results in definition of the ERDF as a Low Hazard facility, indicating that facility hazards present minor onsite and negligible offsite impacts to people or the environment. The requirements of WHC-CM-4-46 have been waived by the WHC Nuclear Safety organization for radiological aspects of ERDF operations because of application of the hazard categorization methodology established in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (DOE 1992a) for these hazards. The radiological hazard classification waiver is contained in the *Preliminary Safety Evaluation for the Environmental Restoration Disposal Facility* (Cain 1994), Appendix A.

3.5.2 Hazard Category

The DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (DOE 1992a) provides guidance on designation of hazard categorization. The purpose of hazard categorization is to determine the applicability of DOE Order 5480.23, *Nuclear Safety Analysis Reports* (DOE 1992) for preparation of Safety Analysis Reports and related documentation. Determination of applicability is based on threshold levels of radionuclides taken from Table A.1 of this standard and the nature of the facility in question. Reactor facilities are automatically defined as Hazard Category 1, presenting the highest level of hazard. Nonreactor facilities may be defined as Hazard Category 2 or 3, or as less than Hazard Category 3, based on comparison of radionuclide inventory with the established thresholds. The Hazard Category definition is associated with a maximum quantitative (rather than qualitative) consequence level.

The initial hazard categorization was documented in the Preliminary Safety Evaluation (WHC 1993). The facility was determined to be Hazard Category 3. Because of the availability of new information on the source inventory since the initial categorization

calculation, a second calculation was performed to determine if the Category 3 designation remained valid. Determination of hazard category was conducted based on the maximum inventory available for dispersion in a single credible event. In accordance with the standard, this is defined as the "inventory at risk." This inventory consists of the exposed layer of the trench horizontal surface plus the working face, which is the waste available for wind suspension and transport. The maximum horizontal surface exposed at any one time prior to annual installation of the interim cover is one cell long and two cells wide [152 m (500 ft) by 433 m (1,420 ft) or 65,800 m² (710,000 ft²)]. Installation is credited as an engineered feature because wind resuspension is precluded when the interim asphaltic cover is in place. The working face is rhombic shaped, with a bottom width of 305 m (1,000 ft), a top width of 433 m (1,420 ft), and a length of 67 m (221 ft), which is the 3:1 slope over the 21 m (70 ft) trench depth. The exposed surface area of the working face is 24,700 m² (267,000 ft²). Only the upper 1 cm of this area is available for resuspension (Sehmel 1980). This represents a total volume of 905 m³ (32,100 ft³) which is equivalent to a mass of 1.45×10^6 kg (3.20×10^6 lb) based on a soil density of 1,600 kg/m³ [1.6 g/cm³ (111 lb/ft³)] as cited in Section 3.3.2.1 of this document.

For assessment as prescribed by the standard, the consequence calculation values from Table 3-2 were multiplied by the inventory at risk to determine the inventory at risk for each isotope. These values were used along with the DOE-STD-1027-93 Table A.1 threshold values to calculate the ratio of the inventory to the corresponding threshold values. The *Waste Acceptance Criteria* (WHC 1994), Section 4.1 requires application of a sum of fractions less than unity method for determining waste acceptance. Therefore, in determination of Hazard Category this calculation need not be repeated, and it will be verified only that each inventory to threshold ratio is less than one. Table 3-8 shows that this calculation verifies that the ERDF categorization as a nuclear facility of Hazard Category 3 remains valid.

Table 3-8. Comparison of Total Inventory with 1027-92 Threshold Values

Isotope	Total Dispersible Inventory (Ci)*	Threshold Values for Category 2 (Ci)	Ratio of Inventory to Threshold	Threshold Values for Category 3 (Ci)	Ratio of Inventory to Threshold
14C	1.02E-02	1,400,000	7.29E-09	420	2.42E-05
22Na	--	6,300	--	240	--
40K	3.34E+02	4,700	7.11E-02	170	1.97E+00
60Co	2.91E+03	190,000	1.53E-02	280	1.04E+01
90Sr	4.36E+02	22,000	1.98E-02	16	2.73E-01
99Tc	1.25E-02	3,800,000	3.29E-09	1700	7.35E-06
137Cs	1.45E+04	89,000	1.63E-01	60	2.42E+02
152Eu	5.09E+01	130,000	3.91E-04	200	2.54E-01
154Eu	7.99E+02	110,000	7.27E-03	200	4.00E+00
155Eu	--	730,000	--	940	--
226Ra	3.49E+01	55	6.34E-01	No Value Given	--
228Th	--	92	--	1	--
232Th	1.16E-01	18	6.46E-03	0.1	1.16E-00
233U/234U	--	220	--	4.2	--
235U	--	240	--	4.2	--
238U	3.63E-04	240	1.51E-06	4.2	8.65E-05
238Pu	7.27E-01	62	1.17E-02	0.62	1.17E-00
239Pu/240P	4.36E-01	56	7.79E-03	0.52	8.39E-01
241Am	4.36E-01	55	7.93E-03	0.52	8.39E-01

*Concentration values from Table 3-2 multiplied times the inventory at risk value.

3.6 REFERENCES

3.6.1 Documents

Cain, F.G., 1993, *Hazard Classification, Environmental Restoration Storage and Disposal Facility, Project W-296*, WHC-SD-W296-HC-001, Westinghouse Hanford Company, Richland, Washington.

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DOE/RL, 1994, *Conceptual Design Report for the Environmental Restoration Disposal Facility*, DOE/RL/12074--28, U.S. Department of Energy, Richland, Washington.

DOE/RL, 1994a, *Source Inventory Development Engineering Study for the Environmental Restoration Disposal Facility*, DOE/RL/12074--29, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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Schmel, 1993, Schmel, G.A., "Particle Resuspension: A Review," *Environmental International*, Vol 4, Pacific Northwest Laboratories, Richland, Washington.

WHC, 1994, *Environmental Restoration Disposal Facility (ERDF) Waste Acceptance Criteria*, WHC-SD-W296-WAC-001, Rev. 0, May 1994, Westinghouse Hanford Company, Richland, Washington.

3.6.2 U.S. Department of Energy Orders

DOE, 1986, *Safety Analysis and Review System*, DOE Order 5481.1B, U.S. Department of Energy, Washington, D.C.

DOE, 1987, *Project Management System*, DOE Order 4700.1, U.S. Department of Energy, Washington, D.C.

DOE, 1992, *Nuclear Safety Analysis Reports*, DOE Order 5480.23, U.S. Department of Energy, Washington, D.C.

DOE, 1992a, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE-STD-1027-92, U.S. Department of Energy, Washington, D.C.

DOE, 1994, *Radiological Control Manual*, DOE/EH-056T, Rev. 1, U.S. Department of Energy, Washington, D.C.

3.6.3 Legal Documents

OSHA, 1994, *Title 29 Code of Federal Regulations*, Part 1910.1000 (29 CFR 1910.1000), *Occupational Safety and Health Standards - Permissible Exposure Limits*, U.S. Department of Labor, Washington, D.C.

3.6.4 Controlled Manuals

WHC, 1992, *Nonreactor Facility Safety Analysis Manual*, WHC-CM-4-46, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-W296-SAD-001, REV 0

**WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

CHAPTER 4.0

HAZARD EVALUATION

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LIST OF TERMS

ALARA	As Low As Reasonably Achievable
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy - Richland Operations Office
ERDF	Environmental Restoration Disposal Facilities
SNL	Sandia National Laboratories
U.S.	United States

4.0 HAZARD EVALUATION

4.1 INTRODUCTION

The potential effects of each hazard associated with facility operations on the facility, facility workers, nearby workers, the public, and the environment must be estimated in order to determine the level of risk associated with operations. The operation of the Environmental Restoration Disposal Facility (ERDF) will involve the handling of hazardous materials and low-level radioactive mixed waste using heavy equipment of the type normally associated with construction activities. The operations conducted at the ERDF in support of radioactive mixed waste disposal have the potential to present industrial safety, fire, industrial hygiene, and radiological safety hazards to facility workers. Other nearby onsite workers, the public, and the environment are expected to be subjected to only minor hazards from operations.

4.2 METHODOLOGY

Evaluation of hazards was performed using the results of the hazard identification steps described in the previous section and the guidance developed by Sandia National Laboratories (SNL) outlined in *Methodology for Evaluating Safety Related Features for a Category 3 Nonreactor Nuclear Facility* (SNL 1993). The results were documented using a standard Preliminary Hazards Analysis format in the Hazard Evaluation Table (Table 3-10).

This SNL methodology applies a graded approach to performance of facility hazard categorization and evaluation while implementing the requirements of the DOE-STD-1027-92 for a Hazard Category 3 facility safety analysis. The method is based on the following premises:

- The release mechanisms need only focus on unique scenarios which could adversely effect the health and safety of workers in the facility;
- The accident sequence selection can be completed by a checklist to ensure a comprehensive list of potential accident conditions are qualitatively considered;
- Only a limited engineering analysis need be performed to determine the effectiveness of preventative and mitigative features; and
- A qualitative consequence analysis and probability for each identified accident sequence determines the overall risk level for that accident.

The qualitative evaluation criteria developed by SNL are used to determine the level of corrective action control required for appropriate mitigation or prevention. These factors are given for each hazard in the Hazard Evaluation (Table 4-1).

4.3 HAZARD EVALUATION

Results of the hazard evaluation are presented in Table 4-2. This table organizes information in four major sections: Hazard Identification, Event Characterization, Hazard Control, and Qualitative Hazard Screening. The Hazard Identification section of the table provides a description of the general hazard type. An alphanumeric system (A-#) is used for identification of hazard type, where the alphabetic character defines whether the hazard of concern is: radiation (R); chemical (C); motion (M); gravity (G); or fire (F). The Event Characterization section of the table defines initiating conditions, identifies potential causes, and provides a qualitative assessment of consequences. The Hazard Control section identifies preventive and mitigative features (both engineered and administrative) and detection capabilities. The Qualitative Hazard Screening provides an assessment of relative risk and indicates whether additional accident analysis has been performed in Chapter 5 of this document. The final column of the hazard table identifies the hazard control features required based on a qualitative and preliminary assessment of probability and consequence for the identified hazards.

The qualitative evaluation criteria developed by SNL and listed in the guidance document are shown in Table 4-1. The consequence and probability criteria are used to determine the level of corrective action control required for appropriate mitigation or prevention. These factors are given for each hazard in the Hazard Evaluation (Table 4-2).

Table 4-1. Qualitative Evaluation Criteria

Consequences	
High (1)	Involving a hazard to the public, environment, or site workers or a potential lethal consequence to the facility workers
Medium (2)	Having the potential to result in an injury (usually non-lethal) to a facility worker or in high radiation dose above approved limits
Low (3)	Potential for property damage or violation of the as low as reasonably achievable (ALARA) principal for exposure

Probability	
High (1)	Anticipated event during plant operation (1 to 1×10^{-2} /year)
Medium (2)	Unlikely event during plant operation (1×10^{-3} to 1×10^{-4} /year)
Low (3)	Extremely unlikely event (1×10^{-4} to 1×10^{-6} /year)
Incredible (4)	Occurrence is incredible ($< 1 \times 10^{-6}$ /year)

Corrective Action Categories	
1	Elimination of the hazard through engineering techniques
2	Redundant passive barriers
3	Passive barriers (continuously present, requiring no external stimulus)
4	Active feature (automatically or manually initiated, fail safe, non-fail-safe)
5	Administrative control (two-person rule)
6	Administrative control (single-person compliance)

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Table 4-2. Hazard Evaluation Tables

Hazard Identification		Event Characterization			Hazard Control		Qualitative Hazard Screening		
III ^a	Hazard description	Initiating Event	Event Cause	Event Consequence ^b	Preventive features	Detection/Mitigation features	Relative risk discussion ^c	AA ^d	Remarks Consequence/ Probability
R1 C1	Contaminated soil fugitive dust	Container breach	Human error during transport activities; equipment failure; loss of operator control	Contamination of the immediate environment; exposure of operators to radiologically and chemically contaminated fugitive dust; damage to and contamination of equipment	Access control of operating area; vehicles equipped with dust filters on cab air intakes; standard operating procedures in place; regular maintenance of equipment.	Audible and visual monitoring of container handling operations; personal dosimeter provides accurate data on actual exposures. Personnel trained in incident response; prompt HAZMAT response.	This is an unlikely event. Due to contamination levels, safe operating procedures, and personnel training, any consequence exceeding allowable limits is incredible.	Yes	Low/Medium One administrative control, single person compliance (Cat 6): operator training
R2 C2	Contaminated soil fugitive dust	Contaminated soil in uncovered and unstabilized condition.	Waste soil handling operations; vehicle movement on contaminated soils, wind dispersion.	Contamination of the immediate environment; exposure of operators to contaminated fugitive dust; contamination of and damage to equipment.	Access control of operating area; application of ALARA techniques for exposure minimization; vehicles equipped with dust filters on cab air intakes; use of physical fixants to immobilize the exposed soil surface at the end of each shift; application of clean fill over waste soils in areas where truck trailers will be operated; personnel trained in radiation safety principles, standard operating procedures in place.	Audible and visual monitoring of container operations or dumping actions. Personal dosimeter provides accurate data on actual exposures. Operations in the trench will cease a windspeeds of over 24 km/h (15 mph).	This is an anticipated condition. Due to contamination levels, standard operating procedures, and personnel training, any consequence exceeding allowable limits is not expected.	Yes	For chronic exposure evaluation a calculation will be performed to provide insight into the magnitude of consequences. Low/High One administrative control, single person compliance (Cat 6): operator training
R3 C3	Contaminated waste fugitive dust	Receipt and placement of waste.	Improper waste characterization, delivery to wrong site, oversight by operator upon receipt	Contamination of the immediate environment; exposure of operators to contaminated fugitive dust; contamination of equipment.	Inventory control using manifests with ERDF identified as receptor, verification of waste compliance with facility WAC, verification of container dose rate.	No provisions for detection identified. Personal dosimeter and area air sampler filters provides accurate data on actual exposures. Personal bioassay after the exposure.	This is an unlikely event requiring failure of the truck driver to go to the correct destination, containers that are used for LLW only being used, and ERDF operators not verifying the manifest when admitting the load. Due to contamination control measures, safe operating procedures, and personnel training, and field ALARA practices doses are expected to be minimal	No	Medium/Medium One administrative control, two-person rule (Cat 5): WAC verification for acceptance of load

^a Hazard identifier.

^b The consequence, as given here, assumes none of the active preventive/mitigative features are in place.

^c The relative risk, as given here, assumes that the preventive/mitigative features are operative.

^d If "yes," additional accident analysis performed in Section 3.4..

Table 4-2 (continued). Hazard Evaluation Tables

Hazard Identification		Event Characterization			Hazard Control		Qualitative Hazard Screening		Remarks Consequence/ Probability
HJ ^a	Hazard description	Initiating Event	Event Cause	Event Consequence ^b	Preventive features	Detection/Mitigation features	Relative risk discussion ^c	AA ^d	
M1	Moving heavy equipment (trucks, earthmovers, bulldozers)	Operation of heavy equipment	Human error or equipment failure	Damage to equipment, personnel injury or fatality	Operator training and certification, use of operating procedures, use of standard traffic regulations, vehicles equipped with audible backing alarms, vehicle maintenance; area access control, maintenance of equipment.	Visual observation, operator vigilance of area. Prompt medical attention from onsite responders.	With trained personnel operating this equipment and access control of the area, the consequences of this type of event will be minimized and limited to only two individuals at most. Occurrence of this event is estimated to be unlikely (may occur during the lifetime of facility operations), but the consequence is estimated to be medium (injury of individual). Therefore, the risk of operation is considered acceptable.	No	Medium/Medium Two administrative controls; single person compliance (Cat 6): area access control; operator training.
M2	Lifting equipment	Operation of lifting equipment	Human error, operator loss of control, equipment failure or fixture failure	Damage to equipment, personnel injury or fatality	Operator training and certification, use of safe operating procedures, area access control; maintenance of equipment.	Visual observation, operator vigilance of area. Prompt medical attention from onsite responders.	With trained personnel operating this equipment and access control of the area, the consequences of this type of event will be minimized and limited to only one individual at most. Occurrence of this event is estimated to be unlikely (may occur during the lifetime of facility operations), but the consequence is estimated to be low (injury of individual). Therefore, the risk of operation is considered acceptable.	No	Medium/Medium Two administrative controls; single person compliance (Cat 6): area access control; operator training.

^a Hazard identifier.^b The consequence, as given here, assumes none of the active preventive/mitigative features are in place.^c The relative risk, as given here, assumes that the preventive/mitigative features are operative.^d If "yes," additional accident analysis performed in Section 3.4..

Table 4-2 (continued). Hazard Evaluation Tables

Hazard Identification		Event Characterization			Hazard Control		Qualitative Hazard Screening		Remarks Consequence/ Probability
HA ^a	Hazard description	Initiating Event	Event Cause	Event Consequence ^b	Preventive features	Detection/Mitigation features	Relative risk discussion ^c	AA ^d	
M3	Conveyor movement of containers	Automatic movement of heavy containers	Human error or equipment failure	Equipment damage should the container impact a portion of the structure, personnel injury should the individual become entangled in the conveyor or be pinched or crushed between the container and the conveyor or building structure.	Load moving slowly [5 m/min. (15 ft/min.)], operator training and certification, use of operating procedures, design with no personnel intervention necessary, area access control, maintenance of equipment.	Visual observation. Shutdown of equipment, prompt medical attention.	With trained personnel operating this equipment and access control of the area, the consequences of this type of event will be minimized and limited to only one individual at most. Occurrence of this event is estimated to be unlikely (may occur during the lifetime of facility operations), but the consequence is estimated to be low (injury of individual). Therefore, the risk of operation is considered acceptable.	No	Low/Medium One administrative control; single person compliance (Cat 6): area access control; operator training.
G1	Elevated load drop	Movement of loads with cranes or wheeled container handlers (forklifts)	Human error, equipment failure, seismic event occurrence	Load swinging or dropping causing equipment damage, potential injuries or fatalities	Operator training and certification, use of operating procedures, limited lift heights, area access control, equipment maintenance.	Visual observation, operator vigilance of area. Prompt medical attention from onsite responders.	With trained personnel operating this equipment, use of safe hoisting and rigging procedures, and access control of the area, the consequences of this type of event will be minimized and limited to only one individual at most. Occurrence of this event is estimated to be unlikely (may occur during the lifetime of facility operations), but the consequence is estimated to be low (injury of individual). Therefore, the risk of operation is considered acceptable.	No	Low/Medium One administrative control; single person compliance (Cat 6): area access control; operator training.
G2	Fall from elevated location	Proximity of personnel or equipment to edge of trench	Human error, operator loss of control, equipment failure, seismic event occurrence	Maximum fall of 21 m (70 ft) down the trench embankment, 3:1 slope should limit consequence to injuries only.	Operator training and certification, use of operating procedures, embankment maintained at 3:1 slope, road at 8% grade, area access control, equipment maintenance.	Visual observation, operator vigilance of area. Prompt medical attention from onsite responders.	With trained personnel and access control of the area, the consequences of this type of event will be minimized and limited to only one individual at most. Occurrence of this event is estimated to be unlikely (may occur during the lifetime of facility operations), but the consequence is estimated to be low (injury of individual). Therefore, the risk of operation is considered acceptable.	No	Low/Medium One administrative control; single person compliance (Cat 6): area access control; operator training.

^a Hazard identifier.^b The consequence, as given here, assumes none of the active preventive/mitigative features are in place.^c The relative risk, as given here, assumes that the preventive/mitigative features are operative.^d If "yes," additional accident analysis performed in Section 3.4..

Table 4-2 (continued). Hazard Evaluation Tables

Hazard Identification		Event Characterization			Hazard Control		Qualitative Hazard Screening		Remarks Consequence/ Probability
HA ^a	Hazard description	Initiating Event	Event Cause	Event Consequence ^b	Preventive features	Detection/Mitigation features	Relative risk discussion ^c	AA ^d	
C4	Fuel spill (diesel – 57,000 l (15,000 gal.); gasoline – 1900 l (500 gal.); bulk lubricating oil 2-950 l (2-250 gal.))	Operation of petroleum fueled equipment	Equipment failure, human error during vehicle movement or during refueling, vehicle/tank collision	Soil contamination inside or outside of trench	Curbed containment area located away from contaminated waste soil in trench, operator training and certification, use of standard traffic regulations, vehicle maintenance, use of safe operating procedures.	Visual observation, operator vigilance of area. Spill cleanup by HAZMAT emergency response team, prompt medical attention.	With trained personnel and access control of the area, the consequences of this type of event will be minimized. Occurrence of this event is estimated to be unlikely (may occur during the lifetime of facility operations), but the consequence is estimated to be low (low toxicity of diesel or gasoline, and limited injury of individual). Therefore, the risk of operation is considered acceptable.	No	Low/Medium One administrative control; single person compliance (Cat 6): operator training.
F1	Petroleum fire	Fuel spill concurrent with ignition source	Equipment failure, human error during vehicle movement or during refueling, vehicle/tank collision, (fuel truck crash being worst case).	Soil contamination, limited liner damage, airborne combustion products, some waste soil transport possible if crash is on working face and involves fuel trucks, fire-related, equipment damage, personnel injury	Operator training and certification, use of standard traffic regulations, vehicle maintenance, road maintenance.	Visual observation, operator vigilance of area. Prompt summons of the fire department, prompt medical attention.	With trained personnel and access control of the area, the consequences of this type of event will be minimized. Review of the Fire Hazards Analysis (WHC 1994) provided assurance that the potential fire events related to ERDF are bounded by this qualitative evaluation. Occurrence of this event is estimated to be unlikely (may occur during the lifetime of facility operations), but the consequence is estimated to be low (low toxicity of diesel or gasoline, and limited injury of individual). Therefore, the risk of operation is considered acceptable.	No	Low/Medium One administrative control; single person compliance (Cat 6): operator training.
C5	Glycol spill	Operation of glycol cooled vehicles and equipment	Equipment failure, human error during maintenance, equipment collision	Soil contamination outside of trench	Operator training and certification, use of standard traffic regulations, vehicle maintenance.	Visual observation, operator vigilance of area. Spill cleanup by HAZMAT emergency response team, Prompt medical attention.	Occurrence of this event is estimated to be unlikely (may occur during the lifetime of facility operations), but the consequence is estimated to be low (low toxicity of glycol, and limited injury of individual). Therefore, the risk of operation is considered acceptable.	No	Low/Medium One administrative control; single person compliance (Cat 6): operator training.

^a Hazard identifier.^b The consequence, as given here, assumes none of the active preventive/mitigative features are in place.^c The relative risk, as given here, assumes that the preventive/mitigative features are operative.^d If "yes," additional accident analysis performed in Section 3.4.

Table 4-2 (continued). Hazard Evaluation Tables

Hazard Identification		Event Characterization			Hazard Control		Qualitative Hazard Screening		Remarks Consequence/ Probability
HI ^a	Hazard description	Initiating Event	Event Cause	Event Consequence ^b	Preventive features	Detection/Mitigation features	Relative risk discussion ^c	AA ^d	
F2	Cutting/welding equipment	Maintenance operations	Ignition of combustibles, human error during maintenance	Fire, equipment damage, personnel injury	Limited combustibles at the site, trained and certified welders performing work, limited operations allowed in vicinity, welding permits review work area for potential hazards.	Visual observation, operator vigilance of area. Prompt summons of the fire department, prompt medical attention.	With trained and certified crafts personnel and access control of the area, the consequences of this type of event will be minimized. Occurrence of this event is estimated to be unlikely (may occur during the lifetime of facility operations), but the consequence is estimated to be low (routine publicly accepted risk and limited injury of individual). Therefore, the risk of operation is considered acceptable.	No	Low/Medium One administrative control; single person compliance (Cat 6): operator training.
P1	Compressed gas cylinders	Cylinder or valve failure	Cylinder drop, cylinder failure, vehicle impact, human error	Release of toxic or flammable gas, high speed projectile	Hydrostatic testing and certification of cylinders, handling fixtures, safe handling procedures, operator training, limited use.	Visual or audible observation. Prompt medical attention.	With trained and certified crafts personnel and access control of the area, the consequences of this type of event will be minimized. Occurrence of this event is estimated to be extremely unlikely (probably will not occur during the lifetime of facility operations), but the consequence is estimated to be medium (equipment or structure damage and injury/fatality of individual). Therefore, the risk of operation is considered acceptable.	No	Medium/Low Two administrative controls; single person compliance (Cat 6): area access control; operator training
G3	Heavy equipment maintenance	Maintenance operations	Heavy component falls on operator	Personnel injury or fatality	Trained and certified mechanics performing work, limited operations allowed in vicinity.	Visual observation. Prompt summons of the fire department and emergency response team, lifting equipment available at the site, prompt medical attention.	With trained and certified mechanics and access control of the area, the consequences of this type of event will be minimized. Occurrence of this event is estimated to be unlikely (may occur during the lifetime of facility operations), but the consequence is estimated to be low (routine publicly accepted risk and limited injury of individual). Therefore, the risk of operation is considered acceptable.	No	Medium/Medium One administrative control; single person compliance (Cat 6): operator training.

^a Hazard identifier.^b The consequence, as given here, assumes none of the active preventive/mitigative features are in place.^c The relative risk, as given here, assumes that the preventive/mitigative features are operative.^d If "yes," additional accident analysis performed in Section 3.4.

Table 4-2 (continued). Hazard Evaluation Tables

Hazard Identification		Event Characterization			Hazard Control		Qualitative Hazard Screening		Remarks Consequence/ Probability
HI ^a	Hazard description	Initiating Event	Event Cause	Event Consequence ^b	Preventive features	Detection/Mitigation features	Relative risk discussion ^c	AA ^d	
E1	Electricity	Maintenance operations	Equipment failure, human error during maintenance	Personnel injury or fatality, minor equipment damage	Trained and certified electricians, access control of equipment rooms, lock and tag program.	Visual observation. Prompt summons of the fire department and emergency response team, lifting equipment available at the site, prompt medical attention.	With trained and certified electricians and access control of the area, the consequences of this type of event will be minimized. Occurrence of this event is estimated to be unlikely (may occur during the lifetime of facility operations), but the consequence is estimated to be Medium (risk of injury or fatality to an individual). Therefore, the risk of operation is considered acceptable.	No	Medium/Medium One administrative control; single person compliance (Cat 6); operator training.
I-3	Range Fire	Ignition of vegetation during dry weather conditions	Human caused, bottle glass in sunlight, lightning	Personnel injury from smoke inhalation, minor equipment damage	Removal of vegetation from around the trench and buildings.	Visual observation. Prompt summons of the fire department, evacuation of the area, fire suppression hydrants on site.	With normal housekeeping of the site, the consequences of this event are reduced to low. Occurrence of this event is estimated to be Medium. Therefore, the risk of operation is considered acceptable.	No	Medium/Low No controls required
R4 C6	Accumulation of leachate	Precipitation	Leachate pump or piping failure, human error, loss of power	No personnel effect, damage to or failure of the liner, potential for release to the environment.	Redundant piping and pump for each leachate cell, automatic operation of pump, equipment maintenance, runoff control system and temporary protective cover (prior to completion of facility cap and cover) to prevent precipitation flow into the active portion of the trench.	Visual collection of water in open part of trench, indication on leachate detection system in other parts of trench. Manual operation of pump, use of portable pump.	Accumulation of leachate for short periods of time in the trench liner may degrade long-term performance, but is unlikely to cause catastrophic failure of the liner. The consequence of this event is low. The estimated probability of occurrence is high. Therefore, the risk is considered acceptable.	No	High/Low One administrative control required; single person compliance (Cat 6); operator monitoring of observation wells

^a Hazard identifier.^b The consequence, as given here, assumes none of the active preventive/mitigative features are in place.^c The relative risk, as given here, assumes that the preventive/mitigative features are operative.^d If "yes," additional accident analysis performed in Section 3.4.

Table 4-2 (continued). Hazard Evaluation Tables

Hazard Identification		Event Characterization			Hazard Control		Qualitative Hazard Screening		Remarks Consequence/ Probability
HI ^a	Hazard description	Initiating Event	Event Cause	Event Consequence ^b	Preventive features	Detection/Mitigation features	Relative risk discussion ^c	AA ^d	
R5 C7	Migration of contaminants from trench or facility liners	Breach in leachate liner	Liner damage, improper installation of liner	Release of contaminants to environment	Double liner in trench, liner designed to meet shear and friction requirement, training of installation personnel, testing of liner sections upon installation, prompt repair of liner damage occurring during installation or trench operations, high density polyethylene piping, design such that piping leaks below ground will drain back to sump, storage tank provided with secondary containment.	Monitoring of secondary liner for leachate, groundwater monitoring, visual inspection of liner in open areas of the facility. None identified.	Leachate leakage into the soil will cause localized contamination, however, migration of contamination to groundwater is considered very unlikely due to limited volume of leachate involved. No consequence to personnel is credible. Therefore, the consequence of this event is considered low. The estimated probability of occurrence is Medium. Therefore, the risk is considered acceptable.	No	Medium/Low No controls required.
R6	Contaminated leachate leakage outside trench	Contaminated leachate leakage from a line breach or a connection leak.	Human error, operating heavy equipment over underground lines, piping damage, leachate collection tank failure, piping or tank corrosion.	Contamination of the local area; contamination of and damage to equipment.	Double piping with monitored annulus, low pressure transport head (gravity in some applications), access control of operating area; personnel trained in standard operating practices, operating procedures in place.	Audible and visual monitoring of operations, audible alarm on annulus monitor for leakage detection. Repair of inner line initiated when leakage detected.	This is an unlikely condition. Due to standard operating procedures and personnel training, any consequence exceeding allowable limits is not expected.	No	Low/Medium One administrative control, single person compliance (Cat 6); operator training.

^a Hazard identifier.

^b The consequence, as given here, assumes none of the active preventive/mitigative features are in place.

^c The relative risk, as given here, assumes that the preventive/mitigative features are operative.

^d If "yes," additional accident analysis performed in Section 3.4.

AIM

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Centimeter

Inches

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4.4 REFERENCES

4.4.1 Documents

SNL, 1993, *Methodology for Evaluating Safety Related Features for a Category 3 Nonreactor Nuclear Facility*, Sandia National Laboratory, Albuquerque, New Mexico.

WHC, 1994, *Preliminary Fire Hazards Analysis for the Environmental Restoration Disposal Facility (ERDF) Project W-296*, WHC-SD-W296-FHA-001, Rev. 0, Dated 6/15/94, Westinghouse Hanford Company, Richland, Washington.

4.4.2 U.S. Department of Energy Orders

DOE, 1992a, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, DOE-STD-1027-92, U.S. Department of Energy, Washington, D.C.

4.4.3 Legal Documents

None.

4.4.4 Controlled Manuals

None.

WHC-SD-W296-SAD-001, REV 0

**WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

CHAPTER 5.0

CONSEQUENCE EVALUATION

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LIST OF TERMS

ACGIH	American Conference of Governmental Industrial Hygienists
ALARA	As Low As Reasonably Achievable
CDE	Committed Dose Equivalent
CEDE	Committed Effective Dose Equivalent
CFR	<i>Code of Federal Regulations</i>
DAC	Derived Air Concentration
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy - Richland Operations Office
EDE	Effective Dose Equivalent
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facilities
ERPG	Emergency Response Planning Guideline
GENII	Generation II of the Hanford Environmental Dose Assessment Model
GXQ	GXQ Version 3.1
HEPA	High Efficiency Particulate Air
NRC	U.S. Nuclear Regulatory Commission
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit(s)
PSAR	Preliminary Safety Analysis Report
SNL	Sandia National Laboratories
TBD	To Be Determined
TLV-C	Threshold Limit Value-Ceiling
TLV-TWA	Threshold Limit Value-Time Weighted Average
U.S.	United States
WAC	Waste Acceptance Criteria
WHC	Westinghouse Hanford Company

5.0 HAZARDS AND ACCIDENT ANALYSIS

5.1 INTRODUCTION

The operation of Environmental Restoration Disposal Facility (ERDF) will involve the handling of hazardous materials and low-level radioactive mixed waste using heavy equipment of the type normally associated with construction activities. These operations have the potential to present industrial safety, industrial hygiene, and radiological safety hazards to facility workers. Other nearby onsite workers, the public, and the environment are expected to be subjected to only minor hazards from operations. The potential does exist for industrial accidents with medium or high consequences; these types of incidents are commonly accepted as routine risks in the public sector, and can be prevented only through combinations of administrative controls such as safe operating procedures, regular equipment maintenance, pre-job planning, and personnel training. This chapter contains the consequence analysis for the hazards identified and evaluated in the previous two chapters. Because industrial safety accidents are dealt with by Westinghouse Hanford Company (WHC) institutional programs, this analysis focuses on toxic and radiological consequences.

5.2 METHODOLOGY

The principle safety concerns associated with operation of the ERDF are industrial incidents resulting in injuries to facility workers or damage to equipment and release of low concentrations of hazardous and radioactive material. Abnormal and accident scenarios are identified in the hazards assessment table (Table 4-2). Injury of facility workers may result from operational errors involving heavy equipment, from failure of such equipment, and from vehicle accidents. Release of contaminants from the facility may result from normal operations, accidents involving loaded waste containers, and strong winds.

The hazardous and radioactive materials inventory used for analysis has been derived from two sources: the projected inventory for remediation wastes presented in the *Source Inventory Development Engineering Study for the Environmental Restoration Disposal Facility* (DOE/RL 1994a), and the *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (Preliminary Draft) (WHC 1994a). Although the document presents the best existing characterization data for remediation wastes planned for ERDF disposal, use of the *Source Inventory Development Engineering Study for the Environmental Restoration Disposal Facility* alone was not considered appropriate for two reasons. First, this study clearly states that some of the waste described in the document is not considered appropriate for disposal at ERDF due to high dose rate, transuranic content, or in some cases potential for definition as high-level waste. Second, the *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (Preliminary Draft) (WHC 1994b), allows concentrations of some hazardous and radioactive constituents orders of magnitude higher than the highest concentrations given in the Engineering Study, and for other hazardous and radioactive constituents allows only concentrations significantly lower than the maximum average values given in the Engineering Study. Use of the *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (Preliminary Draft) (WHC 1994a), alone also was not considered appropriate, primarily

because this draft document does not at this time supply limits for some known waste constituents.

The inventory used for analysis therefore incorporates the published draft waste acceptance criteria as concentrations in inventory where these limits exist. For known waste constituents for which limits have not been published and for which the acceptance limits are given as "unlimited," the maximum average concentration values from the Engineering Study have been used. For waste constituents for which the acceptance limits are listed as "to be determined" or "less than minimum detectable activity," a value of zero has been used. The combination of data from these two documents (Tables 3-2, 3-3, and 3-4) is believed to provide an adequate degree of conservatism in analysis.

Initiating events were developed based on consideration of the energy sources (natural phenomena and human-generated) present onsite or in facility operations and capable of providing a mechanism for release of the defined inventory. Facility operations are not complex, and do not involve many potential initiators. No scenarios were considered which are not physically credible. Industrial-type events such as vehicle accidents and natural wind resuspension and transport of contaminated soil are the major scenarios of concern.

The consequence analysis for a Hazard Category 3 facility is not required to be quantitative in nature. Therefore a qualitative approach has been used to define not only consequence, but associated risk. This approach was utilized in the Hazard Evaluation process as described in this Chapter, which expands on selected scenarios identified in Table 4-2. Results of this approach are presented in Table 4-2. The events postulated for ERDF were found to have medium to high probabilities and low consequences; the overall risk of facility operations is therefore considered to be low.

To verify the results of qualitative analysis, three radiological/hazardous material scenarios were selected as representative of credible worst conditions and simplified calculations were performed for these scenarios. Resuspension factors for these calculations were developed through quarter-scale testing under site-specific conditions with simulated waste soils by Golder Associates and Montgomery Watson, and published in the *Dust Mitigation Study for the Environmental Restoration Disposal Facility* (DOE/RL 1994b). Atmospheric dispersion factors were developed on a scenario-specific basis by WHC using the GENII and GXQ computer models (Appendix A). Dispersion modeling is also tailored to be contaminant-specific, to provide an assessment of maximum concentration at the receptor location for hazardous materials, and an assessment of cumulative dose for radiological materials. Compliance with the risk acceptance criteria given in WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992), is assessed for each scenario.

5.3 DESIGN/EVALUATION BASIS ACCIDENTS

To define the level of consequence associated with ERDF operations and its accident conditions, three representative scenarios have been selected for further analysis. These scenarios are: 1) fugitive dust generation from container unloading [normal operations, stable meteorology]; 2) wind transport of fugitive dust from the waste pile prior to stabilization (operations halted, various wind speeds considered); and 3) dispersal of

contamination from breach of a waste bulk soil container [abnormal operation with stable meteorology]. In accordance with the requirements of DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (DOE 1992a), for facilities defined as Hazard Category 3, only qualitative analyses were required. Numerical consequence values have been included to provide assurance of the severity of qualitatively predicted consequences.

5.3.1 Normal Operations

Normal operations involve receipt and emplacement of bulk soils and solid wastes in the trench. Unloading of bulk waste soils into the trench and spreading and compacting soil provide a mechanism for generation of fugitive dust and release of contaminants.

As the contents of each bulk soil container are placed in the trench, a plume of fugitive dust will be released. Plumes originate from points below each of the two trailer tippers where the soil is unloaded down the trench working face onto the existing waste pile. Spreading and compacting of the waste soil also produces fugitive dust in the immediate area of machine operations. Soil stabilization treatment will be provided at the trailer tippers through use of water spray nozzles and by mobile truck sprayers. Normal operations will be conducted only at windspeeds of below 24 km/h (15 mi/h). The contribution of wind suspension to dust generation during normal operations was assumed to be negligible because it has been experimentally shown that wind suspension of fugitive dust from soils with particle size distribution predicted for the waste matrix (Table 3-1) will not be initiated below the threshold windspeeds of approximately 57.6 km/h (36 mi/h) for untreated soil, and 18.6 to 23.6 m/s (42 to 53 mi/h) for treated soil (DOE/RL 1994b).

Analysis of the exposure hazard presented by normal operations including planned preventive and mitigative features and a qualitative determination of risk is shown in Table 5-1. This analysis was generated using the qualitative consequence analysis technique provided in DOE-STD-1027-92 and the Sandia National Laboratories (SNL) guidance document (SNL 1993) for Hazard Category 3 facilities.

The rate of dust generation for normal operations (R_n) is made up of three components: the rate of dust generation at the three trailer tippers (R_t); the rate of dust generation from operation of the seven bulldozers used for waste spreading and compaction (R_d); and the rate of dust generation due to wind suspension (R_w). The *Dust Mitigation Study for the Environmental Restoration Disposal Facility* (DOE/RL 1994b) experimentally defines the component R_t as equal to 4.5 kg/h (10 lb/h) and the component R_d as equal to 31.8 kg/h (70 lb/h) at the facility design rate of 215 containers per shift and an average container loading of 20.7 m³ (27 yd³) (DOE/RL 1994b). These values assume a soil moisture content of about 3% which is attained by addition of a dust suppressant medium at the trailer tippers and by spray wetting of the working surface. The component R_w will be equal to 0 kg/h (0 lb/h) because operations will be conducted only below windspeeds of 24 km/h (15 mi/h), while wind resuspension of fugitive dust from waste soils will not be initiated below windspeeds of approximately 57.6 km/h (36 mi/h). The component R_t is based on a U.S. Environmental Protection Agency (EPA) model (EPA 1985) for soil dumping in continuous or batch drop modes. The component R_d is based on a EPA model (EPA 1985) for dozing

operations. The component R_w is based on an EPA model (EPA 1985) for wind dispersion from an open area of limited erosion potential due to the presence of particles larger than fine sand or silt. The rate of dust generation for normal operations:

$$R_n = R_t + R_d + R_w$$

is then equal to 36.4 kg/h (80 lb/h), assuming that the mitigating measures described above are used for dust control. For operations with no soil treatment for dust mitigation, the *Dust Mitigation Study for the Environmental Restoration Disposal Facility* (DOE/RL 1994b) estimates the rate of dust generation to be significantly higher at 218 kg/h (480 lb/h).

Table 5-1. Fugitive Dust Generation in Normal Operations

Causes	Waste handling, dumping, spreading, and compacting; and heavy equipment operations on waste bulk soils.
Preventive Features	
Design:	Provision of water/surfactant spray equipment on trailer tippers used for unloading of waste bulk soils.
Administrative:	Application of physical fixants to immobilize dust after each shift; shutdown of operations during high wind conditions; application of clean fill over waste soil to preclude equipment contamination; safe operating procedures.
Method of Detection	Audible/visual monitoring of container handling operations and container dumping; air sampling/monitoring.
Mitigation Features	
Design:	HEPA and dust filtration for heavy equipment cabs.
Administrative:	Use of personal protective equipment; personnel trained in radiation safety, industrial hygiene, ALARA principles.
Potential Impact	Low level contamination in areas adjacent to the trench, exposure of facility personnel to fugitive dust, contamination of equipment.
Risk Determination	
Probability Level:	High
Consequence Level:	Low
Risk Level:	Low

It is estimated that each 8-hour shift will consist of 6.5 hours of active waste placement (dumping and dozing/compacting). The plan is to operate the facility 2 shifts per day, 5 days per week. At the facility design rate of 215 containers per shift, with emissions of 36 kg/h (80 lb/h), annual emissions of fugitive dust will equal 122,910 kg/y (270,400 lb/y). This estimate is considered to be conservative, as the operating rate required for the facility to handle the total waste volume projected for disposal under Project W-296 [4.6 million m³ (6 million yd³)] is only 80 containers per shift.

The respirable portion of the fugitive dust emissions will consist of particles below

10 μm in diameter. Using the soil composition data listed in Table 3-1, and assuming that the emissions consist of all constituent particles less than 70 μm in diameter (very fine sand, silt, and pan), the respirable fraction of the release (R_r) is equal to 68% (silt and pan only). This conservatively assumes all particles less than 30 μm are respirable because no data is available specifically for particles less than 10 μm . The total volume of respirable fugitive dust released is therefore 68% of 122,910 kg/y (270,400 lb/y), or 83,620 kg/y (184,000 lb/y). This annual release volume was used for calculation of radiological consequences for normal operations. For calculation of toxicological consequences, the total amount released [122,910 kg/y (270,400 lb/y)] was assumed to be respirable; this conservatism was added to account for toxicological routes of exposure other than inhalation.

The atmospheric dispersion factors (χ/Q values) selected for radiological consequence determinations are annual average values computed with compass sector averaging. These values and an explanation of their derivation by WHC are included in Appendix A. The GXQ computation model used provides an assessment of cumulative exposure over time. The maximally impacted offsite receptor is located at a distance of 22,700 m (74,500 ft) east of the facility. The selected distance is greater than the distance to the nearest site boundary located at 13,300 m (43,600 ft) south southwest of the facility because the receptor at this location sees a higher calculated consequence than the receptor at the site boundary in any other compass sector. The maximally impacted onsite receptor is located 550 m (1,800 ft) east of the facility (U.S. Ecology, Inc. Low-Level Waste Disposal Site); this employee is not subject to the administrative controls used to limit exposure for facility workers. The distance to this U.S. Ecology, Inc. facility has been estimated conservatively from the position of disposal operations at the end of the facility life, rather than from a location on the central axis of the projected disposal operations to be conducted under Project W-296. The maximally impacted facility worker receptor is assumed to be at a distance of 100 m (300 ft) from the central axis of the W-296 trench; the highest consequence is seen in the east southeast compass sector. All receptors are assumed to receive a combined dose from inhalation and air submersion.

Unit chronic baseline release doses calculated using the GENII dosimetry code were supplied by WHC (Appendix A). For known waste constituents, whole body inhalation and submersion effective dose equivalent [which includes the 50-year committed effective dose equivalent (CEDE) for intake] and maximum organ inhalation and submersion committed dose equivalent values were provided. The unit dose values were designed to be specific for onsite and offsite chronic exposure to account for the difference in exposure time (for external dose) and volume of air inhaled (for internal dose) for site or facility workers who are exposed for an eight-hour shift as opposed to the receptor at the site boundary who is exposed continuously during operations. The unit dose factor values and a detailed explanation of the correction for onsite and offsite receptors are included in Appendix A.

The product of the appropriate atmospheric dispersion factor (χ/Q) selected from Table 4 of Appendix A, the appropriate baseline unit release dose (D_b) selected from Table 5 of Appendix A, the annual release of respirable dust (R_r) as calculated above, and the concentration of the radionuclide in the source term (C) is the normal operations dose (D_n) at the selected receptor location due to a specific radionuclide:

$$D_a = (\chi/Q) (D_b) (R_r) (C)$$

The dose from normal operations to the receptors of concern due to the maximum source term concentration of each radionuclide (as described above) are shown in Table 5-2.

Table 5-2. Isotopic Contributions to Calculated Doses for Annual Chronic Airborne Radioactivity Releases due to Normal Operations

Isotope	Annual Dose at 100 m ESE (rem CEDE)	Annual Dose at 550 m E (rem CEDE)	Annual Dose at 22,700 m E (rem CEDE)
¹⁴ C	3.77E-08	1.60E-09	1.82E-11
²² Na	**	**	**
⁴⁰ K	7.13E-03	3.03E-04	3.42E-06
⁶⁰ Co	1.08E+00	4.58E-02	5.10E-04
⁹⁰ Sr	1.62E-01	6.86E-03	7.94E-05
⁹⁹ Tc	2.00E-07	8.48E-09	9.58E-11
¹³⁷ Cs	7.75E-01	3.29E-02	3.81E-04
¹⁵² Eu	1.89E-02	8.01E-04	9.26E-06
¹⁵⁴ Eu	3.89E-01	1.65E-02	1.89E-04
¹⁵⁵ Eu	**	**	**
²²⁶ Ra	1.94E+00	8.24E-02	9.47E-04
²²⁸ Th	**	**	**
²³² Th	3.50E-01	1.49E-02	1.67E-04
²³³ U/ ²³⁴ U	**	**	**
²³⁵ U	**	**	**
²³⁸ U	7.75E-05	3.29E-06	3.71E-08
²³⁸ Pu	5.22E-01	2.22E-02	2.55E-04
²³⁹ Pu/ ²⁴⁰ Pu	3.44E-01	1.46E-02	1.67E-04
²⁴¹ Am	3.44E-01	1.46E-02	1.67E-04

χ/Q values taken from Appendix A. Worst-case solubilities were used for all isotopes.

** No Waste Acceptance Criteria (WHC 1994a) inventory values are provided.

The maximum dose due to inhalation and submersion for the receptor is the dose that would be received if the entire release were composed of the radionuclide which results in the highest of the individually calculated radionuclide-specific doses. This maximum dose is 1.94×10^{-2} Sv (1.94 rem) CEDE for the facility worker, 8.24×10^{-4} Sv (8.24×10^{-2} rem) CEDE for the nearest onsite worker, and 9.47×10^{-5} Sv (9.47×10^{-4} rem) CEDE for the highest Site Boundary receptor location. As can be seen from Table 5-2, the maximum dose is the dose imparted assuming that the entire radiological concentration of the release is Ra-226. The dose from inhalation and submersion must be added to the direct or external dose for an estimate of total worker dose.

External dose due to operations is estimated using data from the *Source Inventory Development Engineering Study for the Environmental Restoration Disposal Facility* (DOE/RL 1994a) Appendix K, "Contaminated Volumes for Sampled Waste Sites." This Appendix indicates the percentage volume of waste in three dose level categories: 22.1% between 0 and 250 mrem per year at 1 m (3 ft); 74.7% between 250 and 1000 mrem per year at 1 m (3 ft); and 3.2% above 1,000 mrem per year at 1 m (3 ft). These estimated annual exposures are based on worker proximity to the waste for 5 hours per day, 5 days per week, and 50 weeks per year. To be conservative, a standard distribution average was used to calculate the dose rate for each category. For the 0 to 250 mrem per year category, the average was assumed to be 125 mrem per year; for 250 to 1,000 mrem per year, 625 mrem per year; and for above 1,000 mrem per year (5,000 mrem per year assumed maximum), 3,000 mrem per year. The ERDF operating documents assume a daily work period is 6.5 h rather than 5 h assumed in this calculation. Therefore, the dose values have been multiplied by $6.5/5 = 1.3$ to maintain consistent assumptions throughout this document. The dose at 1 m (3 ft) which is representative of walking on the waste pile working face is calculated as follows:

$$(0.221)(163 \text{ mrem/y}) + (0.747)(813 \text{ mrem/y}) + (0.032)(3,900 \text{ mrem/y}) = 768 \text{ mrem/y}$$

The dose at other worker locations were derived by multiplying the 1 m (3 ft) rate by the reciprocal of the radial distance to that location, assuming an infinite plane geometry for the waste pile. For a receptor walking on the interim cover surface 0.6 m (2 ft) above the waste surface, the dose rate at 1 m (3 ft) is multiplied by $3/5$ (i.e., the original receptor distance divided by the total receptor distance), for a dose of 460 mrem per year, taking no credit for interim cover soil attenuation. For a receptor operating a vehicle such as a bulldozer 3 m (10 ft) above the waste surface, the dose rate at 1 m (3 ft) is multiplied by $3/10$, for a dose of 230 mrem per year taking no credit for attenuation provided by the machine.

Adding the external dose to the intake doses completes the projected dose estimate for the facility worker. The resultant dose for a trailer tipper operator standing on the interim cover is 2,400 mrem per year (i.e., $1,940 \text{ mrem/y} + 460 \text{ mrem/y}$); vehicle operators receive an estimated exposure of 2,170 mrem per year. Table 5-3 provides a comparison of the projected total dose from normal operations with the applicable acceptance criteria in the form of the U.S. Department of Energy (DOE) annual exposure limits for the public as established in DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (DOE 1990), for the onsite and facility worker as established in DOE Order 5480.11, *Radiation Protection for Occupational Workers* (DOE 1988), and DOE annual exposure guidance values as given in DOE/EH-0256T (Rev. 1), *Radiological Control Manual*, (DOE 1994). All doses are within DOE Annual Limits, but the facility worker is expected to receive about 115% of the Annual Dose Guidance Value of 2 rem. It should be noted that this level of worker exposure would required approval of the DOE Program Secretarial Officer. These doses were also compared with the WHC Risk Acceptance Guidance Values for anticipated events, given in WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992), Section 7.0. Both the whole body and the maximum anticipated organ doses are below the limits for onsite receptors (5 rem effective dose equivalent (EDE) whole body and 50 rem CDE maximum organ dose) and for offsite receptors (0.5 rem EDE whole body and 5 rem CDE maximum organ dose).

Calculation of consequences using the values given in the *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (WHC 1994) results in dose rates above the 2,000 mrem/y DOE administrative guidance level for facility workers. This potential exposure may be lowered through implementation of engineered features or administrative controls. Reducing the allowable concentration of Ra-226 to $9.4\text{E-}09$ Ci/g would lower the overall annual uptake dose for facility workers from 1,940 mrem/y to 1,080 mrem/y. This reduces the maximum potential total dose for the facility worker from 2,400 mrem/y to 1,540 mrem/y, which will not require DOE approval for normal operations. Where the Table 5-3 indicate conditional compliance, this is contingent upon reduction of waste acceptance limits to the values given above.

Table 5-3. Radiological Impacts of Normal Operations

Receptor Location	Effective Dose Equivalent [Sv (rem)]	DOE Annual Limit [Sv (rem)]	DOE Annual Dose Guidance Value [Sv (rem)]	Compliant
Facility Worker	$2.40\text{E-}02$ ($2.40\text{E+}00$)	$5.0\text{E-}02$ ($5.0\text{E+}00$)*	$2.0\text{E-}02$ *** ($2.0\text{E+}00$)	Yes - Limit Yes Conditional - Guidance
Onsite Worker	$8.24\text{E-}04$ ($8.24\text{E-}02$)	$5.0\text{E-}02$ ($5.0\text{E+}00$)*	$2.0\text{E-}02$ *** ($2.0\text{E+}00$)	Yes
Site Boundary	$9.47\text{E-}06$ ($9.47\text{E-}04$)	$1.0\text{E-}03$ ($1.0\text{E-}01$)**	$1.0\text{E-}04$ **** ($1.0\text{E-}02$)	Yes

* Annual occupational limit (DOE 1988)

** Annual public limit (DOE 1990)

*** Annual dose guidance values (DOE 1992b)

**** Annual reporting limit (DOE 1990)

The airborne concentration is also of concern in determining the adequacy of facility design and requirements for respiratory protection. Table 5-4 provides a comparison of the expected airborne radionuclide concentrations at the receptor locations with the derived air concentrations (DACs) listed in DOE Order 5480.11, *Radiation Protection for Occupational Workers* (DOE 1988). The DAC value is the concentration of a radionuclide in air which is expected to result in a dose of 5 rem CEDE upon 2000 hours of exposure. The, WHC-CM-1-6, *WHC Radiological Control Manual* (WHC 1993) requires posting to warn operators that respiratory protection is required in areas where concentrations of airborne radionuclides may exceed 10% of the DAC. The WHC-CM-1-6, *WHC Radiological Control Manual* (WHC 1993) also requires formal WHC management authorization to allow exposure levels above 2% of the DAC. Table 5-4 shows that for some radionuclides, the airborne concentration may be greater than 50% of the DAC.

The atmospheric dispersion factors (χ/Q values) selected for toxicological consequence determination are acute 99.5% Maximum Sector and 95% Site Wide values. These values and an explanation of their derivation by WHC are included in Appendix A. The GXQ computation model used to generate these factors does not use the plume meander phenomenon in order to ensure the maximum concentration is calculated for the receptor location. The maximally impacted offsite receptor is located at a distance of 15,100 m

(49,500 ft) west of the facility. The selected distance is greater than the distance to the nearest site boundary located at 13,300 m (43,600 ft) south southwest of the facility because the receptor at this location sees a higher calculated consequence than the receptor at the site boundary in any other compass sector. The maximally impacted onsite receptor is located 550 m (1,800 ft) east of the facility (U.S. Ecology, Inc. Low-Level Waste Disposal Site); this employee is not subject to the administrative controls used to limit exposure for facility workers. The distance to this facility has been estimated conservatively from the position of disposal operations at the end of the facility life, rather than from a location on the central axis of the projected disposal operations to be conducted under Project W-296. The maximally impacted facility worker receptor is assumed to be at a within a radius of 100 m (300 ft) from the central axis of the Project W-296 trench; the consequence to this receptor is calculated as an average over the area rather than by individual compass sector.

Table 5-4. Acute Airborne Radionuclide Concentrations at Receptor Locations Due to Normal Operations

Radionuclide	Instant Airborne Concentration at Facility Worker (100 m ESE) (Ci/m ³)	Derived Air Concentration Values (Ci/m ³)*	Percentage of Derived Air Concentration
¹⁴ C	1.94E-14	1.00E-06	< 1 %
²² Na	**	3.00E-07	< 1 %
⁴⁰ K	6.37E-10	2.00E-07	< 1 %
⁶⁰ Co	5.54E-09	1.00E-08	55 %
⁹⁰ Sr	8.31E-10	2.00E-09	42 %
⁹⁹ Tc	2.38E-14	3.00E-07	< 1 %
¹³⁷ Cs	2.77E-08	7.00E-08	40 %
¹⁵² Eu	9.69E-11	1.00E-08	< 1 %
¹⁵⁴ Eu	1.52E-09	8.00E-09	19 %
¹⁵⁵ Eu	**	4.00E-08	< 1 %
²²⁶ Ra	6.65E-11	3.00E-10	22 %
²²⁸ Th	**	4.00E-12	< 1 %
²³² Th	2.22E-13	5.00E-13	44 %
²³⁵ U/ ²³⁴ U	**	2.00E-11	< 1 %
²³⁵ U	**	2.00E-11	< 1 %
²³⁸ U	6.92E-16	2.00E-11	< 1 %
²³⁸ Pu	1.38E-12	3.00E-12	46 %
²³⁹ Pu/ ²⁴⁰ Pu	8.31E-13	2.00E-12	42 %
²⁴¹ Am	8.31E-13	2.00E-12	42 %

* $\mu\text{Ci/ml} = \mu\text{Ci/cc}$ which is also equivalent to Ci/m^3

** No Waste Acceptance Criteria values are provided (WHC 1994a)

The product of the appropriate acute atmospheric dispersion factor (χ/Q) selected from Table 2 of Appendix A, the concentration of the chemical constituent in the source term (C), and the annual release of respirable dust (R_r) as calculated above divided by a time

conversion factor to attain concentration per second is the highest instantaneous concentration of that constituent produced at the selected receptor location due to normal operations (C_n):

$$C_n = (\chi/Q) (C) (R_r) / (52 \text{ wk/y})(5 \text{ d/wk})(2 \text{ shifts/d})(6.5 \text{ h/shift})(3600 \text{ s/h})$$

The hazardous material concentrations from normal operations to the receptors of concern (as described above) are listed in Table 5-5. The WHC risk acceptance criteria given in WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992), Section 7.0 are also listed. The criteria are based on the American Industrial Hygiene Association issued Emergency Response Planning Guides (ERPGs). Airborne concentrations of hazardous materials are required to be below ERPG-1 offsite and ERPG-2 onsite for normal operations. ERPG values are currently available for only 4 of the chemicals listed. In the absence of ERPG values, WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992), allows the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value-time weighted average (TLV-TWA) or Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) (OSHA 1994) to be used for the ERPG-1 and the ACGIH threshold limit value ceiling (TLV-C) to be used for the ERPG-2 value. Hazard and exposure path data was obtained from *Dangerous Properties of Industrial Materials* (Sax 1989).

The average levels of respirable particles generated by facility operations will be below the OSHA PEL of 5 mg/m³ for nuisance dust. Acute concentrations for all chemical waste constituents except iron and chrysene will be below the OSHA PELs at all receptor locations. The acute concentration of iron will be approximately 13-times the PEL at the location of the facility worker, but below the PEL for all other receptor locations. Acute concentrations of chrysene will be 100- and 14-times the PEL for the facility and onsite workers, respectively. Comparison of the acute concentration estimate to the acute exposure limit (TLV-C), or in the absence of a published acute exposure limit to a value 3- to 5-times the PEL as recommended by ACGIH, shows that the acute iron concentration will be about twice the acute exposure limit assuming the most toxic chemical form, whereas the acute chrysene concentration will be 51-times the limit for the facility worker, and about 5-times the limit for the onsite receptor.

Calculation of consequences using the values given in the *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (WHC 1994) results in concentrations of hazardous materials (Chrysene and Iron) above the WHC risk acceptance criteria for facility workers. These potential exposures may be lowered through implementation of engineered features or administrative controls. Reduction of waste acceptance limit concentrations for Iron to 7.44E+03 mg/kg, and Chrysene to 1.49E+03 mg/kg could result in reduction of airborne concentrations of these constituents to limits below the WHC risk acceptance criteria for these constituents. Bolded values in Table 5-5 indicate where conditional compliance can be attained if waste acceptance limit values are reduced to the values given above.

Normal operation of the ERDF will also result in contamination of the area immediately surrounding the facility due to transport of fugitive dust. The projected magnitude of ground contamination is reported in *Projected Annual Hanford Site Ground Contamination from the Environmental Restoration Disposal Facility Operations* (Hey 1994).

Contamination contour maps are shown in Figures 5-1 and 5-2. These figures indicate estimated contamination levels immediately surrounding the ERDF site and within a 50 km (30 mi) radius of the site. Contamination levels are shown in units of milligrams of waste matrix per square meter. These estimates are based on fugitive dust releases unmitigated by the use of dust suppressant spray and application of fixants which will be required during normal facility operations. The resulting contamination estimates may therefore be considered conservative by as much as two orders of magnitude.

In order to provide an estimate of the potential severity of the contamination, two worst-case inventory scenarios (both allowable under the constraints of the *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Preliminary Draft (WHC 1994b)) were postulated: 1) the entire radionuclide inventory in the waste matrix assumed to be Strontium-90 (a beta emitter) and 2) the entire radionuclide inventory in the waste matrix assumed to be Plutonium-239 (an alpha emitter). These radionuclides were selected because they represent the greatest health physics concerns for each type of radiation. The activity resulting from each of these inventories was calculated for a waste matrix concentration of 10 mg/m² (2.0×10^{-6} lb/ft²).

Table 5-5. Acute Airborne Hazardous Material Concentrations at Receptor Locations Due to Normal Operations

Inorganic Metal/ Compound	Airborne Concentration (100 m Site) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (15,100 m W) (mg/m ³)	Hazard and Exposure Route	Permissible Exposure Limits (mg/m ³)
Aluminum	2.74E+00	1.48E-01	1.01E-03	Toxic, Reactive ing, ipr, sbc	1.50E+01
Antimony	8.04E-05	4.35E-06	2.97E-08	Toxic, Carcinogenic ipr, ing, inh, sbc	5.00E-01
Arsenic	6.70E-07	3.62E-08	2.47E-10	Toxic, Carcinogenic sbc, ipr, ing	1.00E-02
Barium	4.15E-01	2.24E-02	1.53E-04	Toxic ing, sbc, par	5.00E-01
Beryllium	5.36E-05	2.90E-06	1.98E-08	Toxic, Carcinogenic ipr, sbc	2.00E-03
Cadmium	6.70E-05	3.62E-06	2.47E-08	Toxic, Carcinogenic ing, ipr, sbc	2.00E-01
Calcium	0.00E+00	0.00E+00	0.00E+00	Toxic ing, ipr	5.00E+00
Chromium	1.34E-03	7.25E-05	4.95E-07	Toxic, Carcinogenic ing, ipr, sbc	1.00E+00
Cobalt	5.50E-03	2.97E-04	2.03E-06	Toxic, Carcinogenic ing, ipr, sbc	1.00E-01
Copper	1.34E-02	7.25E-04	4.95E-06	Toxic ing, ipr, par, sbc	1.00E+00
Iron	1.32E+01	7.13E-01	4.87E-03	Toxic ing	1.00E+00
Lead	3.35E-02	1.81E-03	1.24E-05	Toxic, Carcinogenic ing, ipr, sbc	5.00E-02
Magnesium	4.87E-01	2.63E-02	1.80E-04	Toxic ing, ipr, sbc	1.50E+01
Manganese	6.70E-04	3.62E-05	2.47E-07	Toxic, Reactive inh, ipr, sbc	5.00E+00
Mercury	2.68E-05	1.45E-06	9.90E-09	Toxic inh, ing, ipr	1.00E-01
Nickel	1.34E-03	7.25E-05	4.95E-07	Toxic, Carcinogenic ing, ipr, sbc	1.00E+00
Potassium	3.98E-01	2.15E-02	1.47E-04	Toxic ing, ipr	2.00E+00
Selenium	1.34E-04	7.25E-06	4.95E-08	Toxic inh	2.00E-01
Silver	1.34E-03	7.25E-05	4.95E-07	Toxic ing, inh, ipr, sbc	1.00E-02
Sodium	3.67E-02	1.99E-03	1.36E-05	Toxic ing	2.00E+00
Thallium	1.05E-05	5.65E-07	3.86E-09	Toxic ing, sbc	1.00E-01
Vanadium	1.05E-03	5.65E-05	3.86E-07	Toxic sbc	5.00E-01
Zinc	6.70E-02	3.62E-03	2.47E-05	Toxic sbc, ipr	5.00E+00

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, sbc - subcutaneous,
par - parenteral

Values indicated in bold face text do not meet risk acceptance criteria (WHC 1992).

Table 5-5 (continued). Acute Airborne Hazardous Material Concentrations at Receptor Locations Due to Normal Operations

Organic Chemical	Airborne Concentration (100 m Site) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (15,100 m W) (mg/m ³)	Exposure Route	Permissible Exposure Limits (mg/m ³)
Acetone	3.75E-03	2.03E-04	1.39E-06	Toxic, Ignitable inh	2.50E+03
Benzene	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic Ignitable inh, cut	3.25E+00
2-Butanone (Methyl ethyl ketone)	4.42E-03	2.39E-04	1.63E-06	Toxic, Ignitable inh	5.90E+02
Carbon disulfide	0.00E+00	0.00E+00	0.00E+00	Toxic, Ignitable inh, ing	6.32E+01
1,2-Dichloroethane (Ethylene dichloride)	1.34E-03	7.25E-05	4.95E-07	Toxic, Ignitable ing, inh	2.02E+02
4-Methyl-2-Pentanone (Hexone)	3.73E-02	2.02E-03	1.38E-05	Toxic, Ignitable ing, inh	4.10E+02
Methylene Chloride (Methane Dichloride)	2.79E-03	1.51E-04	1.03E-06	Toxic, Carcinogenic ing, inh, sbc	1.77E+03
Tetrachloroethane	1.51E-02	8.18E-04	5.58E-06	Toxic, Carcinogenic inh, ing	3.50E+01
Toluene	2.49E-02	1.35E-03	9.19E-06	Toxic, Ignitable inh	7.66E+02
Trichloroethene	7.75E-03	4.19E-04	2.86E-06	Toxic, Ignitable inh	5.46E+02
Vinyl Chloride	4.13E-03	2.23E-04	1.52E-06	Toxic, Carcinogenic Ignitable inh, ing	2.60E+00
Acenaphthene	3.76E-01	2.03E-02	1.39E-04	N/A	N/A
Aroclor-1248 (PCB)	1.34E-04	7.25E-06	4.95E-08	Toxic, Carcinogenic Ignitable inh, ing	N/A
Aroclor-1254 (PCB)	1.34E-04	7.25E-06	4.95E-08	Toxic, Carcinogenic Ignitable inh, ing	5.00E-02
Aroclor-1260 (PCB)	1.34E-04	7.25E-06	4.95E-08	Toxic, Carcinogenic Ignitable inh, ing	N/A
Anthracene	1.88E+00	1.01E-01	6.93E-04	Toxic, Ignitable cut	N/A
Benzo(a)anthracene (Benz(a)anthracene)	1.21E-04	6.52E-06	4.45E-08	Toxic, Carcinogenic cut	N/A
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic subc	N/A
Benzo(j)fluoranthene	1.61E-04	8.70E-06	5.94E-08	Carcinogenic	N/A
Benzo(ghi)perylene	6.70E+01	3.62E+00	2.47E-02	Carcinogenic	N/A
Benzo(k)fluoranthene	1.14E+02	6.16E+00	4.21E-02	Carcinogenic	N/A
Benzoic Acid	1.14E-04	6.16E-06	4.21E-08	Toxic, Ignitable subc, ing	N/A

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, sbc - subcutaneous, par - parenteral

Values indicated in boldface text do not meet risk acceptance criteria (WHC 1992).

N/A - No data available

Table 5-5 (continued). Acute Airborne Hazardous Material Concentrations at Receptor Locations Due to Normal Operations

Organic Chemical	Airborne Concentration (100 m Site) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (15,100 m W) (mg/m ³)	Exposure Route	Permissible Exposure Limits (mg/m ³)
Bis (2-ethylhexyl) phthalate	2.01E+00	1.09E-01	7.42E-04	Toxic, Carcinogenic ing, inh	5.00E+00
Butylbenzylphthalate	2.76E-02	1.49E-03	1.02E-05	Carcinogenic, Ignitable ing, inh	N/A
Carbazole	6.70E-05	3.62E-06	2.47E-08	Toxic, Carcinogenic ing	N/A
Carbon Tetrachloride	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic ing, inh	6.39E+01
4-Chloro-3-Methylphenol	0.00E+00	0.00E+00	0.00E+00	Reactive inh	N/A
2-Chlorophenol	8.06E-02	4.36E-03	2.97E-05	Toxic, Ignitable ing, subc	N/A
Chloroform	9.38E-05	5.07E-06	3.46E-08	Toxic, Carcinogenic inh, ing	2.48E+02
4-Chloroaniline	4.22E-04	2.28E-05	1.56E-07	Toxic ing, inh, cut, subc	N/A
Chrysene (Coal tar pitch volatiles)	5.09E+01	2.75E+00	1.88E-02	Carcinogenic cut	2.00E-01
Di-n-octyl-phthalate	0.00E+00	0.00E+00	0.00E+00	Toxic ing	N/A
Di-n-butyl-phthalate	1.87E-04	1.07E-05	7.29E-08	Toxic ing	5.00E+00
Dibenzofuran (Diphenylene Oxide)	0.00E+00	0.00E+00	0.00E+00	N/A	N/A
1,3 Dichlorobenzene	5.36E-05	2.90E-06	1.98E-08	Toxic inh, ing, subc	4.58E+02
1,4 Dichlorobenzene	1.36E-02	7.35E-04	5.02E-06	Toxic inh, ing, subc	4.58E+02
Diethyl phthalate	4.36E-02	2.36E-03	1.61E-05	Toxic ing, subc	5.00E+00
Ethylbenzene	9.38E-03	5.07E-04	3.46E-06	Toxic, Ignitable ing, inh, cut	4.41E+02
Fluoranthene	2.21E+00	1.20E-01	8.17E-04	Toxic ing, cut	N/A
Fluorene	1.68E-01	9.07E-03	6.19E-05	N/A	N/A
Indeno(1,2,3-cd)pyrene	2.68E+00	1.45E-01	9.90E-04	Carcinogenic	N/A
2-Hexanone	0.00E+00	0.00E+00	0.00E+00	Toxic ing, inh, cut	4.17E+02
2-Methylnaphthalene	1.74E-03	9.42E-05	6.43E-07	Toxic ing	N/A
4-Methylphenol (p-Cresol)	6.70E-05	3.62E-06	2.47E-08	Toxic, Ignitable ing, cut, subc	1.90E+01

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, subc - subcutaneous, par - parenteral

Values indicated in bold face text do not meet risk acceptance criteria (WHC 1992).

N/A - No data available

Table 5-5 (continued). Acute Airborne Hazardous Material Concentrations at Receptor Locations Due to Normal Operations

Organic Chemical	Airborne Concentration (100 m Site) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (15,100 m W) (mg/m ³)	Exposure Route	Permissible Exposure Limits (mg/m ³)
Naphthalene	1.88E-01	1.01E-02	6.93E-05	Toxic ing, inh, subc	5.00E+01
2-Nitrophenol	2.28E-05	1.23E-06	8.41E-09	Toxic ing, subc	N/A
N-Nitrosodiphenylamine	4.96E-06	2.68E-07	1.83E-09	Toxic, Ignitable ing	N/A
Pentachlorophenol	1.14E-04	6.16E-06	4.21E-08	Toxic, Carcinogenic ing, cut, subc	5.00E-01
Phenathrene	3.22E+00	1.74E-01	1.19E-03	Toxic, Carcinogenic Ignitable ing	N/A
Phenol	9.60E-03	5.19E-04	3.54E-06	Toxic ing, subc, cut	1.90E+01
1,1,1-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	Toxic ing, inh, subc, cut	4.50E+01
Pyrene	1.61E+00	8.70E-02	5.94E-04	Toxic inh	N/A
Xylenes	1.74E-04	9.42E-06	6.43E-08	Toxic, Ignitable ing, inh, cut	4.41E+02
Dichlorophenoxy acetic acid	0.00E+00	0.00E+00	0.00E+00	Toxic ing, cut	1.00E+01
Chlordane	2.75E+00	1.49E-01	1.01E-03	Toxic ing	N/A
2,2-bis-p-chlorophenyl-1,1-dichloroethylene	1.68E+00	9.06E-02	6.19E-04	Toxic ing	N/A
Aldrin	5.36E-07	2.90E-08	1.98E-10	Toxic ing, cut	2.50E-01
Lindane	2.01E-01	1.09E-02	7.42E-05	Toxic, Carcinogenic ing	N/A
Dieldrin	6.70E-08	3.62E-09	2.47E-11	Toxic, Carcinogenic ing	2.50E-01
Endrin	1.07E-06	5.80E-08	3.96E-10	Toxic ing, cut	1.00E-01
Chlordane	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic ing, inh, cut	5.00E-01
Heptachlor	5.36E-07	2.90E-08	1.98E-10	Toxic, Carcinogenic ing, cut	5.00E-01
Methoxychlor	1.34E-03	7.25E-05	4.95E-07	Toxic ing	1.00E+01
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00	0.00E+00	Carcinogen int	N/A
1,1,2,2-Tetrachloroethene	0.00E+00	0.00E+00	0.00E+00	Poison, Toxic ing, inh, ipr, sbc	3.50E+01

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, int - intravenous,
sbc - subcutaneous, par - parenteral

Values indicated in bold face text do not meet risk acceptance criteria (WHC 1992).

N/A - No data available

The annual deposition per square meter of a selected radionuclide (A_a) may be calculated from the mass of waste matrix deposited (M_d) and the concentration of the radionuclide allowed in the waste matrix (C_a):

$$A_a = (M_d)(C_a)$$

Given a maximum allowable waste matrix concentration of 3.00×10^{-7} Ci/g (1.4×10^{-4} Ci/lb) for Strontium-90 and 3.00×10^{-10} Ci/g (1.4×10^{-7} Ci/lb) for Plutonium-239, this results in an annual deposited activity of 3.00×10^{-9} Ci/m² (2.8×10^{-10} Ci/ft²) for Strontium-90 and 3.00×10^{-12} Ci/m² (2.8×10^{-13} Ci/ft²) for Plutonium-239.

The DOE unconditional release limit for removable contamination is 200 disintegrations per minute (dpm) for Strontium-90 (beta/gamma) and 20 dpm for alpha (Plutonium-239) per 100 cm² (0.11 ft²). The annual deposited activity calculated above may be converted to units of dpm by multiplying by 2.22×10^{12} disintegrations per minute/Curie. This conversion gives an activity of 67 dpm per 100 cm² (0.11 ft²) for Strontium-90 and 0.067 dpm per 100 cm² (0.11 ft²) for Plutonium-239.

The contamination resulting from the annual release of Strontium-90 is 34% of the removable contamination limit for beta/gamma. The contamination resulting from the annual release of Plutonium-239 is 0.3% of the removable contamination limit for alpha.

The environmental impact of facility operations must be considered over the 30-year facility lifetime. The total surface contamination activity for the radionuclides of interest was calculated by multiplying the annual surface deposition value by 30 years. Cumulative contamination over the 30 years of operation could be as high as 90 nCi/m² (8.4 nCi/ft²) Strontium-90 or 0.09 nCi/m² (0.0084 nCi/ft²) Plutonium-239. If this surface contamination activity is assumed to be mixed with the top 15 cm (5.9 in) of soil (being tilled into the soil), the contaminated soil volume generated from each square meter of surface contamination is 0.15 m³ (5.3 ft³). This yields a total contamination activity of 600 nCi/m³ (17 nCi/ft³) or 3.8×10^{-4} nCi/g (0.17 nCi/lb) for Strontium-90 or 0.6 nCi/m³ (1.7×10^{-4} nCi/ft³) or 3.8×10^{-7} nCi/g (1.7×10^{-4}) for Plutonium-239, based on a soil density of 1.6×10^6 g/m³ (100 lb/ft³).

The Environmental Acceptance Limits stated in the WHC-CM-7-5, *Environmental Compliance Manual* (WHC 1988), are 2.80 nCi/g for Strontium-90 and 0.19 nCi/g for Plutonium-239. Both calculated radionuclide concentrations are orders of magnitude below the limit values.

5.3.2 Wind Storm Dispersion

The accident scenario which represents the greatest potential for release of hazardous and radioactive material and exposure to facility workers, the public, and the environment is wind dispersion of contaminated bulk soils. The scenario postulates a 24-hour period of high winds at the design basis wind speed of 31 m/s (70 mi/h). These winds provide a mechanism for suspension of dust from the upper layer of contaminated soil in the disposal trench. It is assumed that soil stabilization through the use of spray nozzles at the trailer

tipper locations has been conducted during placement of the waste, but that no stabilizing fixant was applied at the end of the last operating shift, and that winds capable of causing soil suspension then occur for a period of 24-hours. During this 24-hour period of high winds, no operations occur in the disposal trench since normal operations will be conducted only at wind speeds of below 6.7 m/s (15 mi/h).

Dispersion (χ/Q) values and dust generation rates were compared for various wind speeds from 13 m/s (30 mi/h) to 33 m/s (75 mi/h) and it was determined that the highest consequence would result from the 33 m/s (75 mi/h) case.

Qualitative analysis of the hazards presented by this abnormal operating condition including preventive and mitigative features and a determination of risk is shown in Table 5-6. This analysis was generated using the qualitative consequence analysis technique provided in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (DOE 1992a), and the SNL guidance document (SNL 1993) for Hazard Category 3 facilities.

Particulate materials such as the contaminated dust of concern at ERDF are transported by wind through three primary mechanisms (Sehmel 1980):

- Traction, which is the movement of particles along the ground surface (large particles, short distances);
- Saltation, which is the movement of particles, induced by impact with other particles, in ballistic-type trajectories before returning to the ground surface (intermediate size particles, short distances); and
- Suspension, which is the movement of smaller particles that are carried upwards by the winds to travel at indefinite heights within the atmosphere.

The *Dust Mitigation Study for the Environmental Restoration Disposal Facility* (DOE/RL1994b) provides a review of past studies and modeling for the mechanics of dust entrainment. The study also develops a site-specific model for ERDF operations based on the results of several studies of suspension phenomena conducted or sponsored by the EPA (EPA 1974; EPA 1985; and EPA 1992) and on limited site-specific experimental data. This compendium of studies indicates that the initiation of suspension is dependent upon the sheer stress (S_s) imparted on a dust particle by the wind, the density of the soil particle (d_p) and the density of air (d_a), the particle diameter (D_p), and an empirical coefficient (A) as follows:

$$S_s = A^2 (d_p - d_a) D_p$$

Table 5-6. Wind Storm Dispersion of Waste Soil

Causes	Moderate to high winds.
Preventive Features	
Design:	Trench construction below-grade.
Administrative:	Application of clean fill over waste bulk soil and fixants/surfactants on waste bulk soil to preclude dispersion.
Method of Detection	Visual observation, weather service reports, Hanford meteorological stations.
Mitigation Features	
Design:	None
Administrative:	Access control of area, shutdown of operations during high wind conditions.
Potential Impact	Low level contamination in areas adjacent to the trench, contamination of facility equipment.
Risk Determination	
Probability Level:	Medium
Consequence Level:	Low
Risk Level:	Low

The shear stress is the amount of force required in opposition to the force of friction to start a particle moving on or above the soil surface to render it available for suspension. The force in opposition to friction is supplied by the movement of air at the soil surface, and can be related to the wind speed profile in the surface boundary layer (which is also friction-dependent). The shear stress (S_s) required to initiate suspension can then be related to the wind speed (U) at a specific height (Z) above the soil surface, the aerodynamic roughness of the soil surface (Z_o), the density of air (d_a), and the dimensionless constant (k) as follows:

$$U = [(S_s / d_a)^{0.5} / k] \ln(Z / Z_o)$$

Figure 5-3 shows the relationship between threshold wind velocity and particle diameter expressed as the mode of particle size distribution. For untreated, dry (less than one percent moisture), simulated ERDF waste soil, the calculated threshold is 16 m/s (36 mi/h); for soil to which at least three percent moisture has been added by application of a dust suppressant the threshold ranges from 18.6 to 23.6 m/s (42 to 53 mi/h) (DOE/RL 1994b) due to particle agglomeration. These results suggest that dust entrainment will not be significant during facility operations, which will be conducted only at wind speeds of less than 6.7 m/s (15 mi/h).

For the purposes of estimating erosion it is useful to express shear stress in the form of the quantity "friction velocity." Friction velocity is an erosion parameter with units of length per unit time, which is not equal to but can be estimated from wind speed. The friction velocity is related to shear stress and the density of air as follows:

$$V = (S_s / d_a)^{0.5}$$

The particulate release (E_p) due to erosion from an open area can be related to the number of wind disturbances (N) in the time period of concern, the friction velocity during a specific wind disturbance (V_i), and the friction velocity threshold (V_t) at which particle suspension is initiated as follows:

$$E_p = \sum_{i=1}^N [58 (V_i - V_t)^2 + 25 (V_i - V_t)] \quad \text{for all } V_i > V_t$$

When the friction velocity is less than the threshold friction velocity, the particulate release due to all three erosion effects are negligible. Because the friction velocity shows a logarithmic dependence on wind speed, the particulate release due to erosion will show the same dependence on wind speed. This dependence is shown in Figure 5-4.

The highest consequences (ambient air concentrations) of a given particulate release will result during stable meteorological conditions when plume dispersion occurs more slowly. Because the amount of the particulate release is dependent upon wind speed, as meteorological conditions become less stable and wind speed increases the amount of the particulate release will increase. The wind speed interval of concern is bounded at the lower end by the wind speed which produces the threshold friction velocity [16 m/s (36 mi/h)] and at the upper end by the high wind speed for the facility [33 m/s (75 mi/h)]. Over this interval, the effect of increased windspeed on the amount of particulate released is significant, as shown in Figure 5-4. The calculation of consequences has been conducted using an untreated soil suspension rate of 73 kg/h (160 lb/h), which corresponds to a wind speed of 33 m/s (75 mi/h) and the atmospheric dispersion factor which corresponds to the associated meteorology. Based on the meteorological data given in the *Climatological Summary of Wind and Temperature Data for the Hanford Meteorological Monitoring Network* (PNL 1990), wind speeds above 13.3 m/s (30 mi/h) occur less than 1% of the time.

The exposed surface of the sloped trench working face is rhombic in shape and measures 67 m (221 ft) in height, 305 m (1000 ft) in width at the trench floor, and 440 m (1,420 ft) in width at the trench lip. The exposed surface area is therefore 25,000 m² (6 acres). The soil suspension rates obtained from Figure 5-4 have been calculated for an exposed surface area of 2,430 m² (0.6 acres). To obtain the soil suspension rate for the actual exposed surface area of the trench face during a 33 m/s (75 mi/h) wind, the soil suspension rate of 73 kg/h (160 lb/h) from Figure 5-3 has been multiplied by a factor of 10. The soil suspension rate during the 24-hour period of high winds is therefore 730 kg/h (1,600 lb/h). The total quantity of soil released over the 24-hour period is therefore 17,500 kg (38,400 lb).

The respirable portion of the soil suspended consists of particles below 10 μ m in diameter. Using the soil composition data listed in Table 3-1, and assuming that the emissions consist of all constituent particles below 70 μ m in diameter (very fine sand, silt, and pan), the respirable fraction of the release (R_r) is equal to 68% of the total release volume (silt and pan only). This conservatively assumes all particles 30 μ m and below are respirable. The total volume of respirable soil suspended is therefore 68% of 17,500 kg (38,400 lb), or 11,900 kg (26,110 lb). This release volume was used for calculation of radiological consequences for the accident scenario. For calculation of toxicological

consequences, the total amount released [17,500 kg (38,400 lb)] was used in order to account for toxicological routes of exposure other than inhalation (such as skin contact).

The atmospheric dispersion factors (χ/Q values) selected for use in determination of radiological and toxicological consequences are acute values computed for each receptor of concern. Values corresponding to a 13 m/s (30 mi/h) wind speed were used to provide conservatism in the analysis, as these values provide the lowest degree of dispersion while corresponding to a wind speed close to the threshold required to initiate suspension. These values and an explanation of their derivation by WHC are included in Appendix A. The GXQ computational model used for these factors does not account for the phenomenon of plume meander in order to provide an assessment of the maximum instantaneous exposure at the receptor location. The nearest offsite receptor is located at a distance of 13,300 m (43,640 ft) east of the facility. The nearest onsite receptor is located at a distance of 550 m (1,800 ft) east of the facility, at the U.S. Ecology, Inc. Low-Level Waste Disposal Site; this employee is not subject to the administrative controls used to limit exposure for facility workers. The distance to this facility has been estimated conservatively from the position of disposal operations at the end of the facility life, rather than from a location on the central axis of the projected disposal operations to be conducted under Project W-296. The maximally impacted facility worker is assumed to be at a distance of 100 m (300 ft) from the central axis of the Project W-296 trench; every worker is assumed to see the same consequences as the worker located in the maximally impacted compass sector. All receptors are assumed to receive a combined dose from inhalation and submersion.

Acute unit baseline release doses calculated using the GENII dosimetry code were supplied by WHC and are included in Appendix A. For known waste constituents, whole body inhalation and submersion yearly CEDE and maximum organ inhalation and submersion committed dose equivalent values were provided.

The product of the appropriate atmospheric dispersion factor (χ/Q) selected from Table 2 of Appendix A, the appropriate baseline unit release dose (D_b) selected from Table 3 of Appendix A, the total volume of respirable soil suspended (R_r) as calculated above, and the concentration of the radionuclide in the source term (C) gives the dose due to the wind storm accident scenario (D_w) at the receptor location due to a specific radionuclide:

$$D_w = (\chi/Q) (D_b) (R_r) (C)$$

The maximum dose due to inhalation and submersion for the receptor is the dose that would be received if the entire release were composed of the radionuclide which results in the highest of the individually calculated radionuclide-specific doses. Since the composition is identical to that stated for normal operations (Table 5-2), Ra-226 is again identified as the maximum dose contributor. The maximum dose is divided by a factor of three to obtain the dose to onsite receptors, as these receptors are exposed only 8 hours as opposed to the offsite receptor, who is exposed for the full 24 hours. These values are extremely conservative because personnel would not remain outside in a high wind event for the entire 8 or 24 hour duration, but since no definite times could be identified full duration values were assumed to ensure a conservative estimate of consequences. Table 5-7 provides a comparison of the projected maximum dose from a wind storm event with the applicable acceptance criteria in

the form of the DOE annual exposure limits for the public as established in DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (DOE 1990), and for the onsite and facility worker as established in DOE Order 5480.11, *Radiation Protection for Occupational Workers* (DOE 1988), and DOE Annual Dose Guidance Values as given in DOE/EH-0256T (Rev. 1), *Radiological Control Manual*, (DOE 1994). These doses are below all applicable DOE limits. The doses are also below the WHC Risk Acceptance Guideline Values (WHC 1992) for anticipated frequency events, which are set at 5 rem effective dose equivalent (EDE) whole body and 50 rem committed dose equivalent (CDE) maximum organ for onsite receptors and 0.5 rem EDE whole body and 5 rem CDE maximum organ dose for offsite receptors.

Calculation of consequences using the values given in the *Environmental Restoration Disposal Facility Waste Acceptance Criteria* (WHC 1994) results in concentrations of hazardous materials (Chrysene and Iron) above the WHC risk acceptance criteria for facility workers. These potential exposures may be lowered through implementation of engineered features or administrative controls. Reduction of waste acceptance limit concentrations for Iron to $7.44\text{E}+03$ mg/kg, and Chrysene to $1.49\text{E}+03$ mg/kg could result in reduction of airborne concentrations of these constituents to limits below the WHC risk acceptance criteria for these constituents. Bolded values in Table 5-9 indicate where conditional compliance can be attained if the waste acceptance limit values are reduced to the values given above.

Table 5-7 Radiological Impacts of Wind Storm Dispersion

Receptor Location	Effective Dose Equivalent [Sv (rem)]	DOE Annual Exposure Limit [Sv (rem)]	DOE Annual Dose Guidance Values [Sv (rem)]	Compliant
Facility Worker	2.07E-03 (2.07E-01)	5.0E-02 (5.0E+00)*	2.0E-02*** (2.0E+00)	Yes
Onsite Worker	1.02E-04 (1.02E-02)	5.0E-02 (5.0E+00)*	2.0E-02*** (2.0E+00)	Yes
Site Boundary	2.19E-06 (2.19E-04)	1.0E-03 (1.0E-01)**	1.0E-04**** (1.0E-02)	Yes

* Annual occupational limit (DOE 1988)

** Annual public limit (DOE 1990)

*** Annual guidance values (DOE 1992b)

**** Annual reporting value (DOE 1990)

The airborne radionuclide concentration is also of concern in determining the adequacy of facility design and potential requirements for respiratory protection. Table 5-8 provides a comparison of the expected airborne radionuclide concentrations at the receptor locations with the DAC values listed in DOE Order 5480.11, *Radiation Protection for Occupational Workers* (DOE 1988). The wind storm event will cause airborne concentrations as high as 84-times the DAC at the facility worker location and 4-times the DAC at the onsite worker location for up to 24-hours. These levels are of serious concern.

Table 5-8. Airborne Radionuclide Concentrations at Receptor Locations Due to a Wind Storm

Radionuclide	Instant Airborne Concentration at Facility Worker (100 m ESE) (Ci/m ³)	Derived Air Concentration Values (Ci/m ³)	Percentage of Derived Air Concentration
¹⁴ C	2.10E-13	1.00E-06	< 1 %
²² Na	**	3.00E-07	< 1 %
⁴⁰ K	6.89E-09	2.00E-07	3 %
⁶⁰ Co	5.99E-08	1.00E-08	599 %
⁹⁰ Sr	8.99E-09	2.00E-09	449 %
⁹⁹ Tc	2.58E-13	3.00E-07	< 1 %
¹³⁷ Cs	3.00E-07	7.00E-08	428 %
¹⁵² Eu	1.05E-09	1.00E-08	10 %
¹⁵⁴ Eu	1.65E-08	8.00E-09	206 %
¹⁵⁵ Eu	**	4.00E-08	< 1 %
²²⁶ Ra	7.19E-10	3.00E-10	240 %
²²⁸ Th	**	4.00E-12	< 1 %
²³² Th	2.40E-12	5.00E-13	479 %
²³³ U/ ²³⁴ U	**	2.00E-11	< 1 %
²³⁵ U	**	2.00E-11	< 1 %
²³⁸ U	7.49E-15	2.00E-11	< 1 %
²³⁸ Pu	1.50E-11	3.00E-12	449 %
²³⁹ Pu/ ²⁴⁰ Pu	8.99E-12	2.00E-12	449 %
²⁴¹ Am	8.99E-12	2.00E-12	449 %

χ/Q values and dose conversion factors taken from Appendix A.

Worst-case solubilities were used for all isotopes.

** The Waste Acceptance Criteria (WHC 1994b) does not provide limits for these radionuclides.

The product of the appropriate atmospheric dispersion factor (χ/Q) selected from Table 2 of Appendix A, the total release of respirable suspended soil (R_r) as calculated above, and the concentration of the chemical constituent in the source term (C) is the highest concentration of that constituent produced at the selected receptor location due to normal operations (C_a):

$$C_a = (\chi/Q) (R_r) (C)$$

The hazardous material concentrations to which the receptors of concern (as described above) are exposed are listed in Table 5-9. The table also provides risk acceptance criteria taken from WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992) Section 7.0. This criteria allows concentrations below ERDF-1 or the TLV-TWA or OSHA PEL offsite and ERPG-2 or the TLV-C onsite for anticipated events.

Table 5-9. Airborne Hazardous Material Concentrations at Receptor Locations Due to a Wind Storm

Inorganic Metal/ Compound	Airborne Concentration (100 m ESE) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (13,300 m E) (mg/m ³)	Hazard Exposure Route	Permissible Exposure Limits (mg/m ³)
Aluminum	9.02E-01	4.42E-02	3.17E-04	Toxic, Reactive ing, ipr, sbc	1.50E+01
Antimony	2.64E-05	1.30E-06	9.30E-09	Toxic, Carcinogenic ipr, ing, inh, sbc	5.00E-01
Arsenic	2.20E-07	1.08E-08	7.75E-11	Toxic, Carcinogenic sbc, ipr, ing	1.00E-02
Barium	1.36E-01	6.69E-03	4.80E-05	Toxic ing, sbc, par	5.00E-01
Beryllium	1.76E-05	8.65E-07	6.20E-09	Toxic, Carcinogenic ipr, sbc	2.00E-03
Cadmium	2.20E-05	1.08E-06	7.75E-09	Toxic, Carcinogenic ing, ipr, sbc	2.00E-01
Calcium	0.00E+00	0.00E+00	0.00E+00	Toxic ing, ipr	5.00E+00
Chromium	4.40E-04	2.16E-05	1.55E-07	Toxic, Carcinogenic ing, ipr, sbc	1.00E+00
Cobalt	1.81E-03	8.86E-05	6.35E-07	Toxic, Carcinogenic ing, ipr, sbc	1.00E-01
Copper	4.40E-03	2.16E-04	1.55E-06	Toxic ing, ipr, par, sbc	1.00E+00
Iron	4.33E+00	2.13E-01	1.52E-03	Toxic ing	1.00E+00
Lead	1.10E-02	5.40E-04	3.87E-06	Toxic, Carcinogenic ing, ipr, sbc	5.00E-02
Magnesium	1.60E-01	7.85E-03	5.62E-05	Toxic ing, ipr, sbc	1.50E+01
Manganese	2.20E-04	1.08E-05	7.75E-08	Toxic, Reactive inh, ipr, sbc	5.00E+00
Mercury	8.81E-06	4.32E-07	3.10E-09	Toxic inh, ing, ipr	1.00E-01
Nickel	4.40E-04	2.16E-05	1.55E-07	Toxic, Carcinogenic ing, ipr, sbc	1.00E+00
Potassium	1.31E-01	6.41E-03	4.59E-05	Toxic ing, ipr	2.00E+00
Selenium	4.40E-05	2.16E-06	1.55E-08	Toxic inh	2.00E-01
Silver	4.40E-04	2.16E-05	1.55E-07	Toxic ing, inh, ipr, sbc	1.00E-02
Sodium	1.21E-02	5.92E-04	4.25E-06	Toxic ing	2.00E+00
Thallium	3.44E-06	1.69E-07	1.21E-09	Toxic ing, sbc	1.00E-01
Vandium	3.44E-04	1.69E-05	1.21E-07	Toxic sbc	5.00E-01
Zinc	2.20E-02	1.08E-03	7.75E-06	Toxic sbc, ipr	5.00E+00

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, int - intravenous,
sbc - subcutaneous, par - parenteral

Values indicated in bold face text are above risk acceptance criteria (WHC 1992).

Table 5-9 (continued). Airborne Hazardous Material Concentrations at Receptor Locations Due to a Wind Storm

Organic Chemical	Airborne Concentration (100 m ESE) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (13,300 m E) (mg/m ³)	Hazard Exposure Route	Permissible Exposure Limits (mg/m ³)
Acetone	1.23E-03	6.05E-05	4.34E-07	Toxic, Ignitable inh	2.50E+03
Benzene	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic, Ignitable inh, cut	3.25E+00
2-Butanone (Methyl ethyl ketone)	1.45E-03	7.13E-05	5.11E-07	Toxic, Ignitable inh	5.90E+02
Carbon disulfide	0.00E+00	0.00E+00	0.00E+00	Toxic, Ignitable inh, ing	6.32E+01
1,2-Dichloroethane (Ethylene dichloride)	4.40E-04	2.16E-05	1.55E-07	Toxic, Ignitable ing, inh	2.02E+02
4-Methyl-2-Pentanone (Hexone)	1.22E-02	6.01E-04	4.31E-06	Toxic, Ignitable ing, inh	4.10E+02
Methylene Chloride (Methane Dichloride)	9.16E-04	4.50E-05	3.22E-07	Toxic, Carcinogenic ing, inh, sbc	1.77E+03
Tetrachloroethane	4.97E-03	2.44E-04	1.75E-06	Toxic, Carcinogenic inh, ing	3.50E+01
Toluene	8.17E-03	4.01E-04	2.88E-06	Toxic, Ignitable inh	7.66E+02
Trichloroethene	2.55E-03	1.25E-04	8.96E-07	Toxic, Ignitable inh	5.46E+02
Vinyl Chloride	1.36E-03	6.66E-05	4.77E-07	Toxic, Carcinogenic, Ignitable inh, ing	2.60E+00
Acenaphthene	1.24E-01	6.06E-03	4.35E-05	N/A	N/A
Aroclor-1248 (PCB)	4.40E-05	2.16E-06	1.55E-08	Toxic, Carcinogenic, Ignitable inh, cut	N/A
Aroclor-1254 (PCB)	4.40E-05	2.16E-06	1.55E-08	Toxic, Carcinogenic, Ignitable inh, cut	5.00E-02
Aroclor-1260 (PCB)	4.40E-05	2.16E-06	1.55E-08	Toxic, Carcinogenic, Ignitable inh, cut	N/A
Anthracene	6.17E-01	3.03E-02	2.17E-04	Toxic, Ignitable cut	N/A
Benzo(a)anthracene (Benz(a)anthracene)	3.96E-05	1.95E-06	1.39E-08	Toxic, Carcinogenic cut	N/A
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic sbc	N/A
Benzo(j)fluoranthene	5.28E-05	2.59E-06	1.86E-08	Carcinogenic	N/A
Benzo(ghi)perylene	2.20E+01	1.08E+00	7.75E-03	Carcinogenic	N/A
Benzo(k)fluoranthene	3.74E+01	1.84E+00	1.32E-02	Carcinogenic	N/A
Benzoic Acid	3.74E-05	1.84E-06	1.32E-08	Toxic, Ignitable sbc, ing	N/A

Values indicated in bold face text are above the risk acceptance criteria (WHC 1992).

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, int - intravenous, sbc - subcutaneous, par - parenteral

N/A - No data available

Table 5-9 (continued). Airborne Hazardous Material Concentrations at Receptor Locations Due to a Wind Storm

Organic Chemical	Airborne Concentration (100 m ESE) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (13,300 m E) (mg/m ³)	Hazard Exposure Route	Permissible Exposure Limits (mg/m ³)
Bis(2-ethylhexyl) phthalate	6.61E+01	3.24E-02	2.32E-04	Toxic, Carcinogenic ing, inh	5.00E+00
Butylbenzylphthalate	9.07E-03	4.45E-04	3.19E-06	Carcinogenic, Ignitable ing, inh	N/A
Carbazole	2.20E-05	1.08E-06	7.75E-09	Toxic, Carcinogenic ing	N/A
Carbon Tetrachloride	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic ing, inh	6.39E+01
4-Chloro-3-Methylphenol	0.00E+00	0.00E+00	0.00E+00	Reactive inh	N/A
2-Chlorophenol	2.65E-02	1.30E-03	9.31E-06	Toxic, Ignitable ing, subc	N/A
Chloroform	3.08E-05	1.51E-06	1.08E-08	Toxic, Carcinogenic inh, ing	2.48E+02
4-Chloroaniline	1.39E-04	6.81E-06	4.88E-08	Toxic ing, inh, cut, subc	N/A
Chrysene (Coal tar pitch)	1.67E-01	8.21E-01	5.89E-03	Carcinogenic cut	2.00E-01
Di-n-octyl-phthalate	0.00E+00	0.00E+00	0.00E+00	Toxic ing	N/A
Di-n-butyl-phthalate	6.48E-05	3.18E-06	2.28E-08	Toxic ing	5.00E+00
Dibenzofuran (Diphenylene Oxide)	0.00E+00	0.00E+00	0.00E+00	N/A	N/A
1,3 Dichlorobenzene	1.76E-05	8.65E-07	6.20E-09	Toxic inh, ing, subc	4.58E+02
1,4 Dichlorobenzene	4.47E-03	2.19E-04	1.57E-06	Toxic inh, ing, subc	4.58E+02
Diethyl phthalate	1.43E-02	7.03E-04	5.04E-06	Toxic ing, subc	5.00E+00
Ethylbenzene	3.08E-03	1.51E-04	1.08E-06	Toxic, Ignitable ing, inh, cut	4.41E+02
Fluoranthene	7.27E-01	3.57E-02	2.56E-04	Toxic ing, cut	N/A
Fluorene	5.51E-02	2.70E-03	1.94E-05	N/A	N/A
Indeno(1,2,3-cd)pyrene	8.81E-01	4.32E-02	3.10E-04	Carcinogenic	N/A
2-Hexanone	0.00E+00	0.00E+00	0.00E+00	Toxic ing, inh, cut	4.17E+02
2-Methylnaphthalene	5.73E-04	2.81E-05	2.01E-07	Toxic ing	N/A
4-Methylphenol (p-Cresol)	2.20E-05	1.08E-06	7.75E-09	Toxic, Ignitable ing, cut, subc	1.90E+01

Values indicated in bold face text are above the risk acceptance criteria (WHC 1992).

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, int - intravenous,
sbc - subcutaneous, par - parenteral

N/A - No data available

Table 5-9 (continued). Airborne Hazardous Material Concentrations at Receptor Locations Due to a Wind Storm

Organic Chemical	Airborne Concentration (100 m ESE) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (13,300 m E) (mg/m ³)	Hazard Exposure Route	Permissible Exposure Limits (mg/m ³)
Naphthalene	6.17E-02	3.03E-03	2.17E-05	Toxic ing, inh, subc	5.00E+01
2-Nitrophenol	7.49E-06	3.67E-07	2.63E-09	Toxic ing, subc	N/A
N-Nitrosodiphenylamine	1.63E-06	8.00E-08	5.73E-10	Toxic, Carcinogenic ing	N/A
Pentachlorophenol	3.74E-05	1.84E-06	1.32E-08	Toxic, Carcinogenic ing, cut, subc	5.00E-01
Phenathrene	1.06E+00	5.19E-02	3.72E-04	Toxic, Ignitable Carcinogenic ing	N/A
Phenol	3.15E-03	1.55E-04	1.11E-06	Toxic ing, subc, cut	1.90E+01
1,1,1-Trichloroethane	0.00E+00	0.00E+00	0.00E+00	Toxic ing, inh, subc, cut	4.50E+01
Pyrene	5.28E-01	2.59E-02	1.86E-04	Toxic inh	N/A
Xylenes	5.73E-05	2.81E-06	2.01E-08	Toxic, Ignitable ing, inh, cut	4.41E+02
Dichlorophenoxyacetic acid	0.00E+00	0.00E+00	0.00E+00	Toxic ing, cut	1.00E+01
Chlordane	9.03E-01	4.43E-02	3.18E-04	Toxic ing	N/A
2,2-bis-p-chlorophenyl-1,1-dichloroethylene	5.51E-01	2.70E-02	1.94E-04	Toxic ing	N/A
Aldrin	1.76E-07	8.65E-09	6.20E-11	Toxic ing, cut	2.50E-01
Lindane	6.61E-02	3.24E-03	2.32E-05	Toxic, Carcinogenic ing	N/A
Dieldrin	2.20E-08	1.08E-09	7.75E-12	Toxic, Carcinogenic ing	2.50E-01
Endrin	3.52E-07	1.73E-08	1.24E-10	Toxic ing, cut	1.00E-01
Chlordane	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic ing, inh, cut	5.00E-01
Heptachlor	1.76E-07	8.65E-09	6.20E-11	Toxic, Carcinogenic ing, cut	5.00E-01
Methoxychlor	4.40E-04	2.16E-05	1.55E-07	Toxic ing	1.00E+01
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00	0.00E+00	Carcinogen, Tumorigen	N/A
1,1,2,2-Tetrachloroethane	0.00E+00	0.00E+00	0.00E+00	Poison, Toxic ing, inh, ipr, subc	3.50E+01

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, int - intravenous,

subc - subcutaneous, par - parenteral

N/A - No data available

The average levels of respirable particles generated during the windstorm event are below the OSHA PEL of 5 mg/m³ for nuisance dust. Acute concentrations for all chemical waste constituents except iron and chrysene are below the OSHA PELs at all receptor locations. The acute concentration of iron is 4.5-times the PEL at the location of the facility worker. The acute concentrations of chrysene are 84- and 4-times the PEL for the facility and onsite workers, respectively. Comparison of the acute concentration estimate to the acute exposure limit (TLV-C), or in the absence of a published acute exposure limit to a value 3- to 5-times the PEL as recommended by ACGIH, shows that iron concentrations are acceptable for the facility worker. The acute concentration of chrysene is 16-times the acute exposure limit for facility worker and acceptable for the onsite worker.

5.3.3 Container Spill

Abnormal events involving container breach have the potential to provide a path for dispersion of relatively small amounts of bulk waste soil and fugitive dust. This type of release will actually be similar in nature to normal disposal operations, although much smaller in magnitude than the fugitive releases resulting from a normal operational shift, as only one container is involved. The release from the container spill will be larger than any one-container release during normal operations because the waste soil will not have been treated by application of dust suppressants.

This acute exposure scenario consists of a postulated incident in which a single container of waste bulk soil is spilled due to an operator error allowing unplanned dumping or a vehicle accident which breaches the container. The contents of a breached container are assumed to be ejected from the container with sufficient force to create an amount of fugitive dust comparable to the amount released in dumping the contents of a container down the trench working face. The plume will originate from the point of the release, which is presumed to occur on or adjacent to a facility road or transfer pad. Spill cleanup is assumed to be accomplished promptly using front end loaders and vacuum trucks. Some additional fugitive dust will be created in the process of spill cleanup; this release is assumed to be comparable in magnitude to the release resulting from spreading and compaction of one container of bulk waste soil in the disposal trench. Because waste handling will not occur at wind speeds of greater than 6.7 m/s (15 mi/h), the contribution of wind suspension to the release is considered to be negligible.

Qualitative analysis of the hazards presented by this accident including preventive and mitigative features and a determination of risk is shown in Table 5-10. This analysis was generated using the qualitative consequence analysis technique provided in DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (DOE 1992a) and the SNL guidance document *Methodology for Evaluation Safety Related Features for a Category 3 Nonreactor Nuclear Facility* (SNL 1993) for Hazard Category 3 facilities.

Table 5-10. Accidental Container Breach and Spill

Causes	Human error during transport or transfer operations, equipment failure, loss of operator control.
Preventive Features	
Design:	None
Administrative:	Access control of area, equipment maintenance program, personnel trained in radiation safety principles and ALARA, standard operating procedures in place.
Method of Detection	Audio/visual monitoring of container handling operations and container dumping.
Mitigation Features	
Design:	Vehicles equipped with dust filters and remote operating capability.
Administrative:	Personnel trained in incident response, dedicated cleanup (vacuum) equipment available onsite for prompt response, personal protective equipment.
Potential Impact	Low level contamination spread in immediate vicinity, exposure of operators to fugitive dust, contamination of equipment.
Risk Determination	
Probability Level:	Medium
Consequence Level:	Low
Risk Level:	Low

The rate of dust generation for the container spill (R_s) is made up of three components: the rate of dust generation from the actual spill or container breach (R_b); the rate of dust generation from clean up operations (R_c); and the rate of dust generation due to wind suspension (R_w). The rate of dust generation from a container breach (R_b) is assumed to be similar to the rate of dust generation from unloading bulk soil at a trailer tipper with no application of dust suppressant credited. The *Dust Mitigation Study for the Environmental Restoration Disposal Facility* (DOE/RL 1994b) defines the rate of fugitive dust generation from dumping operations as 32 kg/h (70 lb/h) for the unloading of 215 containers over a 6.5 hour working shift. The amount of dust generated from the dumping of one container (R_b) is therefore 1 kg (2 lb) for dry waste soil. The rate of dust generation from clean-up operations (R_c) is assumed to be similar to the rate of dust generation from waste spreading and compacting, if a soil moisture content of only one percent is assumed. The Dust Mitigation Study defines the component R_c as equal to 64 kg/h (140 lb/h). The component R_w will be equal to 0 kg/h (lb/h) because operations involving bulk soil handling will be conducted only below windspeeds of 6.7 m/s (15 mi/h), and wind resuspension of fugitive dust will not be initiated below this windspeed. A total time of 30 s has been assumed for the actual spill, with cleanup operations occurring over the 2 h time period immediately following the incident. The total amount of the release (R_s) for the postulated spill is therefore 128 kg (282 lb):

$$R_s = R_b + 2(R_c) + R_w$$

The respirable portion of the fugitive dust release will consist of particles below

10 μm in diameter. Using the soil composition data listed in Table 3-1, and assuming that the emissions consist of all constituent particles below 70 μm in diameter (very fine sand, silt, and pan), the respirable fraction of the release (R_r) is equal to 68% of the total (silt and pan only). The volume of respirable dust released is therefore 68% of 128 kg (282 lb), or 87 kg (192 lb). This release rate was used for calculation of radiological consequences for the accident scenario. For calculation of toxicological consequences, the total amount released [128 kg (282 lb)] was used in the calculations in order to account for toxicological routes of exposure other than inhalation.

The atmospheric dispersion factors (χ/Q values) selected for use in determination of radiological and toxicological consequences are acute values computed as the higher of the 99.5% maximum sector values and the 95% site-wide values for each receptor of concern. These values, and an explanation of their derivation by WHC, are included in Appendix A. The GXQ computational model used for the radiological dispersion factor takes into account the phenomenon of plume meander in order to provide an assessment of cumulative exposure over time. The GXQ computational model used for the toxicological dispersion factor does not account for the phenomenon of plume meander in order to provide an assessment of the maximum exposure at the receptor location over the exposure time. The maximally impacted offsite receptor is located at a distance of 18,400 m (60,300 ft) east of the facility. The nearest onsite receptor is located at a distance of 550 m (1800 ft) east of the facility, at the U.S. Ecology, Inc. Low-Level Waste Disposal Site; this individual is not subject to the administrative controls used to limit exposure for WHC workers. The distance to this facility has been estimated conservatively from the position of disposal operations at the end of the facility life, rather than from a location on the central axis of the projected disposal operations to be conducted under Project W-296. The maximally impacted facility worker is assumed to be at a distance of 100 m (300 ft) from the central axis of the Project W-296 trench; every worker is assumed to see the same consequences as the worker located in the maximally impacted compass sector. All receptors are assumed to receive a combined dose from inhalation and air submersion.

Acute unit baseline release doses calculated using the GENII dosimetry code were supplied by WHC. For known waste constituents, whole body inhalation and submersion annual effective dose equivalent and maximum organ inhalation and submersion committed dose equivalent values were provided. The unit dose factors are included in Appendix A.

The product of the appropriate atmospheric dispersion factor (χ/Q) selected from Table 2 of Appendix A, the appropriate baseline unit release dose (D_b) selected from Table 3 of Appendix A, the total volume of respirable soil suspended (R_r) as calculated above, and the concentration of the radionuclide in the source term (C) gives the dose due to the wind storm accident scenario (D_w) at the receptor location due to a specific radionuclide:

$$D_w = (\chi/Q) (D_b) (R_r) (C)$$

The maximum dose due to inhalation and submersion for the receptor is the dose that would be received if the entire release were composed of the radionuclide which results in the highest of the individually calculated radionuclide-specific doses. Since the waste composition is the same as that postulated for normal operations, the maximum dose will

again be the dose imparted assuming that the entire radiological concentration of the release is Ra-226. Table 5-11 provides a comparison of this projected maximum dose with the applicable acceptance criteria in the form of the DOE annual exposure limits for the public as established in DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (DOE 1990), and for the onsite and facility worker as established in DOE Order 5480.11, *Radiation Protection for Occupational Workers* (DOE 1988), and Annual Dose Guidance Values given in the DOE/EH-0256T (Rev. 1), *Radiological Control Manual*, (DOE 1994). All calculated doses are below the appropriate DOE limits, and below the WHC Risk Acceptance Guideline Values (WHC 1992) for anticipated events.

Table 5-11. Radiological Impacts of Container Breach and Spill

Receptor Location	Effective Dose Equivalent [Sv (rem)]	DOE Annual Limit [Sv (rem)]	DOE Annual Dose Guidance Value [Sv (rem)]	Compliant
Facility Worker	4.27E-09 (4.27E-07)	5.0E-02 (5.0E+00)*	2.0E-02*** (2.0E+00)	Yes
Onsite Worker	2.24E-10 (2.24E-08)	5.0E-02 (5.0E+00)*	2.0E-02*** (2.0E+00)	Yes
Site Boundary	4.04E-12 (4.04E-10)	1.0E-03 (1.0E-01)**	1.0E-04**** (1.0E-02)	Yes

* Annual occupational limit (DOE 1988)

** Annual public limit (DOE 1990)

*** Annual guidance values (DOE 1992b)

**** Annual reporting value (DOE 1990)

The airborne radionuclide concentration is also of concern in determining the adequacy of facility design and requirements for respiratory protection. Table 5-12 provides a comparison of the expected airborne radionuclide concentrations at the receptor locations with the DACs listed in DOE Order 5480.11, *Radiation Protection for Occupational Workers* (DOE 1988). The container spill scenario is estimated to cause airborne concentrations that are 1.0×10^{-4} times the DAC value.

The product of the appropriate atmospheric dispersion factor (χ/Q) selected from Table 2 of Appendix A, the total release of respirable suspended soil (R_r) as calculated above, and the concentration of the chemical constituent in the source term (C) is the highest concentration of that constituent produced at the selected receptor location due to normal operations (C_a):

$$C_a = (\chi/Q) (R_r) (C)$$

The hazardous material concentrations resulting from a spill event to the receptors of concern (as described above) are listed in Table 3-23. The table also provides a comparison of the expected concentrations at the receptor locations with the applicable risk acceptance criteria from WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992), Section 7.0. This criteria allows concentrations below ERPG-1 offsite and ERPG-2 onsite for anticipated events. In the absence of ERPG values, WHC-CM-4-46, *Nonreactor Facility Safety Analysis*

Manual (WHC 1992) allows the ACGIH TLV-TWA or the OSHA PEL to be used for the ERPG-1 and the ACGIH TLV-C to be used for the ERPG-2 value.

The average levels of respirable particles generated by facility operations are below the OSHA PEL of 5 mg/m³ for nuisance dust. Acute concentrations for all chemical waste constituents are below the OSHA PELs at all receptor locations.

Table 5-12. Airborne Radionuclide Concentrations at Receptor Locations Due to a Container Breach and Spill

Radionuclide	Instant Airborne Concentration (100 m ESE) (Ci/m ³)	Derived Air Concentration Values* (Ci/m ³)	Percentage of Derived Air Concentration
¹⁴ C	1.73E-18	1.00E-06	< 1%
²² Na	**	3.00E-07	< 1%
⁴⁰ K	5.68E-14	2.00 E-07	< 1%
⁶⁰ Co	4.94E-13	1.00E-08	< 1%
⁹⁰ Sr	7.41E-14	2.00E-09	< 1%
⁹⁹ Tc	2.12E-18	3.00E-07	< 1%
¹³⁷ Cs	2.47E-12	7.00E-08	< 1%
¹⁵² Eu	8.65E-15	1.00E-08	< 1%
¹⁵⁴ Eu	1.36E-13	8.00E-09	< 1%
¹⁵⁵ Eu	**	4.00E-08	< 1%
²²⁶ Ra	5.93E-15	3.00E-10	< 1%
²²⁸ Th	**	4.00E-12	< 1%
²³² Th	1.98E-17	5.00E-13	< 1%
²³³ U/ ²³⁴ U	**	2.00E-11	< 1%
²³⁵ U	**	2.00E-11	< 1%
²³⁸ U	6.18E-20	2.00E-11	< 1%
²³⁹ Pu	1.24E-16	3.00E-12	< 1%
²⁴⁰ Pu/ ²⁴¹ Pu	7.41E-17	2.00E-12	< 1%
²⁴¹ Am	7.41E-17	2.00E-12	< 1%

χ/Q values and dose conversion factors taken from Appendix A.

** Waste acceptance limits are not provided for these radionuclides (WHC 1994b).

Table 5-13. Airborne Hazardous Material Concentrations at Receptor Locations Due to a Container Breach and Spill

Inorganic Metal/ Compound	Airborne Concentration (100 m ESE) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (13,300 m E) (mg/m ³)	Hazard Exposure Route	Permissible Exposure Limits (mg/m ³)
Aluminum	2.26E-05	1.22E-06	8.35E-09	Toxic, Reactive ing, ipr, sbc	1.50E+01
Antimony	6.63E-10	3.59E-11	2.45E-13	Toxic, Carcinogenic ipr, ing, inh, sbc	5.00E-01
Arsenic	5.53E-12	2.99E-13	2.04E-15	Toxic, Carcinogenic sbc, ipr, ing	1.00E-02
Barium	3.42E-06	1.85E-07	1.26E-09	Toxic ing, sbc, par	5.00E-01
Beryllium	4.42E-10	2.39E-11	1.63E-13	Toxic, Carcinogenic ipr, sbc	2.00E-03
Cadmium	5.53E-10	2.99E-11	2.04E-13	Toxic, Carcinogenic ing, ipr, sbc	2.00E-01
Calcium	0.00E+00	0.00E+00	0.00E+00	Toxic ing, ipr	5.00E+00
Chromium	1.11E-08	5.98E-10	4.08E-12	Toxic, Carcinogenic ing, ipr, sbc	1.00E+00
Cobalt	4.53E-08	2.45E-09	1.67E-11	Toxic, Carcinogenic ing, ipr, sbc	1.00E-01
Copper	1.11E-07	5.98E-09	4.08E-11	Toxic ing, ipr, par, sbc	1.00E+00
Iron	1.09E-04	5.88E-06	4.01E-08	Toxic ing	1.00E+00
Lead	2.76E-07	1.49E-08	1.02E-10	Toxic, Carcinogenic ing, ipr, sbc	5.00E-02
Magnesium	4.01E-06	2.17E-07	1.48E-09	Toxic ing, ipr, sbc	1.50E+01
Manganese	5.53E-09	2.99E-10	2.04E-12	Toxic, Reactive inh, ipr, sbc	5.00E+00
Mercury	2.21E-10	1.20E-11	8.16E-14	Toxic inh, ing, ipr	1.00E-01
Nickel	1.11E-08	5.98E-10	4.08E-12	Toxic, Carcinogenic ing, ipr, sbc	1.00E+00
Potassium	3.28E-06	1.77E-07	1.21E-09	Toxic ing, ipr	2.00E+00
Selenium	1.11E-09	5.98E-11	4.08E-13	Toxic inh	2.00E-01
Silver	1.11E-08	5.98E-10	4.08E-12	Toxic ing, inh, ipr, sbc	1.00E-02
Sodium	3.03E-07	1.64E-08	1.12E-10	Toxic ing	2.00E+00
Thallium	8.62E-11	4.66E-12	3.18E-14	Toxic ing, sbc	1.00E-01
Vanadium	8.62E-09	4.66E-10	3.18E-12	Toxic sbc	5.00E-01
Zinc	5.53E-07	2.99E-08	2.04E-10	Toxic sbc, ipr	5.00E+00

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, int - intravenous,
sbc - subcutaneous, par - parenteral

Table 5-13 (continued). Airborne Hazardous Material Concentrations at Receptor Locations Due to a Container Breach and Spill

Organic Chemical	Airborne Concentration (100 m ESE) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (13,300 m E) (mg/m ³)	Hazard Exposure Route	Permissible Exposure Limits (mg/m ³)
Acetone	3.10E-08	1.67E-09	1.14E-11	Toxic, Ignitable inh	2.50E+03
Benzene	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic, Ignitable inh, cut	3.25E+00
2-Butanone (Methyl ethyl ketone)	3.65E-08	1.97E-09	1.35E-11	Toxic, Ignitable inh	5.90E+02
Carbon disulfide	0.00E+00	0.00E+00	0.00E+00	Toxic, Ignitable inh, ing	6.32E+01
1,2-Dichloroethane (Ethylene dichloride)	1.11E-08	5.98E-10	4.08E-12	Toxic, Ignitable ing, inh	2.02E+02
4-Methyl-2-Pentanone (Hexone)	3.07E-07	1.66E-08	1.13E-10	Toxic, Ignitable ing, inh	4.10E+02
Methylene Chloride (Methane Dichloride)	2.30E-08	1.24E-09	8.49E-12	Toxic, Carcinogenic ing, inh, sbc	1.77E+03
Tetrachloroethane	1.25E-07	6.74E-09	4.60E-11	Toxic, Carcinogenic inh, ing	3.50E+01
Toluene	2.05E-07	1.11E-08	7.57E-11	Toxic, Ignitable inh	7.66E+02
Trichloroethene	6.39E-08	3.45E-09	2.36E-11	Toxic, Ignitable inh	5.46E+02
Vinyl Chloride	3.40E-08	1.84E-09	1.26E-11	Toxic, Carcinogenic, Ignitable inh, ing	2.60E+00
Acenaphthene	3.10E-06	1.68E-07	1.14E-09	N/A	N/A
Aroclor-1248 (PCB)	1.11E-09	5.98E-11	4.08E-13	Toxic, Carcinogenic, Ignitable inh, cut	N/A
Aroclor-1254 (PCB)	1.11E-09	5.98E-11	4.08E-13	Toxic, Carcinogenic, Ignitable inh, cut	5.00E-02
Aroclor-1260 (PCB)	1.11E-09	5.98E-11	4.08E-13	Toxic, Carcinogenic, Ignitable inh, cut	N/A
Anthracene	1.55E-05	8.37E-07	5.71E-09	Toxic, Ignitable cut	N/A
Benzo(a)anthracene (Benz(a)anthracene)	9.95E-10	5.38E-11	3.67E-13	Toxic, Carcinogenic cut	N/A
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic subc	N/A
Benzo(j)fluoranthene	1.33E-09	7.17E-11	4.90E-13	Carcinogenic	N/A
Benzo(ghi)perylene	5.53E-04	2.99E-05	2.04E-07	Carcinogenic	N/A
Benzo(k)fluoranthene	9.40E-04	5.08E-05	3.47E-07	Carcinogenic	N/A
Benzoic Acid	9.40E-10	5.08E-11	3.47E-13	Toxic, Ignitable subc, ing	N/A
Bis(2-ethylhexyl) phthalate	1.66E-05	8.97E-07	6.12E-09	Toxic, Carcinogenic ing, inh	5.00E+00

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, int - intravenous, sbc - subcutaneous, par - parenteral

N/A - No data available

Table 5-13 (continued). Airborne Hazardous Material Concentrations at Receptor Locations Due to a Container Breach and Spill

Organic Chemical	Airborne Concentration (100 m ESE) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (13,300 m E) (mg/m ³)	Hazard Exposure Route	Permissible Exposure Limits (mg/m ³)
Butylbenzylphthalat	2.28E-07	1.23E-08	8.41E-11	Carcinogenic, Ignitable ing, inh	N/A
Carbazole	5.53E-10	2.99E-11	2.04E-13	Toxic, Carcinogenic ing	N/A
Carbon Tetrachloride	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic ing, inh	6.39E+01
4-Chloro-3-Methylphenol	0.00E+00	0.00E+00	0.00E+00	Reactive inh	N/A
2-Chlorophenol	6.64E-07	3.59E-08	2.45E-10	Toxic, Ignitable ing, subc	N/A
Chloroform	7.74E-10	4.18E-11	2.86E-13	Toxic, Carcinogenic inh, ing	2.48E+02
4-Chloroaniline	3.48E-09	1.88E-10	1.29E-12	Toxic ing, inh, cut, subc	N/A
Chrysene (Coal tar pitch)	4.20E-04	2.27E-05	1.55E-07	Carcinogenic cut	2.00E-01
Di-n-octyl-phthalate	0	0	0	Toxic ing	N/A
Di-n-butyl-phthalate	1.63E-09	8.80E-11	6.01E-13	Toxic ing	5.00E+00
Dibenzofuran	0.00E+00	0.00E+00	0.00E+00	N/A	N/A
1,3 Dichloro benzene	4.42E-10	2.39E-11	1.63E-13	Toxic inh, ing, subc	4.58E+02
1,4 Dichloro benzene	1.12E-07	6.06E-09	4.14E-11	Toxic inh, ing, subc	4.58E+02
Diethyl phthalate	3.59E-07	1.94E-08	1.33E-10	Toxic ing, subc	5.00E+00
Ethylbenzene	7.74E-08	4.18E-09	2.86E-11	Toxic, Ignitable ing, inh, cut	4.41E+02
Fluoranthene	1.82E-05	9.86E-07	6.73E-09	Toxic ing, cut	N/A
Fluorene	1.38E-06	7.48E-08	5.11E-10	N/A	N/A
Indeno(1,2,3-cd) pyrene	2.21E-05	1.20E-06	8.16E-09	Carcinogenic	N/A
2-Hexanone	0.00E+00	0.00E+00	0.00E+00	Toxic ing, inh, cut	4.17E+02
2-Methyl naphthalene	1.44E-08	7.77E-10	5.31E-12	Toxic ing	N/A
4-Methylphenol (p-Cresol)	5.53E-10	2.99E-11	2.04E-13	Toxic, Ignitable ing, cut, subc	1.90E+01
Naphthalene	1.55E-06	8.37E-08	5.71E-10	Toxic ing, inh, subc	5.00E+01
2-Nitrophenol	1.88E-10	1.02E-11	6.94E-14	Toxic ing, subc	N/A

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, int - intravenous, subc - subcutaneous, par - parenteral

N/A - No data available

Table 5-13 (continued). Airborne Hazardous Material Concentrations at Receptor Locations Due to a Container Breach and Spill

Organic Chemical	Airborne Concentration (100 m ESE) (mg/m ³)	Airborne Concentration (550 m E) (mg/m ³)	Airborne Concentration (13,300 m E) (mg/m ³)	Hazard Exposure Route	Permissible Exposure Limits (mg/m ³)
N-Nitrosodi phenylamine	4.09E-11	2.21E-12	1.51E-14	Toxic, Carcinogenic ing	N/A
Pentachlorophenol	9.40E-10	5.08E-11	3.47E-13	Toxic, Carcinogenic ing, cut, subc	5.00E-01
Phenathrene	2.65E-05	1.43E-06	9.80E-09	Toxic, Ignitable Carcinogenic ing	N/A
Phenol	7.92E-08	4.28E-09	2.92E-11	Toxic ing, subc, cut	1.90E+01
1,1,1-Trichloro ethane	0.00E+00	0.00E+00	0.00E+00	Toxic ing, inh, subc, cut	4.50E+01
Pyrene	1.33E-05	7.17E-07	4.90E-09	Toxic inh	N/A
Xylenes	1.44E-09	7.77E-11	5.31E-13	Toxic, Ignitable ing, inh, cut	4.41E+02
Dichlorophenoxy acetic acid	0.00E+00	0.00E+00	0.00E+00	Toxic ing, cut	1.00E+01
Chlodithane	2.27E-05	1.23E-06	8.37E-09	Toxic ing	N/A
2,2-bis-p-chlorophenyl	1.38E-05	7.47E-07	5.10E-09	Toxic ing	N/A
Aldrin	4.42E-12	2.39E-13	1.63E-15	Toxic ing, cut	2.50E-01
Lindane	1.66E-06	8.97E-08	6.12E-10	Toxic, Carcinogenic ing	N/A
Dieldrin	5.53E-13	2.99E-14	2.04E-16	Toxic, Carcinogenic ing	2.50E-01
Endrin	8.84E-12	4.78E-13	3.27E-15	Toxic ing, cut	1.00E-01
Chlordane	0.00E+00	0.00E+00	0.00E+00	Toxic, Carcinogenic ing, inh, cut	5.00E-01
Heptachlor	4.42E-12	2.39E-13	1.63E-15	Toxic, Carcinogenic ing, cut	5.00E-01
Methoxychlor	1.11E-08	5.98E-10	4.08E-12	Toxic ing	1.00E+01
Dibenzo(a,h) anthracene	0.00E+00	0.00E+00	0.00E+00	Carcinogen int	N/A
1,1,2,2-Tetrachloroethane	0.00E+00	0.00E+00	0.00E+00	Poison, Toxic ing, inh, ipr, subc	3.50E+01

Exposure Routes: ipr - intraperitoneal, ing - ingestion, inh - inhalation, int - intravenous,
subc - subcutaneous, par - parenteral

N/A - No data available

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5.3.4 EXTERNAL EVENTS

The consequences of accident conditions at nearby facilities as stated in the safety documentation for these facilities, and the distance separating those facilities from the ERDF are listed in Table 5-14. The most significant potential impact on ERDF is from a seismically-initiated event at the Plutonium Finishing Plant. None of the credible accidents for the facilities listed will impose life-threatening affects at ERDF.

Table 5-14 Potential Impacts of Other Facilities on ERDF

Site	Accident Description	Distance to Onsite Receptor [m (ft)]	Onsite Dose CEDE [Sv (rem)]	Distance to ERDF [m (ft)]	ERDF Whole Body CEDE [Sv (rem)]
Analytical Laboratories (222-S)	Seismic-induced fire (Lavender 1993)	900 (2950)	6.2E-3 (6.2E-1)	1100 (3600)	4.2E-3 (4.2E-1)
Tank Farms (101-SY)	Hydrogen explosion (Lentach 1993)	0.78 (2.5)	5.0E-3 (5.0E-1)	1200 (3900)	2.1E-9 (2.1E-7)
Transuranic Storage and Assay Facility (224-T)	Drum rupture and fire (Olson 1991)	550 (1800)	7.2E-3 (7.2E-1)	1200 (3900)	1.5E-3 (1.5E-1)
Double Shell Tank Farms (241-TX)	Filter rupture (Koontz 1986)	100 (305)	2.0E-3 (2.0E-1)	1300 (4250)	1.2E-5 (1.2E-3)
Plutonium Finishing Plant (234-5Z)	Seismic event (Szempruch 1993)	550 (1800)	1.6E-1 (1.6E+1)	2400 (7900)	8.4E-3 (8.4E-1)
Central Waste Complex (CWC)	Vehicle fire (Bonner 1992)	300 (980)	5.0E-2 (5.0E+0)	2800 (9200)	5.7E-4 (5.7E-2)
Evaporator (242-A)	Pump spray from DBE (Lavender 1993a)	100 (305)	2.9E-2 (2.9E+0)	4100 (13,450)	1.7E-5 (1.7E-3)
Aging Waste Tank Farms (241-AW)	Tank bump (Dunford 1989)	100 (305)	2.2E-1 (2.2E+1)	4000 (13,100)	1.4E-2 (1.4E+0)
Solid Waste Burial Grounds	Vehicle fire (Saito 1993)	180 (590)	9.0E-2 (9.0E+0)	2800 (9200)	2.7E-4 (2.7E-2)
U.S. Ecology LLW Disposal Site	Closure leakage	*	2.5E-4 (2.5E-3)	*	*

* Washington State Radioactive Materials License WN-1019-2 only places limits on public doses from normal operation and after trench closure of ≤ 25 mrem/y to the public.

Figure 5-1. Ground Contamination Contours for ERDF Operations - Near Field
(mg/m²)

Figure 5-2. Ground Contamination Contours for ERDF Operations - Far Field (mg/m²)

CAI-115-004-081594

Figure 5-3. Threshold Wind Velocity - Particle Diameter Relationship

79405040.25

Figure 5-4. Wind Velocity - Erosion Rate Relationship

79405040.24

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WHC-SD-W296-SAD-001, REV 0

**WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

CHAPTER 6.0

CONTROLS

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CONTENTS

- 6.0 CONTROLS**
- 6.1 INTRODUCTION**
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- 6.4 OPERATIONAL SAFETY REQUIREMENTS DOCUMENT CONTROLS**
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TABLES

Table 6-1 Safety Significant Items with Related OSRs

Table 6-2 Safety Significant Items without Related OSRs

LIST OF TERMS

ALARA	As Low As Reasonably Achievable
CEDE	Committed Effective Dose Equivalent
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy - Richland Operations Office
ERDF	Environmental Restoration Disposal Facility
ERPG	Emergency Response Planning Guideline
OSR	Operational Safety Requirements
U.S.	U.S. Department of Energy
WHC	Westinghouse Hanford Company

6.0 CONTROLS

This chapter identifies each barrier, feature, or administrative control required to mitigate the consequences or to preclude or reduce the probability of occurrence of Environmental Restoration Disposal Facility (ERDF) evaluation basis events analyzed in Chapter 5 of this document. Operational Safety Requirements (OSRs) provide a method for ensuring implementation of this minimum set of requirements necessary to ensure that the risk of operations is within the envelope described in this Safety Assessment. The ERDF OSRs will act in the capacity of an agreement or contract between U.S. Department of Energy (DOE) and Westinghouse Hanford Company (WHC) regarding the safe operation of the facility. Modifications to the OSRs will be controlled in the same manner and require the same approval level as modifications to the ERDF safety analysis documentation.

6.1 INTRODUCTION

This chapter furnishes concise, logical bases for each OSR proposed to be necessary at ERDF. These OSRs are required for mitigation of onsite accident condition consequences. The policies, programs, and specific procedures associated with controlling scenarios for normal, abnormal, and accident events are included in this Chapter with information on the method for implementation as administrative controls.

Application of the graded approach is demonstrated by the fact that no Safety Limits, Limiting Control Settings, or Limiting Conditions for Operation were identified as being required to ensure safe facility operation. This is consistent with the definition of ERDF as a low complexity, low hazard facility. The hazard categorization for ERDF is included in Chapter 3 of this document.

6.2 REQUIREMENTS

The basis for issuing OSRs is established by DOE Order 5480.22, *Technical Safety Requirements* (DOE 1992). This Order is implemented by WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* (WHC 1992), Chapter 6.0, "Technical Safety Requirements."

OSRs may consist of operational limits or administrative controls. The basic components of OSRs include:

- A concise definition of the operating limit;
- Specific surveillance actions required to ensure the operating limit is met;
- A logical basis for the operating limit and its surveillance actions;
- Defined administrative controls necessary to protect the public health and safety; and
- Defined administrative controls that reduce potential risk to the facility workers.

Safety Limits apply to process variables associated with passive physical barriers that are necessary for the intended facility function and are found to be required to guard against uncontrolled releases which would result in unmitigated accident consequence greater than 500 mrem committed effective dose equivalent (CEDE) or Emergency Response Planning Guide Level 2 (ERPG-2) offsite. No credible accident scenarios were identified for ERDF which require implementation of Safety Limits. Limiting Control Settings are implemented to prevent exceeding Safety Limits. Since no Safety Limits were identified, no Limiting Control Settings will be required at ERDF.

Limiting Conditions for Operations are implemented for items that detect, indicate, or act as the physical barrier to preclude an uncontrolled release greater than 500 mrem CEDE or ERPG-2 offsite, or greater than 5 rem CEDE or ERPG-3 onsite. No limiting conditions for operations were identified for ERDF.

Administrative Controls are established to ensure that facility operations are conducted in a safe manner. They include items such as organizational responsibilities, procedures, programs, staffing and operating support, training, and qualification requirements. There are three conditions identified at ERDF that require specific control as credited in the hazards analysis and accident consequence evaluation: 1) compliance with the facility waste acceptance criteria; 2) application of fixant materials to bulk waste soil and the working face of the disposal trench; and 3) monitoring of wind conditions or airborne contamination to halt waste soil placement during high wind conditions. These three conditions are addressed in seven identified Operational Controls. Other programmatic Administrative Controls are contained in later sections of this chapter.

6.3 OPERATIONAL SAFETY REQUIREMENTS DERIVATION

OSRs are derived based on the facility-specific requirements necessary to allow the facility to be operated as described in the Safety Analysis Report. The basis for each OSR can therefore be found within the Safety Analysis Report. The preliminary OSRs for ERDF which have been derived by WHC based on the information included in this Safety Assessment are attached to this document as Appendix B.

Chapters 3, 4, and 5 of this document contain descriptions of hazards and potential accident scenarios that are of concern for ERDF operation. These sections identify each preventive or mitigative feature that is required to control accident probability or consequences to within an acceptable risk envelope, including both administrative controls and safety significant items (structures, systems, or components).

6.3.1 Completeness of the Operational Safety Requirements

This section lists the features identified to be necessary to: satisfy assumptions made in the normal and accident event analyses; perform a significant worker safety function; or provide significant defense-in-depth. In addition, any structure, system, or component for which a OSR will not be provided is specifically listed with justification of the reasoning behind this decision.

The list of Safety Significant items identified for ERDF, and definitions of the safety function for each item are presented below, with those items having related OSRs listed in Table 6-1 and those without related OSRs listed in Table 6-2.

Table 6-1. Safety Significant Items with Related OSRs

Safety-Significant Item	Safety Function	Safety Class
Working Face Soil Fixant Application System	Provides fugitive dust and airborne contaminant control.	Not Yet Assigned
Trench Ambient Air Monitoring and Alarm System	This system provides fugitive dust and airborne contaminant detection. Data from this system is used to control doses to within the onsite limits.	Not Yet Assigned
Dust Suppressant Spray System on Trailers Tipper	Provides fugitive dust and airborne contaminant control credited in evaluation basis analysis.	Not Yet Assigned
Dust suppressant Mist Spray System on Dozers In Trench	Provides fugitive dust and airborne contaminant control credited in evaluation basis analysis.	Not Yet Assigned

6.3.2 Mode Development

This section presents information on expected operational conditions that establish characteristics to permit developing OSR modes.

For ERDF, there are four modes of facility operation tentatively identified:

- **OPERATION:** Normal activities such as receiving, transferring, transporting, dumping, spreading, and compacting waste soils will be conducted. Container decontamination, maintenance, and surveillance will also be performed. Leachate from the trench will be processed and decontamination liquid waste and leachate may be treated.
- **STANDBY:** Receipt of additional waste soil in containers may be allowed depending on available staging space. Placement of waste soil into the trench will not be allowed. Fixants may be applied to waste in placed but personnel must not occupy the trench working face. Facility maintenance and surveillance may be performed away from the trench working face. Leachate from the trench may be processed and decontamination liquid waste and leachate may be treated.
- **STABLE:** No activities or operations involving waste soil receipt, handling, or placement may be conducted. The trench working face has been covered with clean soil and soil fixant has been applied.

Table 6-2. Safety Significant Items without Related OSRs

Safety-Significant Items	Safety Function
Operations Building: Ventilation and Associated Systems for Radiological Control Area	This system provides airborne contamination control within the facility and for effluent exhaust. Because the contamination concentration is low, this system provides an implementation of ALARA practices for minimizing hazardous and radioactive material exposures.
Operations Building: Fire Protection System	This system provides fire suppression and alarm for facility protection and aid in evacuation. Because there is no large inventory at risk, it is not required to mitigate onsite or offsite hazardous or radioactive material releases.
Decontamination Facility: Building Structure	This system provides containment for potentially contaminated liquid effluent. It is backed up by the in-ground liner mat under the facility which provides an additional line of defense to prevent environmental releases.
Decontamination Facility: Fire Protection System	This system provides fire suppression and alarm for facility protection and aid in evacuation. Because there is no large, dispersible inventory at risk, it is not required to mitigate onsite or offsite hazardous or radioactive material releases.
Decontamination Facility: Piping for all systems except fire protection	This system provides containment for potentially contaminated liquid effluent. It is backed up by the in-ground liner mat under the facility which provides an additional line of defense to prevent environmental releases.
Decontamination Facility: Ventilation and Associated Systems for Radiological Control Area	This system provides contamination control within the facility and filtration of airborne effluent. It is not taken credit for in the consequence evaluation.
Decontamination Facility: Electrical System	This system provides primary power for facility ventilation system. It is not taken credit for in the consequence evaluation.
Wastewater Treatment Facility: Fire Protection System	This system provides fire suppression and alarm for facility protection and aid in evacuation. Because there is no large, dispersible inventory at risk, it is not required to mitigate onsite or offsite hazardous or radioactive material releases.
Trench Vehicles: Filtered Ventilation Intake Systems	This system reduces airborne contaminants from breathing zone for vehicle operators. It is not credited in the consequence evaluation, but implements ALARA practices for minimizing hazardous and radioactive material exposures.
Liquid Waste Transport Piping (Leachate/Decon/Stormwater)	These structures, systems, and components provide containment of and leakage detection for potentially contaminated liquid. Leakage of the liquid does not cause consequences greater than 500 mrem CEDE or ERPG-2 offsite, or 5 rem CEDE or ERPG-3 onsite.
Disposal Trench (Including Liner and Leachate Collection System)	These structures, systems, and components provide containment of and leakage detection for potentially contaminated liquid. Leakage of the liquid does not cause consequences greater than 500 mrem CEDE or ERPG-2 offsite, or 5 rem CEDE or ERPG-3 onsite.

- **RESTRICTED:** No operations may be conducted due to a safety violation or a mandated stoppage of work unless required by an approved Recovery Plan. Facility operations are shut down. Leachate may be processed and stored, and airborne sampling or monitoring may be conducted. Placement of an interim cover on the working face may be allowed if long-term inactivity is expected.

6.3.3 Operational Controls

Based on the criteria presented above, the following minimum operating conditions are required to ensure ERDF operation within the safety envelope documented in the safety analysis documentation:

- **Hazardous Material/Radioactive Material Concentration Limits:** All waste to be placed within the ERDF trench must be verified to comply with the *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Preliminary Draft (WHC 1994). This is necessary to ensure that the source term upon which consequence calculations were based is not exceeded. Each container manifest shall be confirmed to originate from an acceptable Hanford Site remediation location, to have a dose rate below ERDF waste acceptance limits, and to have an inventory of radionuclides below the waste acceptance concentration limits. Each manifest shall be logged to provide a traceable record of its verification.
- **Soil Fixant Application:** In order to control fugitive dust emissions application of a soil fixant preparation shall be performed when operations are halted due to wind conditions and after each operating shift during which soil placement has occurred.
- **Trench Air Monitoring:** In order to accurately define personnel exposures, air monitoring must be performed.
- **Operation of Trailer Tipper Dust Suppressant Spray System:** Control of fugitive dust generated in waste unloading is dependent on operation of the dust suppressant spray system installed on the trailer tippers. The consequence analysis credits a 2% increase in the moisture content of the waste soil during unloading and placement. This results in a total moisture content of more than 3%, which limits the dust generation rate to an estimated 4.5 kg/h (10 lb/h) for unloading of 215 containers in a 6.5 hour working shift. This increase in moisture content requires the addition of approximately 620 liters (164 gallons) of liquid to each container of waste soil.
- **Operation of Dozer Spray or Mister System:** Control of fugitive dust generated by movement of dozers on waste bulk soil for spreading and compacting is dependent on operation of a dust suppressant spray or mist system on the dozer or in the trench. This system is credited in the consequence analysis as maintaining fugitive dust generation at 4.5 kg/h/vehicle (10 lb/h/vehicle).
- **Halting Waste Placement During Windstorm Conditions:** Control of fugitive dust and operator exposures during windstorm conditions is dependent on cessation of waste handling operations. Fugitive dust transport occurs on untreated soil once the surface

crust has been penetrated, which will occur at windspeeds above 56 km/h (35 mph). Once penetration has occurred, transport continues for windspeeds as low as 24 km/h (15 mph). The consequence analysis assumes that operations will be halted at windspeeds above 24 km/h (15 mph).

- **Interim Cover Installation:** The quantity of contaminated fugitive dust available for dispersal is controlled in part by limiting the surface area of the waste soil pile exposed to wind and vehicle traffic through installation of a clean interim cover soil over surfaces where vehicles will operate. This is to be performed on a daily basis. This interim cover is credited in the consequence evaluation as limiting the surface area of bulk waste available for wind suspension and in the calculation of occupational exposure as providing additional distance between personnel and bulk waste.

6.3.4 Design Features Assessment

This section identifies the passive safety significant structures, systems, and components that are credited in the hazards analysis and accident consequence evaluations. These features are listed in the Safety Assessment to ensure awareness of their importance to the analysis and ensure that this importance is considered during final design modifications.

The following features are provided for environmental protection:

- **Trench Liner:** Because the trench liner is installed in sections, liner installation quality records must be confirmed to show acceptable installation prior to allowing placement of waste into each active trench cell. This precaution is taken to preclude contaminant transport to the environment. In addition to the initial installment inspection, weekly inspections of the trench must be performed to ensure that heavy equipment operations have not damaged the liner.
- **Concentric Piping:** Monitoring of concentric piping annuli between the trench, tankage, and Decontamination Building/Wastewater Treatment Facility will allow action to be taken to limit or preclude contamination spread to the environment. Monitoring of the interstitial space between concentric pipes for liquid is possible; the design does specify how this will be accomplished at this time. Any piping of non-concentric design must be monitored visually on a daily basis.
- **Liner Mat beneath the Decontamination Building and Wastewater Treatment Facility:** Monitoring of the liner mat beneath the buildings will allow action to be taken to limit or preclude contamination spread to the environment. The design does not currently define how monitoring will be performed.

The following features are provided to ensure personnel safety and exposure minimization:

- **Trench Vehicle Cab Filters:** High efficiency particulate air filters provided in vehicles that operate in the disposal trench and on the working face provide potential

reductions in hazardous and radioactive material intakes by facility workers. Performance of filters must be confirmed as described in Chapter 7 of this document.

- **Operations Building Controlled Rooms Ventilation:** Operation of the ventilation system provides contamination control within the facility, controls effluent releases, and implements ALARA practices for facility worker protection. This is not specifically credited in the safety documentation evaluations due to the extremely small inventory at risk.
- **Operations Building Fire Protection:** The fire protection system is designed to provide fire suppression and alarm annunciation capabilities to limit capital equipment and structural losses and aid in personnel evacuation in the event of a fire. This system is not specifically credited in the consequence evaluation due to the extremely small inventory at risk in the facility.
- **Decontamination Facility Structure:** The structure acts as a confinement for contaminants, but it does not serve a mitigative or preventive function in support of the safety documentation evaluations.
- **Decontamination Facility Piping:** The Decontamination Facility piping system provides containment for potentially contaminated water generated in the decontamination process. The design of this system provides dose control and implementation of ALARA principles, but is not credited in the consequence evaluation due to the extremely small inventory at risk.
- **Decontamination Facility Ventilation:** Operation of the ventilation system provides contamination control within the facility and controls effluent releases. This system is not specifically credited in the consequence evaluation due to the low dispersibility of the inventory at risk in the facility.
- **Decontamination Facility Electrical:** This system was identified as required to operate the facility ventilation. Since the ventilation was not credited in the consequence evaluation due to the extremely small inventory at risk, this system is not credited.
- **Decontamination Facility Fire Protection:** The fire protection system is designed to provide fire suppression and alarm annunciation capabilities to limit capital equipment and structural losses and aid in personnel evacuation in the event of a fire. This system is not specifically credited in the consequence evaluation due to the extremely small inventory at risk in the facility.
- **Wastewater Treatment Facility Fire Protection:** The fire protection system is designed to provide fire suppression and alarm annunciation capabilities to limit capital equipment and structural losses and aid in personnel evacuation in the event of a fire. This system is not specifically credited in the consequence evaluation due to the extremely small inventory at risk in the facility.

6.3.5 Administrative Controls

The following programs, organizations, procedures, record keeping, and reviews or audits are necessary to ensure the facility is operated safely and remains as described in this Safety Assessment:

- **Organization and Responsibilities Requirements:** Interfaces between WHC organizations have been credited to supply support to the ERDF operation to ensure safe operation. No facility-specific procedures and plans have been developed at this time for formalization of facility-specific arrangements. These procedures and plans will require development and analysis prior to facility operations.
- **Operating Procedures Control:** The operating procedures are credited to implement the requirement of the OSRs. Control of these procedures must be provided including initial production, modification, and distribution.
- **Programmatic Requirements:** Several programmatic areas were identified to provide significant worker protection features that are controlled through existing programs. These programs are credited as being part of the safety envelope: radiation protection, industrial hygiene, industrial safety, emergency preparedness, and fire protection. The programmatic requirements and provisions for implementation of requirements in these areas are addressed in other portions of this document.
- **Staffing Requirements:** Lines of responsibility and authority are ensured by providing minimum staffing and qualification requirements. This allows required OSR verifications to be performed and decisions to be made by authorized personnel.
- **Qualification and Training Requirements:** Details of these requirements are not provided at this time. Definition of qualification and training requirements will be necessary for the Final Safety Analysis Report stage of safety documentation.

6.4 OPERATIONAL SAFETY REQUIREMENTS DOCUMENT CONTROLS

The WHC configuration and document control system applies to Safety Analysis Reports and OSRs including annual reviews and updates. The primary requirements are identified in 10 CFR 830, *Nuclear Safety Management*, Section 830.120 "Quality Assurance" (CFR 1994), *Unreviewed Safety Questions* (DOE 1991a), 5480.22, *Technical Safety Requirements* (DOE 1992), and 5480.23, *Nuclear Facility Safety Analysis* (DOE 1992a).

The 10 CFR 830, *Nuclear Safety Management*, Section 830.120 "Quality Assurance" (CFR 1994), implements requirements for formal document control and specifies that facility safety documents be administered as configuration controlled documents, thus defining requirements for formal documentation and approval of changes. The WHC-CM-4-2, *Quality Assurance Manual* (WHC 1990), implements the requirements of this Order.

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Approval of document changes must be performed at the same level as the initial document approval for issuance. The controlled manual WHC-CM-4-46, *Nuclear Facility Safety Analysis* (WHC 1992), implements the requirements of this Order.

The DOE Order 5480.21, *Unreviewed Safety Questions* (DOE 1991a), provides a formal method to determine if facility- and process-related proposed changes or discovered conditions are outside of the described safety envelope. Evaluation of unreviewed safety question conditions is performed in accordance with requirements of WHC-CM-1-3, *Management Requirements and Procedures* (WHC 1991), MRP 5.12, "Identifying and Resolving Unreviewed Safety Questions," and WHC-CM-4-46, *Nuclear Facility Safety Analysis* (WHC 1992). Approved Unreviewed Safety Question evaluations are incorporated into the safety documentation text during scheduled annual updates.

6.5 REFERENCES

6.5.1 Documents

WHC, 1994, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Preliminary Draft, WHC-SD-W296-WAC-001, Westinghouse Hanford Company, Richland, Washington.

6.5.2 U.S. Department of Energy Orders

DOE, 1991a, *Unreviewed Safety Questions*, DOE Order 5480.21, U.S. Department of Energy, Washington, D.C.

DOE, 1992, *Technical Safety Requirements*, DOE Order 5480.22, U.S. Department of Energy, Washington, D.C.

DOE, 1992a, DOE Order 5480.23, *Nuclear Safety Analysis Reports*, U.S. Department of Energy, Washington, D.C.

6.5.3 Legal Documents

CFR, 1994, *Title 10 Code of Federal Regulations*, 10 CFR 830, *Nuclear Safety Management*, Section 830.120, "Quality Assurance," U.S. Department of Labor, Washington D.C.

6.5.4 Controlled Manuals

WHC, 1990, *Quality Assurance Manual*, WHC-CM-4-2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991, *Management Requirement and Procedures*, WHC-CM-1-3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992, *Nonreactor Facility Safety Analysis Manual*, WHC-CM-4-46, Westinghouse Hanford Company, Richland, Washington.

**Westinghouse
Hanford Company**

**Internal
Memo**

From: SWOSE
Phone: 376-8009
Date: May 13, 1994
Subject: UNIT RELEASES FOR THE ENVIRONMENTAL REMEDIATION DISPOSAL FACILITY
(ERDF) ACCIDENT ANALYSES

8D141-094-013

To: M. R. Greutman H4-70

cc: A. L. Bonner H4-70
J. P. Estrellado H4-70
F. G. Cain H4-70
J. P. Joyce H4-68
P. D. Rittman H0-36
MAM File/LB

Attached is the requested analysis. X/Q and "baseline" unit release doses are reported for use in ERDF accident analyses.

If you have any questions, do not hesitate to contact me.

Mark A. Medsker
Engineer

Attachments

ATTACHMENT 1

BASELINE UNIT RELEASE DOSES AND X/Q VALUES

000142

Baseline Unit Release Dose and X/Q Calculations for Accident Scenarios at the Environmental Remediation Disposal Facility Project W-296

M. A. Medsker
April 11, 1994

SUMMARY

This report contains the baseline unit release doses and the atmospheric dispersion factors (X/Qs) for use in the evaluation of normal operations and accident scenarios at the Environmental Remediation Disposal Facility (ERDF). The X/Q results are given in Table 2 for acute releases and Table 4 for releases from normal operations (chronic). The baseline unit release dose results are given in Table 3 for acute releases and Tables 5 and 6 for releases from normal operations (chronic).

INTRODUCTION

The ERDF is responsible for the disposal of radioactive wastes recovered in environmental remediation activities in the 100 and 300 areas. The wastes, predominantly bulk soils, will be placed into a large trench located just outside the southeastern fence of the 200 west area. When completed, the trench will measure 1,000 ft by 9,000 ft.

This report provides input into the calculation of dose consequences for normal operations and accident conditions associated with the ERDF. "Baseline" unit release doses and atmospheric dispersion factors (X/Qs) are provided for four defined cases: normal operations, abnormal operations, accident conditions (high winds), and accident conditions (other than high winds). These four cases are handled by dividing the report into two sections, one for chronic releases (normal operations) and one for acute releases (abnormal operations and accidents).

SOURCE TERM DESCRIPTION

The isotopes used in the calculations in this report, shown in Tables 3, 5 and 6, were specified by the customer (Attachment 2). The dose for each isotope includes the dose(s) from the daughters specified in Table 3. These same daughters were accounted for in the chronic calculations, but not shown in those tables for brevity. If no daughter is specified for a particular isotope, then any daughters of that isotope were not taken into account.

RECEPTOR DESCRIPTION

Calculations are performed for each of the following receptors for both acute and chronic releases. It is left to the accident analyst to choose the appropriate receptor.

100 m Maximum Receptor:

The greatest X/Q value calculated at a distance of 100 m from the point of release.

Next Nearest DOE Facility:

The receptor at the 222-S facility, approximately 1,100 m WNW.

Nearest non-DOE Facility:

The receptor at the U.S. Ecology low-level waste site, approximately 550 m E.

Nearest 24 hr Receptor:

The receptor at the Hanford Fire Station, approximately 1,800 m NE.

Present Site Boundary:

The receptor at the current Hanford Site boundary in the worst-case direction. In the cases where the meteorological conditions were specified by the accident scenario under analysis, the distance used was the closest point from the ERDF location to the site boundary, approximately 13,300 m SSW.

Alternate Site Boundary:

The receptor at the proposed Hanford Site boundary in the worst-case direction. The proposed Hanford Site boundary is defined here as identical to the current site boundary excluding lands west of Highway 240 and north of the Columbia River. This is intended to proactively account for lands on the Hanford Reservation which might revert to public use and control in the future. Otherwise, the alternate site boundary is treated identical to the present site boundary. For high wind conditions the closest distance from the ERDF location to the alternate site boundary is 4,300 m SSW or SW.

Agricultural Area:

N/A.

GENERAL TRANSPORT AND DOSE ASSUMPTIONS

The X/Q values calculated in this report are given as acute (release duration less than 8 hr) and chronic (release duration of 1 yr). Specific release durations of 8 hr to 1 yr were not provided. However, the acute X/Q values would be conservative for application to releases which last longer than 8 hr. In this case, the acute X/Q would over-estimate the concentration or dose consequence.

The list of isotopes specified by the customer in Attachment 2 includes three isotopes which have very short half-lives. Be-7 has a half-life of 53.4 days,

Cr-51 has a half-life of 27.7 days, and Co-58 has a half-life of 70.8 days. Over a period of 7 years (since the shut down of N-reactor), these isotopes have gone through 47.8, 92.2, and 36.1 half-lives respectively. Generally, an isotope is discounted in accident analyses if only 5 or 6 half-lives have passed. Therefore, these isotopes are not used in the calculations in this report.

ACUTE RELEASES

Transport and Dose Assumptions

The acute X/Q values reported here were calculated by the GXQ code (WHC 1993). Where applicable, credit was given for plume meander using the NRC methodology (NRC 1982) as implemented in the GXQ code. Table 1 shows the acute release scenarios specified by the customer and the models used to calculate the X/Qs.

In the high windspeed cases, no atmospheric stability class was specified by the customer. Therefore, based on the relative frequency of occurrence of each stability class at the higher windspeeds (PNL 1990, pg 6.49), Pasquill stability class D is used for all cases, except the 15 & 30 mph windspeeds. For these two windspeeds stability classes F & E were used respectively.

Table 1: Acute Release Scenarios Analyzed

Case	Accident Type	Models Used to Calculate X/Qs
1	Abnormal Operations, moderate windspeeds: 15, 30, and 45 mph	Acute X/Q, no plume meander due to high windspeeds
2	Accident Conditions, high windspeeds: 60, 75, 90, 105, and 120 mph	Acute X/Q, no plume meander due to high windspeeds
3	Accident Conditions, other than high windspeeds	Acute X/Q, 99.5% maximum sector compared with 95% site-wide per NRC; NRC RG 1.145 plume meander (NRC 1982) used for radiological materials (only when release or exposure time > 1 hr), no plume meander used for toxic materials

The acute baseline unit release doses in this report were calculated by the GENII dosimetry code (Napier, et al 1988). All GENII runs were made with an input X/Q value of 1.0 s/m^3 to obtain a unit dose which could be used with any of the acute X/Qs also in this report. Worst-case solubilities were used for all isotopes.

Dose Consequence Methodology

This report is intended to provide the customer with a simple and easy methodology for calculating the dose consequences from accidents at the ERDF.

Provided here are acute X/Q values and baseline unit release doses which may be multiplied together to find acute unit release values corresponding to numerous receptor locations and accident conditions.

To determine the dose consequences for a particular accident, the appropriate X/Q value is selected from Table 2 and multiplied by the appropriate baseline unit release dose in Table 3. This can then be multiplied by the amount of the material released in the accident (determined by the accident analysis) to determine the dose consequences. For example, an accidental release of Sr-90 to the maximally exposed 100 m receptor (60 mph windspeed) would have a whole body unit release dose of

$$\left(\frac{X}{Q}\right) \cdot (\text{Baseline Unit Release Dose}) = \text{Unit Release Dose}$$

$$\left(2.7E-04 \frac{s}{m^3}\right) \cdot \left(7.0E+01 \frac{\frac{rem\ EDE}{Ci}}{\frac{s}{m^3}}\right) = 1.9E-02 \frac{rem\ EDE}{Ci}$$

If it is assumed in this example that 10 Ci of Sr-90 were released as respirable particles from the accident, then the dose consequences would be

$$\begin{aligned} \text{Dose} &= (\text{Unit Release Dose}) \cdot (\text{Amount Released}) \\ &= \left(1.9E-02 \frac{rem\ EDE}{Ci}\right) \cdot (10Ci) \\ &= 1.9E-01\ rem\ EDE \end{aligned}$$

Acute X/Q values are given in Table 2 both with and without the effects of plume meander. The phenomenon of plume meander is the horizontal "wandering" of the plume that occurs as the wind shifts directions. Since the NRC model is used for the plume meander, it is appropriate only for radiological releases (or exposures) greater than one hour in length. For short duration radiological releases (less than one hour) and for releases of toxic materials it becomes difficult to justify the use of plume meander. Therefore, for the purposes of this report, the X/Q values in Table 2 which include the effects of plume meander should be used only when a release or exposure time of greater than one hour can be justified (for radiological materials only).

Results

X/Q Values:

The X/Q values for the various acute release scenarios and receptor locations are provided in Table 2. In all cases, the maximum X/Q value, denoted with an asterisk, should be used as this represents the maximally exposed individuals.

Table 2: Acute X/Q Values

Cases 1 and 2. High Windspeed X/Qs

15 mph Windspeed			30 mph Windspeed	
Receptor	Distance (m)	X/Q (s/m ³)	Distance (m)	X/Q (s/m ³)
100 m Max.	100	4.51E-03*	100	1.00E-03*
DOE Fac.	1100	7.71E-05*	1100	1.75E-05*
non-DOE	550	2.46E-04*	550	5.39E-05*
24 hr Rec.	1800	3.55E-05*	1800	7.98E-06*
Pres. Site	13300	2.39E-06*	13300	4.81E-07*
Alt. Site	4300	1.03E-05*	4300	2.24E-06*

45 mph Windspeed			60 mph Windspeed	
Receptor	Distance (m)	X/Q (s/m ³)	Distance (m)	X/Q (s/m ³)
100 m Max.	100	3.62E-04*	100	2.72E-04*
DOE Fac.	1100	5.61E-06*	1100	4.21E-06*
non-DOE	550	1.78E-05*	550	1.34E-05*
24 hr Rec.	1800	2.56E-06*	1800	1.93E-06*
Pres. Site	13300	1.28E-07*	13300	9.58E-08*
Alt. Site	4300	6.78E-07*	4300	5.09E-07*

75 mph Windspeed			90 mph Windspeed	
Receptor	Distance (m)	X/Q (s/m ³)	Distance (m)	X/Q (s/m ³)
100 m Max.	100	2.18E-04*	100	1.81E-04*
DOE Fac.	1100	3.37E-06*	1100	2.81E-06*
non-DOE	550	1.07E-05*	550	8.94E-06*
24 hr Rec.	1800	1.54E-06*	1800	1.29E-06*
Pres. Site	13300	7.67E-08*	13300	6.39E-08*
Alt. Site	4300	4.08E-07*	4300	3.40E-07*

105 mph Windspeed			120 mph Windspeed	
Receptor	Distance (m)	X/Q (s/m ³)	Distance (m)	X/Q (s/m ³)
100 m Max.	100	1.56E-04*	100	1.36E-04*
DOE Fac.	1100	2.41E-06*	1100	2.11E-06*
non-DOE	550	7.66E-06*	550	6.71E-06*
24 hr Rec.	1800	1.10E-06*	1800	9.65E-07*
Pres. Site	13300	5.48E-08*	13300	4.80E-08*
Alt. Site	4300	2.91E-07*	4300	2.55E-07*

Table 2 (cont.)

Case 2. Accident Conditions Other Than High Winds

<u>99.5% Maximum Sector and 95% Site Wide X/Qs without Plume Meander</u>			<u>99.5% Maximum Sector and 95% Site Wide X/Qs with Plume Meander</u>		
Sector	Distance (m)	X/Q (s/m ³)	Sector	Distance (m)	X/Q (s/m ³)
<u>100 m Max. Ind.</u>			<u>100 m Max. Ind.</u>		
S	100	1.56E-02	S	100	5.96E-03
SSW	100	1.13E-02	SSW	100	4.54E-03
SW	100	1.21E-02	SW	100	4.80E-03
WSW	100	1.22E-02	WSW	100	4.80E-03
W	100	2.80E-02	W	100	7.43E-03
WNW	100	1.60E-02	WNW	100	6.67E-03
NW	100	2.89E-02	NW	100	7.65E-03
NNW	100	2.90E-02	NNW	100	8.06E-03
N	100	3.12E-02	N	100	8.29E-03
NNE	100	1.54E-02	NNE	100	5.36E-03
NE	100	1.57E-02	NE	100	6.02E-03
ENE	100	2.52E-02	ENE	100	7.79E-03
E	100	3.41E-02	E	100	1.09E-02
ESE	100	3.25E-02	ESE	100	1.13E-02*
SE	100	3.07E-02	SE	100	8.37E-03
SSE	100	1.58E-02	SSE	100	6.20E-03
Site	100	3.44E-02*	Site	100	8.61E-03
<u>Next Nearest DOE Facility</u>			<u>Next Nearest DOE Facility</u>		
WNW	1100	2.78E-04*	WNW	1100	1.41E-04*
<u>Nearest non-DOE Facility</u>			<u>Nearest non-DOE Facility</u>		
E	550	1.86E-03*	E	550	5.94E-04*
<u>Nearest 24 hr Receptor</u>			<u>Nearest 24 hr Receptor</u>		
NE	1800	1.25E-04*	NE	1800	7.53E-05*

Table 2 (cont.)

99.5% Maximum Sector and
95% Site Wide X/Qs
without Plume Meander

Sector	Distance (m)	X/Q (s/m ³)
<u>Present Site Boundary</u>		
S	14400	7.08E-06
SSW	13300	4.92E-06
SW	16000	5.01E-06
WSW	15400	5.27E-06
W	15100	1.27E-05*
WNW	15400	6.99E-06
NW	18400	1.03E-05
NNW	19400	9.73E-06
N	21600	9.12E-06
NNE	29200	2.71E-06
NE	24200	3.73E-06
ENE	21000	7.67E-06
E	22700	9.33E-06
ESE	25400	7.77E-06
SE	21000	9.31E-06
SSE	18900	5.14E-06
Site	All	1.01E-05

Alternate Site Boundary

S	4600	3.23E-05
SSW	4300	2.57E-05
SW	4300	2.77E-05
WSW	5400	2.05E-05
W	6700	3.59E-05*
WNW	8000	1.61E-05
NW	12500	1.68E-05
NNW	12200	1.73E-05
N	12300	1.84E-05
NNE	18400	4.92E-06
NE	16700	5.96E-06
ENE	16500	1.03E-05
E	19200	1.15E-05
ESE	16300	1.34E-05
SE	11100	2.06E-05
SSE	6000	2.29E-05
Site-Wide	All	2.42E-05

99.5% Maximum Sector and
95% Site Wide X/Qs
with Plume Meander

Sector	Distance (m)	X/Q (s/m ³)
<u>Present Site Boundary</u>		
S	14400	6.44E-06
SSW	13300	4.46E-06
SW	16000	4.46E-06
WSW	15400	4.67E-06
W	15100	1.07E-05*
WNW	15400	6.65E-06
NW	18400	8.88E-06
NNW	19400	8.40E-06
N	21600	7.95E-06
NNE	29200	2.54E-06
NE	24200	3.54E-06
ENE	21000	6.84E-06
E	22700	8.15E-06
ESE	25400	6.88E-06
SE	21000	8.09E-06
SSE	18900	4.83E-06
Site	All	8.72E-06

Alternate Site Boundary

S	4600	2.54E-05
SSW	4300	1.67E-05
SW	4300	1.97E-05
WSW	5400	1.54E-05
W	6700	2.56E-05*
WNW	8000	1.48E-05
NW	12500	1.36E-05
NNW	12200	1.40E-05
N	12300	1.48E-05
NNE	18400	4.47E-06
NE	16700	5.55E-06
ENE	16500	8.98E-06
E	19200	9.81E-06
ESE	16300	1.12E-05
SE	11100	1.63E-05
SSE	6000	1.94E-05
Site	All	1.81E-05

A sample GXQ acute output file is provided in Attachment 3.

Baseline Unit Release Doses:

The acute baseline unit release doses in Table 3 were calculated using the GENII dosimetry code (Napier, et al 1988). For the isotopes listed in Table 3, the whole body inhalation+submersion baseline unit release dose was taken from the annual effective dose equivalent (AEDE) for each isotope. The maximum organ inhalation+submersion baseline unit release dose was taken from the committed dose equivalent for each isotope. The analyst must choose the value which is appropriate to the dose criteria used in the analysis.

A sample GENII input file is provided in Attachment 3.

Table 3: Acute Baseline Unit Release Doses for the ERDF

Isotope	Whole Body Unit Doses (rem EDE/Ci) (s/m ³)	Max. Organ Unit Doses (rem/Ci) (s/m ³)	Limiting Organ	Daughters
H 3	3.0e-02	3.8e-02	R. Marrow	
C 14	6.8e-01	8.7e-01	R Mar.	
NA 22	2.8e+00	4.8e+00	BS	
K 40	4.0e+00	5.7e+00	Lung	
CO 60	6.7e+01	4.3e+02	Lung	
NI 63	1.0e+00	1.2e+00	R. Marrow	
SR 90	7.0e+01	8.0e+02	BS	(Includes Y 90)
TC 99	3.0e+00	2.1e+01	Lung	
CS 134	1.4e+01	1.7e+01	S. Int.	
CS 137	1.0e+01	1.1e+01	S. Int.	
EU 152	6.9e+01	4.2e+02	Liver	
EU 154	9.1e+01	6.5e+02	BS	
EU 155	1.3e+01	1.8e+02	BS	
RA 226	1.0e+04	7.5e+04	BS	(Includes RN 222 + PB 210 + BI 210 + PO 210)
TH 228	1.1e+05	8.6e+05	Lung	(Includes RA 224 + PB 212 + BI 212)
TH 232	5.5e+05	1.4e+07	BS	(Includes RA 228 + AC 228)
U 233	4.5e+04	3.7e+05	Lung	
U 234	4.4e+04	3.6e+05	Lung	

Isotope	Whole Body Unit Doses (rem EDE/Ci) (s/m ³)	Max. Organ Unit Doses (rem/Ci) (s/m ³)	Limiting Organ	Daughters
U 235	4.1e+04	3.4e+05	Lung	(Includes TH 231)
U 238	3.9e+04	3.2e+05	Lung	(Includes TH 234 + PA 234)
PU 238	1.3e+05	2.3e+06	BS	
PU 239	1.4e+05	2.6e+06	BS	
PU 240	1.4e+05	2.6e+06	BS	
AM 241	1.5e+05	2.7e+06	BS	

Chronic Releases

Transport and Dose Assumptions

The chronic X/Q values reported here were calculated by the GXQ code (WHC 1993). Credit is given for meander of the plume by the use of sector averaging as implemented in the GXQ code. The chronic X/Q values were found by:

Normal Operations: Annual average X/Q with sector averaging for radiological materials (only).

The chronic baseline unit release doses in this report were calculated by the GENII dosimetry code (Napier, et al 1988). All GENII runs were made with an input X/Q value of 1.0 s/m³ to obtain a unit dose which could be used with any of the chronic X/Qs also in this report. Worst-case solubilities were used for all isotopes.

Dose Consequence Methodology

The dose consequence methodology for the chronic release of radioactive materials from the ERDF is the same as for the acute releases. The appropriate X/Q is multiplied by the appropriate baseline unit dose release which is in turn multiplied by the amount of radiological material made airborne (and respirable).

The chronic release X/Q values are given in Table 4. These X/Q values are appropriate for all chronic (annual) releases of radiological materials. For shorter releases of radiological materials and for all releases of toxic materials, the acute X/Q values should be used. For the release of toxic materials in particular, the wide variety of criteria, with associated averaging times, makes it difficult to justify the use of plume meander, sector averaging, or a chronic X/Q. Multiple cases could be run for toxic material release scenarios, but it is not obvious which cases should be run, nor how those cases would be applied in the consequence analysis. Therefore,

it is recommended that the acute X/Qs without plume meander (Table 2) be used for the chronic release of toxic materials.

Results

X/Q Values:

The X/Q values for the various chronic receptor locations are provided in Table 4. In all cases, the maximum X/Q value, denoted with an asterisk, should be used as this represents the maximally exposed individuals.

A sample GXQ acute output file is provided in Attachment 3.

Table 4: Chronic X/Q Values

Annual Average X/Qs With Sector Averaging		
Sector	Distance (m)	X/Q (s/m ³)
<u>100 m Max. Ind.</u>		
S	100	1.68E-04
SSW	100	1.04E-04
SW	100	9.93E-05
WSW	100	9.97E-05
W	100	1.73E-04
WNW	100	1.39E-04
NW	100	1.57E-04
NNW	100	1.54E-04
N	100	1.61E-04
NNE	100	9.04E-05
NE	100	1.07E-04
ENE	100	1.42E-04
E	100	3.78E-04
ESE	100	4.03E-04*
SE	100	2.52E-04
SSE	100	1.47E-04
<u>Next Nearest DOE Facility</u>		
WNW	1100	1.75E-06
<u>Nearest non-DOE Facility</u>		
E	550	1.71E-05
<u>Nearest 24 hr Receptor</u>		
NE	1800	6.13E-07

Table 4 (cont.)

Annual Average X/Qs
With Sector Averaging

Sector	Distance (m)	X/Q (s/m ³)
<u>Present Site Boundary</u>		
S	14400	3.83E-08
SSW	13300	2.58E-08
SW	16000	1.96E-08
WSW	15400	2.07E-08
W	15100	3.84E-08
WNW	15400	3.10E-08
NW	18400	2.83E-08
NNW	19400	2.69E-08
N	21600	2.48E-08
NNE	29200	9.16E-09
NE	24200	1.38E-08
ENE	21000	2.24E-08
E	22700	5.55E-08*
ESE	25400	4.95E-08
SE	21000	3.79E-08
SSE	18900	2.41E-08
<u>Alternate Site Boundary</u>		
S	4600	2.03E-07*
SSW	4300	1.37E-07
SW	4300	1.34E-07
WSW	5400	9.48E-08
W	6700	1.23E-07
WNW	8000	7.84E-08
NW	12500	4.84E-08
NNW	12200	5.11E-08
N	12300	5.38E-08
NNE	18400	1.71E-08
NE	16700	2.30E-08
ENE	16500	3.12E-08
E	19200	6.97E-08
ESE	16300	9.09E-08
SE	11100	9.23E-08
SSE	6000	1.24E-07

Baseline Unit Release Doses:

The chronic baseline unit release doses in Tables 5 and 6 were calculated using the GENII dosimetry code (Napier, et al 1988). For the isotopes listed, the whole body inhalation+submersion baseline unit release dose was taken from the annual effective dose equivalent (AEDE) for each isotope. The maximum organ inhalation+submersion baseline unit release dose was taken from the committed dose equivalent for each isotope. The total AEDE or maximum organ dose, whichever is appropriate, should be used in the consequence analysis of

normal operations. The internal EDE and external doses are shown so that adjustments could be made between the offsite receptors and the onsite receptors.

The difference in Tables 5 and 6 for the offsite and onsite chronic unit dose releases arise from the differences in exposure of the receptor to the plume. Onsite receptors cannot be expected to be exposed 24 hrs a day for 365 days a year as is assumed for the offsite receptor. Therefore, the unit dose releases for the offsite receptor are corrected for the onsite receptor as follows:

- **Inhalation Doses:** The offsite inhalation unit dose releases are multiplied by 0.286 which is the ratio of the volume of air breathed at work (2400 m³) to the total volume of air breathed during the year (8400 m³). Volumes are for a reference man from ICRP 23.
- **External Doses:** The offsite external unit dose releases are multiplied by 0.228 which is the ratio of the number of hours at work (2000 hrs) to the number of hours in a year (8760 hrs).

For the 24 hour onsite receptor (the fire station) the offsite values should be used for the unit dose releases. This is conservative and eliminates the need to estimate new correction factors which would lead to another unit dose release table for chronic releases.

A sample GENII input file is provided in Attachment 3

Table 5: Chronic Baseline Unit Releases, Offsite

Isotope	Internal EDE (rem EDE/Ci) (s/m ³)	External Dose (rem/Ci) (s/m ³)	Total AEDE (rem EDE/Ci) (s/m ³)	Max. Organ Doses (rem/ci) (s/m ³)	Limiting Organ
H 3	2.4E-02	2.3E-11	2.4E-02	3.1E-02	R. Marrow
C 14	5.6E-01	1.7E-06	5.6E-01	7.1E-01	R Mar.
NA 22	1.9E+00	4.6E-01	2.4E+00	4.0E+00	BS
K 40	3.2E+00	3.4E-02	3.2E+00	4.7E+00	Lung
CO 60	5.4E+01	5.1E-01	5.5E+01	3.5E+02	Lung
NI 63	8.2E-01	7.7E-08	8.2E-01	9.9E-01	R. Marrow
SR 90	5.7E+01	1.5E-03	5.7E+01	6.5E+02	BS
TC 99	2.4E+00	7.8E-06	2.4E+00	1.7E+01	Lung
CS 134	1.1E+01	3.5E-01	1.1E+01	1.4E+01	S. Int.
CS 137	8.1E+00	1.2E-01	8.2E+00	9.2E+00	S. Int.
EU 152	5.7E+01	2.5E-01	5.7E+01	3.4E+02	Liver
EU 154	7.4E+01	2.5E-01	7.4E+01	5.3E+02	BS
EU 155	1.1E+01	8.5E-03	1.1E+01	1.5E+02	BS
RA 226	8.5E+03	3.9E-01	8.5E+03	6.1E+04	BS
TH 228	9.4E+04	3.6E-01	9.4E+04	7.1E+05	Lung

Table_5 (cont.)

Isotope	Internal EDE (rem EDE/Ci) (s/m ³)	External Dose (rem/Ci) (s/m ³)	Total AEDE (rem EDE/Ci) (s/m ³)	Max. Organ Doses (rem/ci) (s/m ³)	Limiting Organ
TH 232	4.5E+05	2.0E-01	4.5E+05	1.1E+07	BS
U 233	3.6E+04	4.9E-05	3.6E+04	3.0E+05	Lung
U 234	3.6E+04	4.2E-05	3.6E+04	3.0E+05	Lung
U 235	3.3E+04	2.2E-02	3.3E+04	2.8E+05	Lung
U 238	3.2E+04	5.3E-03	3.2E+04	2.7E+05	Lung
PU 238	1.1E+05	3.2E-05	1.1E+05	1.9E+06	BS
PU 239	1.2E+05	2.2E-05	1.2E+05	2.2E+06	BS
PU 240	1.2E+05	3.1E-05	1.2E+05	2.2E+06	BS
AM 241	1.2E+05	2.2E-03	1.2E+05	2.2E+06	BS

Table 6: Chronic Baseline Unit Releases, Onsite

Isotope	Internal EDE (rem EDE/Ci) (s/m ³)	External Dose (rem/Ci) (s/m ³)	Total AEDE (rem EDE/Ci) (s/m ³)	Max. Organ Doses (rem/ci) (s/m ³)	Limiting Organ
H 3	6.9E-03	5.2E-12	6.9E-03	8.9E-03	R. Marrow
C 14	1.6E-01	3.9E-07	1.6E-01	2.0E-01	R Mar.
NA 22	5.4E-01	1.0E-01	6.5E-01	1.2E+00	BS
K 40	9.2E-01	7.8E-03	9.2E-01	1.4E+00	Lung
CO 60	1.5E+01	1.2E-01	1.6E+01	1.0E+02	Lung
NI 63	2.3E-01	1.8E-08	2.3E-01	2.8E-01	R. Marrow
SR 90	1.6E+01	3.5E-04	1.6E+01	1.9E+02	BS
TC 99	6.9E-01	1.8E-06	6.9E-01	4.9E+00	Lung
CS 134	3.1E+00	8.0E-02	3.2E+00	4.2E+00	S. Int.
CS 137	2.3E+00	2.7E-02	2.3E+00	2.7E+00	S. Int.
EU 152	1.6E+01	5.7E-02	1.6E+01	9.7E+01	Liver
EU 154	2.1E+01	5.7E-02	2.1E+01	1.5E+02	BS
EU 155	3.1E+00	1.9E-03	3.1E+00	4.3E+01	BS
RA 226	2.4E+03	8.9E-02	2.4E+03	1.7E+04	BS
TH 228	2.7E+04	8.2E-02	2.7E+04	2.0E+05	Lung
TH 232	1.3E+05	4.6E-02	1.3E+05	3.1E+06	BS
U 233	1.0E+04	1.1E-05	1.0E+04	8.6E+04	Lung
U 234	1.0E+04	9.6E-06	1.0E+04	8.6E+04	Lung
U 235	9.4E+03	4.9E-03	9.4E+03	8.0E+04	Lung
U 238	9.2E+03	1.2E-03	9.2E+03	7.7E+04	Lung
PU 238	3.1E+04	7.3E-06	3.1E+04	5.4E+05	BS
PU 239	3.4E+04	5.0E-06	3.4E+04	6.3E+05	BS
PU 240	3.4E+04	7.1E-06	3.4E+04	6.3E+05	BS
AM 241	3.4E+04	5.0E-04	3.4E+04	6.3E+05	BS

Code Documentation

GXQ GXQ Version 3.1 (WHC 1993a)
200 Area - 10 m - Pasquill A-G (1983-1991 average)

GENII GENII version 1.485 (12/3/90) (Napier, et al 1988)
GENII default parameter values (28-Mar-90 RAP)
Radionuclide Master Library (7/23/93 PDR)
External Dose Factor Library (5/8/90)
Internal Dose Increments, Worst Case Solubilities (7/23/93)

References

Napier, et al. 1988, *GENII - The Hanford Environmental Dosimetry Software System*, PNL-6584, Richland, Washington.

NRC 1982, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*, Regulatory Guide 1.145, Rev 1, United States Nuclear Regulatory Commission, Washington, D.C. 20555.

PNL 1990, *Climatological Summary of Wind and Temperature Data for the Hanford Meteorology Monitoring Network*, PNL-7471, Pacific Northwest Laboratory, Richland, Washington.

WHC 1993, *GXQ Program Users' Guide*, WHC-SD-GN-SWD-30002, Westinghouse Hanford Company, Richland, Washington.

ATTACHMENT 2

ANALYSIS REQUEST AND INVENTORY DATA

000157

M.H. Chew & Associates, Inc.
Safety Professionals

1933 Judwin Avenue, Suite 135, Richland, WA 99352
509-943-3634 Fax: 509-946-7365

April 1, 1994

Mark Meulsker
Solid Waste Documentation Safety Support
Westinghouse Hanford Company
PO Box 1970
Richland, WA 99352

Dear Mark:

As agreed in the Wednesday, March 23, meeting of personnel involved in preparation of Project W-296 safety documentation, M.H. Chew & Associates, Inc. (CAI) personnel have prepared a preliminary set of parameters for input to GENII and GXQ computer calculations of plume dispersion and dose consequence. These parameters are derived from the set of normal operating, abnormal operating, and accident scenario conditions defined in the *Preliminary Safety Evaluation for the Environmental Restoration Disposal Facilities, Project W-296*, W11C-SD-W296-PSE-001. It is our understanding that you will perform these computer runs in support of the Project W-296 accident analysis. We would appreciate any input you may have on the scenarios or parameters described herein.

The scenarios for analysis, and the associated parameters, are as follows:

- Case 1: Normal Operations. Apply the 50 percent X/Q. The height of the release will be: at ground level, 35 ft below grade (at the intermediate operating level), and 70 ft below grade (on the trench floor). Position of the release (assumed to be at the midpoint of the trench) will be approximately HCS 36000N, 67500W. The maximum size of the excavation over the life of the project will be 1000 by 4500 ft at the trench floor (1410 by 4845 ft at grade); the trench sides will be graded at a 3:1 slope.
- Case 2: Abnormal Operations. Meteorology will be intermediate, with wind speeds ranging from 15 to 45 mph (analyze at 15, 30, and 45). Height and position of releases will be the same as in Case 1, with the addition of an at grade release at the train and truck unloading pad.
- Case 3: Accident Conditions. Meteorology will be unstable, with wind speeds ranging from 45 to 120 mph (analyze at 60, 75, 90, 105, and 120). Height and position of releases will be the same as in Case 2.
- Case 4: Accident Conditions. Apply the 99.5th percent X/Q. The release will be at grade at the train and truck unloading pad.

All computations should be performed with and without the averaging effect of plume meandering, as results must be applicable to both radionuclide and hazardous chemical releases. The receptors of concern are located: at the facility (100 m radius); at the nearest adjacent facility (222-S Plant, approximately 1100 m WNW); at the nearest adjacent non-DOE facility (U.S. Ecology, approximately 550 m E); at the nearest 24-hr receptor location (609-A Fire Station, approximately 6000 ft NE); at the present Hanford Site Boundary; and at the proposed Hanford Site Boundary.

The source term (list of radionuclides) to be used in these calculations, as derived from the *Source Inventory Development Engineering Study for the Environmental Restoration Disposal Facility*, DOE/RL-12074--29, is as follows:

tritium	^3H	europium	^{152}Eu
beryllium	^7Be		^{154}Eu
carbon	^{14}C		^{155}Eu
sodium	^{22}Na	radium	^{226}Ra
potassium	^{40}K	thorium	^{228}Th
chromium	^{51}Cr		^{232}Th
cobalt	^{58}Co	uranium	^{233}U
	^{60}Co		^{234}U
nickel	^{63}Ni		^{235}U
strontium	^{90}Sr		^{238}U
technecium	^{99}Tc	plutonium	^{238}Pu
cesium	^{134}Cs		^{239}Pu
	^{137}Cs		^{240}Pu
		americium	^{241}Am

Engineering drawings of the planned facility (ES-296-2 and ES-296-12), produced by the U.S. Army Corps of Engineers for the U.S. Department of Energy, are attached for your use.

If you have any questions or would like to recommend any additions or modifications to the above information, please contact either George Larson or I at our Livermore office (510-443-5071).

Sincerely,

Susan K. Onberg, PE
Project Manager

cc: Craig A. Carro
George F. Larson
Project Files

att: 2

ATTACHMENT 3

SAMPLE GENII INPUT FILE
AND
GXQ OUTPUT FILE

000160

Program GENII Input File #####
 title: Inhalation & Submersion, Chronic, Ground Level Release
 \SAMPL\G-AIR.AC

CTIONS----- Default -----
 Near-field scenario? (Far-field) NEAR-FIELD: narrowly-focused
 Population dose? (Individual) release, single site
 Acute release? (Chronic) FAR-FIELD: wide-scale release,
 Maximum Individual data set used multiple sites

TRANSPORT OPTIONS----- Complete Section EXPOSURE PATHWAY OPTIONS----- Complete Section
 Air Transport 1 F Finite plume, external 5
 Surface Water Transport 2 T Infinite plume, external 5
 Biotic Transport (near-field) 3,4 F Ground, external 5
 Waste Form Degradation (near) 3,4 F Recreation, external 5
 T Inhalation uptake 5,6

REPORT OPTIONS-----
 Report AEDE only F Drinking water ingestion 7,8
 Report by radionuclide F Aquatic foods ingestion 7,8
 Report by exposure pathway F Terrestrial foods ingestion 7,9
 Debug report on screen F Animal product ingestion 7,10
 F Inadvertent soil ingestion

INVENTORY #####

4 Inventory input activity units: (1-pCi 2-uCi 3-mCi 4-Ci 5-Bq)
 0 Surface soil source units (1- m2 2- m3 3- kg)
 Equilibrium question goes here

Use when	Release Terms			Basic Concentrations				
	transport selected			near-field scenario, optionally				
Release	Air	Surface	Buried	Air	Surface	Deep	Ground	Surface
Radio-		Water	Waste		Soil	Soil	Water	Water
nuclide	/yr	/yr	/m3	/m3	/unit	/m3	/L	/L
H 3	1.0E+00							
BE7	1.0E+00							
C 14	1.0E+00							
NA22	1.0E+00							
K 40	1.0E+00							
CR51	1.0E+00							
CO58	1.0E+00							
CO60	1.0E+00							
NI63	1.0E+00							
SR90	1.0E+00							
Y 90	1.0E+00							
TC99	1.0E+00							
CS134	1.0E+00							
CS137	1.0E+00							
EU152	1.0E+00							
EU154	1.0E+00							
EU155	1.0E+00							
RA226	1.0E+00							
RN222	1.0E+00							
PB210	1.0E+00							
BI210	1.0E+00							
PO210	1.0E+00							
TH228	1.0E+00							
RA224	1.0E+00							
PB212	1.0E+00							
BI212	1.0E+00							

000161

TH232 1.0E+00
 RA228 1.0E+00
 AC228 1.0E+00
 U 233 -1.0E+00
 U 234 1.0E+00
 U 235 1.0E+00
 TH231 1.0E+00
 U 238 1.0E+00
 TH234 1.0E+00
 PA234 1.6E-03
 PU238 1.0E+00
 PU239 1.0E+00
 PU240 1.0E+00
 AM241 1.0E+00

-----Derived Concentrations-----				
Use when	measured values are known			
Release	Terres.	Animal	Drink	Aquatic
Radio-	Plant	Product	Water	Food
nuclide	/kg	/kg	/L	/kg

TIME #####

Intake ends after (yr)
 0 Dose calc. ends after (yr)
 Release ends after (yr)
 0 No. of years of air deposition prior to the intake period
 No. of years of irrigation water deposition prior to the intake period

EAR-FIELD SCENARIOS (IF POPULATION DOSE) #####

0 Definition option: 1-Use population grid in file POP.IN
 0 2-Use total entered on this line

NEAR-FIELD SCENARIOS #####

Prior to the beginning of the intake period: (yr)
 0 When was the inventory disposed? (Package degradation starts)
 0 When was LOIC? (Biotic transport starts)
 0 Fraction of roots in upper soil (top 15 cm)
 0 Fraction of roots in deep soil
 0 Manual redistribution: deep soil/surface soil dilution factor
 0 Source area for external dose modification factor (m2)

TRANSPORT #####

-----AIR TRANSPORT-----SECTION 1-----

	0-Calculatè PM	0	Release type (0-3)
1	Option: 1-Use chi/Q or PM value	F	Stack release (T/F)
	2-Select MI dist & dir	0	Stack height (m)
	3-Specify MI dist & dir	0	Stack flow (m3/sec)
1.0	Chi/Q or PM value	0	Stack radius (m)
0	MI sector index (1-S)	0	Effluent temp. (C)
0.0	MI distance from release point (m)	0	Building x-section (m2)
	Use jf data, (T/F) else chi/Q grid	0	Building height (m)

-----SURFACE WATER TRANSPORT-----SECTION 2-----

0 Mixing ratio model: 0-use value, 1-river, 2-lake
 0 Mixing ratio, dimensionless
 0 Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),

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Transit time to irrigation withdrawal location (m)

If mixing ratio model > 0:

Rate of effluent discharge to receiving water body (m3/s)

Longshore distance from release point to usage location (m)

Offshore distance to the water intake (m)

Average water depth in surface water body (m)

Average river width (m), MIXFLG=1 only

Depth of effluent discharge point to surface water (m), lake only

-----WASTE FORM AVAILABILITY-----SECTION 3-----

Waste form/package half life, (yr)

Waste thickness, (m)

Depth of soil overburden, m

-----BIOTIC TRANSPORT OF BURIED SOURCE-----SECTION 4-----

Consider during inventory decay/buildup period (T/F)?

Consider during intake period (T/F)?

Pre-Intake site condition.....

1-Arid non agricultural

2-Humid non agricultural

3-Agricultural

EXPOSURE #####

-----EXTERNAL EXPOSURE-----SECTION 5-----

Exposure time:

766.0

Plume (hr)

Soil contamination (hr)

Swimming (hr)

Boating (hr)

Shoreline activities (hr)

Residential irrigation:

T

Consider: (T/F)

0

Source: 1-ground water

2-surface water

0

Application rate (in/yr)

0

Duration (mo/yr)

Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)

Transit time for release to reach aquatic recreation (hr)

.0

Average fraction of time submersed in acute cloud (hr/person hr)

-----INHALATION-----SECTION 6-----

766.0

Hours of exposure to contamination per year

0-No resus- 1-Use Mass Loading

2-Use Anspaugh model

pension

Mass loading factor (g/m3)

Top soil available (cm)

-----INGESTION POPULATION-----SECTION 7-----

Atmospheric production definition (select option):

0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line

1-Use population-weighted chi/Q

2-Use uniform production

3-Use chi/Q and production grids (PRODUCTION will be overridden)

Population ingesting aquatic foods, 0 defaults to total (person)

Population ingesting drinking water, 0 defaults to total (person)

Consider dose from food exported out of region (default=F)

Note below: S* or Source: 0-none, 1-ground water, 2-surface water

3-Derived concentration entered above

----- AQUATIC FOODS / DRINKING WATER INGESTION-----SECTION 8-----

F

Salt water? (default is fresh)

USE	TRAN-	PROD-	-CONSUMPTION-				
? FOOD	SIT	UCTION	HOLDUP	RATE			
T/F TYPE	hr	kg/yr	da	kg/yr		DRINKING WATER	
F FISH	0.00	0.0E+00	0.00	0.0	0	Source (see above)	
F MOLLUS	0.00	0.0E+00	0.00	0.0	T	Treatment? T/F	

F	CRUSTA	0.00	0.0E+00	0.00	0.0	0	holdup/transition
F	PLANTS	0.00	0.0E+00	0.00	0.0	0	Consumption (L/yr)

====TERRESTRIAL FOOD INGESTION=====SECTION 9=====

USE ?	FOOD TYPE	GROW TIME da	--IRRIGATION-- S RATE TIME * in/yr mo/yr		YIELD kg/m2	PROD- UCTION kg/yr	--CONSUMPTION-- HOLDUP RATE da kg/yr	
F	LEAF V	0.00	0	0.0	0.0	0.0E+00	0.0	0.0
F	ROOT V	0.00	0	0.0	0.0	0.0E+00	0.0	0.0
F	FRUIT	0.00	0	0.0	0.0	0.0E+00	0.0	0.0
F	GRAIN	0.00	0	0.0	0.0	0.0E+00	0.0	0.0

-----ANIMAL PRODUCTION CONSUMPTION-----SECTION 10-----

FEED TYPE	HUMAN CONSUMPTION		TOTAL PRODUCTION	DRINK WATER CONTAM FRACT.	DIET FRAC-TION	GROW TIME da	STORED FEED--IRRIGATION--			YIELD kg/m3	STOR-AGE da
	RATE kg/yr	HOLDUP da	kg/yr				S RATE * in/yr	TIME mo/yr			
BEEF	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
POULTR	-0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
MILK	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
EGG	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
								FRESH FORAGE			
BEEF					0.00	0.0	0	0.0	0.00	0.00	0.0
MILK					0.00	0.0	0	0.0	0.00	0.00	0.0

 

Program Genie Input File #####
 Title: Inhalation & Submersion, Chronic, Ground Level Release
 -\SAMPLE\G-AIR.AC

TIONS----- Default -----
 Near-field scenario? (Far-field) NEAR-FIELD: narrowly-focused
 Population dose? (Individual) release, single site
 Acute release? (Chronic) FAR-FIELD: wide-scale release,
 Maximum Individual data set used multiple sites

Complete

Complete

TRANSPORT OPTIONS-----	Section	EXPOSURE PATHWAY OPTIONS-----	Section
Air Transport	1	F Finite plume, external	5
Surface Water Transport	2	T Infinite plume, external	5
Biotic Transport (near-field)	3,4	F Ground, external	5
Waste Form Degradation (near)	3,4	F Recreation, external	5
		T Inhalation uptake	5,6
REPORT OPTIONS-----		F Drinking water ingestion	7,8
Report AEDE only		F Aquatic foods ingestion	7,8
Report by radionuclide		F Terrestrial foods ingestion	7,9
Report by exposure pathway		F Animal product ingestion	7,10
Debug report on screen		F Inadvertent soil ingestion	

INVENTORY #####

4 Inventory input activity units: (1-pCi 2-uCi 3-mCi 4-Ci 5-Bq)
 0 Surface soil source units (1- m2 2- m3 3- kg)
 Equilibrium question goes here

Use when	---Release Terms---			-----Basic Concentrations-----				
	transport selected			near-field scenario, optionally				
Release		Surface	Buried		Surface	Deep	Ground	Surface
Radio-	Air	Water	Waste	Air	Soil	Soil	Water	Water
nuclide	/yr	/yr	/m3	/m3	/unit	/m3	/L	/L
H 3	1.0E+00							
BE7	1.0E+00							
C 14	1.0E+00							
NA22	1.0E+00							
K 40	1.0E+00							
CR51	1.0E+00							
CO58	1.0E+00							
CO60	1.0E+00							
NI63	1.0E+00							
SR90	1.0E+00							
Y 90	1.0E+00							
TC99	1.0E+00							
CS134	1.0E+00							
CS137	1.0E+00							
EU152	1.0E+00							
EU154	1.0E+00							
EU155	1.0E+00							
RA226	1.0E+00							
RN222	1.0E+00							
PB210	1.0E+00							
BI210	1.0E+00							
PO210	1.0E+00							
TH228	1.0E+00							
RA224	1.0E+00							
PB212	1.0E+00							
BI212	1.0E+00							

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TH232 1.0E+00
 RA228 1.0E+00
 AC228 1.0E+00
 U 233 1.0E+00
 U 234 1.0E+00
 U 235 1.0E+00
 TH231 1.0E+00
 U 238 1.0E+00
 TH234 1.0E+00
 PA234 1.6E-03
 PU238 1.0E+00
 PU239 1.0E+00
 PU240 1.0E+00
 AM241 1.0E+00

-----Derived Concentrations-----				
Use when	measured values are known			
Release	Terres.	Animal	Drink	Aquatic
Radio-	Plant	Product	Water	Food
nuclide	/kg	/kg	/L	/kg

ME #####

Intake ends after (yr)
 Dose calc. ends after (yr)
 Release ends after (yr)
 No. of years of air deposition prior to the intake period
 No. of years of irrigation water deposition prior to the intake period

IR-FIELD SCENARIOS (IF POPULATION DOSE) #####

Definition option: 1-Use population grid in file POP.IN
 2-Use total entered on this line

EAR-FIELD SCENARIOS #####

Prior to the beginning of the intake period: (yr)
 When was the inventory disposed? (Package degradation starts)
 When was LOIC? (Biotic transport starts)
 Fraction of roots in upper soil (top 15 cm)
 Fraction of roots in deep soil
 Manual redistribution: deep soil/surface soil dilution factor
 Source area for external dose modification factor (m2)

RANSPORT #####

-----AIR TRANSPORT-----SECTION 1-----

	0-Calculate PM	0	Release type (0-3)
	Option: 1-Use chi/Q or PM value	F	Stack release (T/F)
	2-Select MI dist & dir	0	Stack height (m)
	3-Specify MI dist & dir	0	Stack flow (m3/sec)
1.0	Chi/Q or PM value	0	Stack radius (m)
0	MI sector index (1-5)	0	Effluent temp. (C)
0.0	MI distance from release point (m)	0	Building x-section (m2)
	Use jf data, (T/F) else chi/Q grid	0	Building height (m)

-----SURFACE WATER TRANSPORT-----SECTION 2-----

0 Mixing ratio model: 0-use value, 1-river, 2-lake
 0 Mixing ratio, dimensionless
 0 Average river flow rate for: MIXFLG=0 (m3/s), MIXFLG=1,2 (m/s),

Transit time to irrigation withdrawal location (nr)

If mixing ratio model > 0:

Rate of effluent discharge to receiving water body (m3/s)

Longshore distance from release point to usage location (m)

Offshore distance to the water intake (m)

Average water depth in surface water body (m)

Average river width (m), MIXFLG=1 only

Depth of effluent discharge point to surface water (m), lake only

-----WASTE FORM AVAILABILITY-----SECTION 3-----

Waste form/package half life, (yr)

Waste thickness, (m)

Depth of soil overburden, m

-----BIOTIC TRANSPORT OF BURIED SOURCE-----SECTION 4-----

Consider during inventory decay/buildup period (T/F)?

Consider during intake period (T/F)?

Pre-Intake site condition.....

1-Arid non agricultural

2-Humid non agricultural

3-Agricultural

EXPOSURE #####

-----EXTERNAL EXPOSURE-----SECTION 5-----

Exposure time:

766.0

Plume (hr)

Soil contamination (hr)

Swimming (hr)

Boating (hr)

Shoreline activities (hr)

Shoreline type: (1-river, 2-lake, 3-ocean, 4-tidal basin)

Transit time for release to reach aquatic recreation (hr)

.0

Average fraction of time submersed in acute cloud (hr/person hr)

Residential irrigation:

T

Consider: (T/F)

0

Source: 1-ground water

2-surface water

0

Application rate (in/yr)

0

Duration (mo/yr)

-----INHALATION-----SECTION 6-----

766.0

Hours of exposure to contamination per year

0-No resuspension

1-Use Mass Loading

2-Use Anspaugh model

Mass loading factor (g/m3)

Top soil available (cm)

-----INGESTION POPULATION-----SECTION 7-----

Atmospheric production definition (select option):

0-Use food-weighted chi/Q, (food-sec/m3), enter value on this line

1-Use population-weighted chi/Q

2-Use uniform production

3-Use chi/Q and production grids (PRODUCTION will be overridden)

Population ingesting aquatic foods, 0 defaults to total (person)

Population ingesting drinking water, 0 defaults to total (person)

Consider dose from food exported out of region (default=F)

Note below: S* or Source: 0-none, 1-ground water, 2-surface water

3-Derived concentration entered above

----- AQUATIC FOODS / DRINKING WATER INGESTION-----SECTION 8-----

F Salt water? (default is fresh)

USE ? FOOD T/F TYPE	TRAN- SIT hr	PROD- UCTION kg/yr	-CONSUMPTION- HOLDUP da	RATE kg/yr	DRINKING WATER	
F FISH	0.00	0.0E+00	0.00	0.0	0	Source (see above)
F MOLLUS	0.00	0.0E+00	0.00	0.0	T	Treatment? T/F

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F	CRUSTA	0.00	0.0E+00	0.00	0.0	0	Holdup/transit(da)
F	PLANTS	0.00	0.0E+00	0.00	0.0	0	Consumption (L/yr)

-----TERRESTRIAL FOOD INGESTION-----SECTION 9-----

USE ? T/F	FOOD TYPE	GROW TIME da	--IRRIGATION-- S RATE * in/yr		TIME mo/yr	YIELD kg/m2	PROD- UCTION kg/yr	--CONSUMPTION-- HOLDUP da		RATE kg/yr
F	LEAF V	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0	
F	ROOT V	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0	
F	FRUIT	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0	
F	GRAIN	0.00	0	0.0	0.0	0.0	0.0E+00	0.0	0.0	

-----ANIMAL PRODUCTION CONSUMPTION-----SECTION 10-----

SE /F	FOOD TYPE	---HUMAN---		TOTAL PROD- UCTION kg/yr	DRINK WATER CONTAM FRACT.	-----STORED FEED-----						
		CONSUMPTION RATE kg/yr	HOLDUP da			DIET FRAC- TION	GROW TIME da	--IRRIGATION-- S RATE * in/yr		TIME mo/yr	YIELD kg/m3	STOR- AGE da
	BEEF	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
	POULTR	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
	MILK	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
	EGG	0.0	0.0	0.00	0.00	0.00	0.0	0	0.0	0.00	0.00	0.0
		-----FRESH FORAGE-----										
	BEEF					0.00	0.0	0	0.0	0.00	0.00	0.0
	MILK					0.00	0.0	0	0.0	0.00	0.00	0.0

#####

GXQ Version 3.1 C
June 8, 1993

General Purpose Atmospheric Dispersion Code
Produced by Radiological & Toxicological Analysis
Westinghouse Hanford Company

Users Guide documented in WHC-SD-GN-SWD-3002 Rev. 0.
Validation documented in WHC-SD-GN-SWD-3003 Rev. 0.
Code Custodian is Brit E. Hey, WHC, ext. 6-2921.

Run Date = 4/12/1994
Run Time = 12:57 45.24

INPUT ECHO:

-- W-296 X/Q Values - Acute, 99.5% Maximum Sector ---
GXQ Ver. 3.1 Input File
mode
1

MODE CHOICE:

mode = 1 then X/Q based on Hanford site specific meteorology
mode = 2 then X/Q based on atmospheric stability class and wind speed
mode = 3 then X/Q plot file is created

LOGICAL CHOICES:

	ifox	inorm	icdf	ichk	isite	ipop	icon
	T	F	F	F	F	F	F

: ifox = t then joint frequency used to compute frequency to exceed X/Q
: = f then joint frequency used to compute annual average X/Q
: inorm = t then joint frequency data is normalized (as in GENII)
: = f then joint frequency data is un-normalized
: icdf = t then cumulative distribution file created (CDF.OUT)
: = f then no cumulative distribution file created
: ichk = t then X/Q parameter print option turned on
: = f then no parameter print
c isite = t then X/Q based on joint frequency data for all 16 sectors
c = f then X/Q based on joint frequency data of individual sectors
c ipop = t then X/Q is population weighted
c = f then no population weighting
c icon = t then X/Q is air concentration
c = f then X/Q is integrated exposure
c

MODEL CHOICES:

c	idep	iwake	ipm	irise	igrav	iwash	iflow	iwind
	0	0	0	0	0	0	0	0

c idep = 1 then plume depletion model turned on (Chamberlain model)
c iwake = 1 then NRC RG 1.145 building wake model turned on
c = 2 then MACCS virtual distance building wake model turned on
c ipm = 1 then NRC RG 1.145 plume meander model turned on
c = 2 then 5th Power Law plume meander model turned on
c = 3 then sector average model turned on
c irise = 1 then momentum/buoyancy plume rise model turned on, buoyancy
c = 2 then momentum/buoyancy plume rise model turned on, buoyancy
c = 1 then rise based on sensible heat emission
c = 2 then momentum/buoyancy plume rise model turned on, buoyancy

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rise based on initial plume density
 igrav = 1 then gravitational settling model turned on
 iwash = 1 then stack downwash model turned on
 flow = 1 then sigmas adjusted for volume flow rate
 wind = 1 then wind speed corrected for plume height
 = 0 to turn any of the above models off

PARAMETER INPUT:

stack release height (m)	wind speed height (m)	mixing height (m)	frequency to exceed (%)	scaling factor (mg)
0.00000E+00	1.00000E+01	1.00000E+03	5.00000E-01	1.00000E+00
building width (m)	building height (m)	release duration (hr)	deposition velocity (m/s)	gravitational settling velocity (m/s)
7.90000E+00	3.00000E+00	1.00000E+00	1.00000E-03	1.00000E-03
initial plume density (g/cc)	initial plume flow rate (m3/s)	stack diameter (m)	sensible heat emission rate (cal/s)	
4.36000E-04	7.07000E+00	3.00000E+00	4.56820E+04	

RECEPTOR DEPENDENT DATA

FOR MODE	make	RECEPTOR DEPENDENT DATA
1 (site specific)		sector distance z-height
2 (by class & wind speed)		class windspeed distance offset z-height
3 (create plot file)		class windspeed xmax imax ymax jmax xqmin power

RECEPTOR PARAMETER DESCRIPTION:

c sector = 0, 1, 2... (all, S, SSW, etc.)
 c distance = meters
 c class = 1, 2, 3, 4, 5, 6, 7 (P-G stability class A, B, C, D, E, F, G)
 c windspeed = m/s
 c offset = meters offset from plume centerline
 c xmax = maximum distance to plot or calculate to (m)
 c imax = distance intervals
 c ymax = maximum offset to plot (m)
 c jmax = offset intervals
 c xqmin = minimum scaled X/Q to calculate
 c power = exponent in power function step size

MODE:

Site specific X/Q calculated

LOGICAL CHOICES:

Joint frequency used to calculate X/Q based on
 frequency of exceedance.
 No normalization of joint frequency.
 X/Q calculated for single sector.
 tput is atmospheric dispersion coefficient.

MODELS SELECTED:

WARNING/ERROR MESSAGES:

AIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIM STANDARDS
BY APPLIED IMAGE, INC.

3 of 3

INT FREQUENCY DATA:

0 AREA (HMS) - 10 M - Pasquill A - G (1983 - 1991 Average)
 dated 8/26/92 KR

-- W-296 X/Q Values - Acute, 99.5% Maximum Sector ---

SECTOR	DISTANCE (m)	RECEPT HEIGHT (m)	SECT. FREQ. (%)	POPULATION	TOTAL POPULATION SCALED X/Q (s/m3)	AVERAGE INDIVIDUAL SCALED X/Q (s/m3)	ATM. STAB. CLASS	WIND SPEED (m/s)
	100	0	6.30	1	1.56E-02	1.56E-02	E	.89
SW	100	0	4.53	1	1.13E-02	1.13E-02	F	2.65
W	100	0	2.93	1	1.21E-02	1.21E-02	F	2.65
SW	100	0	2.72	1	1.22E-02	1.22E-02	F	2.65
	100	0	4.80	1	2.80E-02	2.80E-02	G	2.65
NW	100	0	3.98	1	1.60E-02	1.60E-02	G	4.70
W	100	0	4.72	1	2.89E-02	2.89E-02	G	2.65
NW	100	0	4.58	1	2.90E-02	2.90E-02	G	2.65
	100	0	4.36	1	3.12E-02	3.12E-02	G	2.65
NE	100	0	2.49	1	1.54E-02	1.54E-02	E	.89
E	100	0	3.90	1	1.57E-02	1.57E-02	E	.89
NE	100	0	6.17	1	2.52E-02	2.52E-02	G	2.65
	100	0	14.05	1	3.41E-02	3.41E-02	F	.89
SE	100	0	18.80	1	3.25E-02	3.25E-02	F	.89
	100	0	10.83	1	3.07E-02	3.07E-02	G	2.65
	100	0	4.78	1	1.58E-02	1.58E-02	G	4.70
S	14400	0	6.30	1	7.08E-06	7.08E-06	E	.89
SSW	13300	0	4.53	1	4.92E-06	4.92E-06	F	2.65
SW	16000	0	2.93	1	5.01E-06	5.01E-06	F	2.65
WSW	15400	0	2.72	1	5.27E-06	5.27E-06	F	2.65
W	15100	0	4.80	1	1.27E-05	1.27E-05	G	2.65
NNW	15400	0	3.98	1	6.99E-06	6.99E-06	G	4.70
NW	18400	0	4.72	1	1.03E-05	1.03E-05	G	2.65
NNW	19400	0	4.58	1	9.73E-06	9.73E-06	G	2.65
N	21600	0	4.36	1	9.12E-06	9.12E-06	G	2.65
NNE	29200	0	2.49	1	2.71E-06	2.71E-06	E	.89
NE	24200	0	3.90	1	3.73E-06	3.73E-06	E	.89
ENE	21000	0	6.17	1	7.67E-06	7.67E-06	G	2.65
E	22700	0	14.05	1	9.33E-06	9.33E-06	F	.89
ESE	25400	0	18.80	1	7.77E-06	7.77E-06	F	.89
SE	21000	0	10.83	1	9.31E-06	9.31E-06	G	2.65
SSE	18900	0	4.78	1	5.14E-06	5.14E-06	G	4.70
S	4600	0	6.30	1	3.23E-05	3.23E-05	E	.89
SSW	4300	0	4.53	1	2.57E-05	2.57E-05	F	2.65
SW	4300	0	2.93	1	2.77E-05	2.77E-05	F	2.65
WSW	5400	0	2.72	1	2.05E-05	2.05E-05	F	2.65
W	6700	0	4.80	1	3.59E-05	3.59E-05	G	2.65
WNW	8000	0	3.98	1	1.61E-05	1.61E-05	G	4.70
NW	12500	0	4.72	1	1.68E-05	1.68E-05	G	2.65
NNW	12200	0	4.58	1	1.73E-05	1.73E-05	G	2.65
	12300	0	4.36	1	1.84E-05	1.84E-05	G	2.65
NNE	18400	0	2.49	1	4.92E-06	4.92E-06	E	.89
NE	16700	0	3.90	1	5.96E-06	5.96E-06	E	.89
ENE	16500	0	6.17	1	1.03E-05	1.03E-05	G	2.65
E	19200	0	14.05	1	1.15E-05	1.15E-05	F	.89
ESE	16300	0	18.80	1	1.34E-05	1.34E-05	F	.89

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E	11100	0	10.83	1	2.06E-05	2.06E-05 G	2.65
	6000	0	4.78	1	2.29E-05	2.29E-05 G	4.70

ution Time = 0 hr 0 min 1.93 sec
-r - Program terminated.

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A-14

ATTACHMENT 4

CHECKLISTS FOR TECHNICAL PEER AND HEDOP REVIEWS

000173

HEDOP REVIEW CHECKLIST

Document Reviewed: Internal Memo from M. A. Medsker to M. R. Greutman, "Unit Releases for the Environmental Remediation Disposal Facility (ERDF) Accident Analysis", May 13, 1994, 80141-094-013.

Scope of Review: Whole Thing!

Yes No* N/A

☒	☐	☐	1. A detailed technical review and approval of the environmental transport and dose calculation portion of the analysis has been performed and documented.
☒	☐	☐	2. Detailed technical review(s) and approval(s) of scenario and release determinations have been performed and documented.
☒	☐	☐	3. HEDOP-approved code(s) were used.
☐	☐	☒	4. Receptor locations were selected according to HEDOP recommendations.
☒	☐	☐	5. All applicable environmental pathways and code options were included and are appropriate for the calculations.
☒	☐	☐	6. Hanford site data were used.
☒	☐	☐	7. Model adjustments external to the computer program were justified and performed correctly.
☒	☐	☐	8. The analysis is consistent with HEDOP recommendations.
☐	☒	☐	9. Supporting notes, calculations, comments, comment resolutions, or other information is attached. (Use the "Page 1 of X" page numbering format and sign and date each added page.)
☒	☐	☐	10. Approval is granted on behalf of the Hanford Environmental Dose Overview Panel.

*All "No" responses must be explained. The use of nonstandard methods must be justified.

HEDOP Reviewer: P. D. Rittmann, PhD CHP

<u>Paul Rittmann</u>	<u>May 13, 1994</u>
Signature	Date

COMMENTS (add additional signed and dated pages if necessary):

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PEER REVIEW CHECKLIST

Document Reviewed: Internal Memo from M. A. Medsker to M. R. Greutman, "Unit Releases for the Environmental Remediation Disposal Facility (ERDF) Accident Analysis", May 13, 1994, 80141-094-013.

Yes	No	N/A	
☒	☐	☐	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
☒	☐	☐	Problem completely defined.
☒	☐	☐	Accident scenarios developed in a clear and logical manner.
☒	☐	☐	Necessary assumptions explicitly stated and supported.
☒	☐	☐	Computer codes and data files documented.
☒	☐	☐	Data used in calculations explicitly stated in document.
☒	☐	☐	Data checked for consistency with original source information as applicable.
☒	☐	☐	Mathematical derivations checked including dimensional consistency of results.
☒	☐	☐	Models appropriate and used within range of validity or use outside range of established validity justified.
☒	☐	☐	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
☒	☐	☐	Software input correct and consistent with document reviewed.
☒	☐	☐	Software output consistent with input and with results reported in document reviewed.
☒	☐	☐	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
☒	☐	☐	Safety margins consistent with good engineering practices.
☒	☐	☐	Conclusions consistent with analytical results and applicable limits.
☒	☐	☐	Results and conclusions address all points required in the problem statement.
☐	☐	☒	Format consistent with appropriate NRC Regulatory Guide or other standards
☐	☒	☐	Review calculations, comments, and/or notes are attached.
☒	☐	☐	Document approved.

Peer Reviewer: P. D. Rittmann, PhD CHP

Paul Rittmann May 13, 1994
Signature Date

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**WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

APPENDIX A2

**CONSEQUENCE CALCULATIONS FOR THE ENVIRONMENTAL RESTORATION
DISPOSAL FACILITY ACCIDENT ANALYSIS**

•Hazard Category Det./WAC r2

Mass At Risk Calculations				Soil Density		
ERDF Trench Surface (2 cells exposed at any one time)				1600 kg/m3		
Width	Length	Thickness		Volume	Mass	
1420	500	3.28E-02	feet	2.33E+04	cu ft	2.32E+06 lb
433	152	1.00E-02	meters	6.60E+02	cu m	1.06E+06 kg
ERDF Working Face Surface (rhomboid shape)						
Width	Length	Thickness		Volume	Mass	
1210	221	3.28E-02	feet	8.79E+03	cu ft	8.76E+05 lb
369	67	1.00E-02	meters	2.49E+02	cu m	3.98E+05 kg
				Total Volume	Total Mass At Risk	
				3.21E+04	cu ft	3.20E+06 lb
				9.08E+02	cu m	1.45E+06 kg

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•Hazard Category Det./WAC r2

Mass Released (kg)		Mass Released = Exposed area to a depth of 1 cm with a density of 1.6 g/cc					
1.45E+06		WAC Soil Concentration * Mass Released = Activity Released					
		Activity Released / Cat. 2 Threshold Values = Fraction for Isotope for Cat. 2					
		Activity Released / Cat. 3 Threshold Values = Fraction for Isotope for Cat. 3					
		Sum of each Fraction for Isotope for Cat. 2 = Sum of Fractions for Cat. 2					
		Sum of each Fraction for Isotope for Cat. 3 = Sum of Fractions for Cat. 3					
		Where <Minimum Detection Activity indicated in WAC, a value of 0 was used.					
			DOE-STD-1027		DOE-STD-1027		
	WAC	Activity	Cat. 2	Fraction for	Cat. 3	Fraction for	
Radioactive	Soil Conc.	At Risk	Threshold Values	Isotope	Threshold Values	Isotope	
Isotope	(Ci/g)	(Ci)	(Ci)	for Cat. 2	(Ci)	for Cat. 3	
3H		0.00E+00	300000	0.00E+00	1000	0.00E+00	
7Be		0.00E+00	430000	0.00E+00	no value		
14C	7.00E-12	1.02E-02	1400000	7.27E-09	420	2.42E-05	
22Na	0.00E+00	0.00E+00	6300	0.00E+00	240	0.00E+00	
40K	2.30E-07	3.34E+02	4700	7.11E-02	170	1.97E+00	
51Cr		0.00E+00	100000000	0.00E+00	22000	0.00E+00	
60Co	2.00E-06	2.91E+03	190000	1.53E-02	280	1.04E+01	
63Ni		0.00E+00	4500000	0.00E+00	5400	0.00E+00	
90Sr	3.00E-07	4.36E+02	22000	1.98E-02	16	2.73E+01	
99Tc	8.60E-12	1.25E-02	3800000	3.29E-09	1700	7.35E-06	
134Cs		0.00E+00	60000	0.00E+00	42	0.00E+00	
137Cs	1.00E-05	1.45E+04	89000	1.63E-01	60	2.42E+02	
152Eu	3.50E-08	5.09E+01	130000	3.91E-04	200	2.54E-01	
154Eu	5.50E-07	7.99E+02	110000	7.27E-03	200	4.00E+00	
155Eu	0.00E+00	0.00E+00	730000	0.00E+00	940	0.00E+00	
226Ra	2.40E-08	3.49E+01	55	6.34E-01	no value		
228Th	0.00E+00	0.00E+00	92	0.00E+00	1	0.00E+00	
232Th	8.00E-11	1.16E-01	18	6.46E-03	0.1	1.16E+00	
233U/234U	0.00E+00	0.00E+00	220	0.00E+00	4.2	0.00E+00	
235U	0.00E+00	0.00E+00	240	0.00E+00	4.2	0.00E+00	
238U	2.50E-13	3.63E-04	240	1.51E-06	4.2	8.65E-05	
238Pu	5.00E-10	7.27E-01	62	1.17E-02	0.62	1.17E+00	
239Pu/240Pu	3.00E-10	4.36E-01	56	7.79E-03	0.52	8.39E-01	
241Am	3.00E-10	4.36E-01	55	7.93E-03	0.52	8.39E-01	
			Sum of Fractions =	9.45E-01	Sum of Fractions =	2.90E+02	
			Category 2		Category 3		

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Cont Vol (yd3)	Emission Factor (lb/h)	Active Time per Shift (h)	Shifts/y	Release (lb/y)	Soil Lifting Rate (lb/s)	Respirable Fraction Factor				
27	80	6.5	520	2.70E+05	2.22E-02	0.68				
(m3)	(kg/h)			(kg/y)	(g/s)					
21	36.36		122896.8	1.23E+05	1.01E+01					
Golder Emissions Values				Annual Average X/Q w/Sector Averaging (s/m3)						
7 x 10 lb/h/dozer				100 m ESE	550 m E	22,700 m E		OSHA		
10 lb/h/2 tippers				4.03E-04	1.71E-05	5.55E-08		PEL (respirable)		
Normal moisture content (3%)				Dust Concentration (mg/m3)				(mg/m3)		
				4.07	0.17	0.00		5		
√ gfl	20-May-94									
√ mm	30-Jul-94									
		DRAFT	CAI-Modified		Annual	Instant Concentration at Receptor			DAC (5480.11)	Order of
	Max. Ave.	WAC	WAC	Contaminant	Respirable		(CI/m3)		Values	Maximum
	Soil Conc.	as published	Soil Conc.	Soil Conc.	Quantity Released	Facility	Onsite	Offsite	(μCi/mL	Dose
Isotope	(CI/kg)	(CI/g)	(CI/g)	(CI/kg)	(CI)	(100 m ESE)	(550 m E)	(22,700 m E)	or CI/m3)	Contribution
14C	1.99E-07	7.00E-12	7.00E-12	7.00E-09	5.85E-04	1.94E-14	8.23E-16	2.67E-18	1.00E-06	19
22Na	5.40E-09	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-07	17
40K	1.60E-08	2.30E-07	2.30E-07	2.30E-04	1.92E+01	6.37E-10	2.70E-11	8.77E-14	2.00E-07	11
60Co	1.58E-07	2.00E-06	2.00E-06	2.00E-03	1.67E+02	5.54E-09	2.35E-10	7.63E-13	1.00E-08	1
90Sr	2.67E-07	3.00E-07	3.00E-07	3.00E-04	2.51E+01	8.31E-10	3.53E-11	1.14E-13	2.00E-09	9
99Tc	5.00E-10	8.60E-12	8.60E-12	8.60E-09	7.19E-04	2.38E-14	1.01E-15	3.28E-18	3.00E-07	16
137Cs	4.49E-07	1.00E-05	1.00E-05	1.00E-02	8.36E+02	2.77E-08	1.18E-09	3.81E-12	7.00E-08	3
152Eu	9.25E-07	3.50E-08	3.50E-08	3.50E-05	2.93E+00	9.69E-11	4.11E-12	1.33E-14	1.00E-08	12
154Eu	2.08E-07	5.50E-07	5.50E-07	5.50E-04	4.60E+01	1.52E-09	6.46E-11	2.10E-13	8.00E-09	5
155Eu	1.80E-08	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E-08	15
226Ra	9.40E-09	2.40E-08	2.40E-08	2.40E-05	2.01E+00	6.65E-11	2.82E-12	9.15E-15	3.00E-10	2
228Th	1.10E-09	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.00E-12	14
232Th	1.74E-09	8.00E-11	8.00E-11	8.00E-08	6.69E-03	2.22E-13	9.40E-15	3.05E-17	5.00E-13	6
233U/234U	3.60E-07	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-11	10
235U	5.00E-09	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-11	13
238U	4.51E-07	2.50E-13	2.50E-13	2.50E-10	2.09E-05	6.92E-16	2.94E-17	9.53E-20	2.00E-11	18
238Pu	2.90E-09	5.00E-10	5.00E-10	5.00E-07	4.18E-02	1.38E-12	5.88E-14	1.91E-16	3.00E-12	4
239Pu/240Pu	6.22E-08	3.00E-10	3.00E-10	3.00E-07	2.51E-02	8.31E-13	3.53E-14	1.14E-16	2.00E-12	7
241Am	1.56E-08	3.00E-10	3.00E-10	3.00E-07	2.51E-02	8.31E-13	3.53E-14	1.14E-16	2.00E-12	8
Bolded-italicized value is modified by CAI.										
Where no WAC value was given, the Maximum Average Concentration waste used.										
Bolded values are where maximum average concentrations are above the WAC values.										
Only value given for Uranium is U-238, none given for other isotopes, so <MDA substituted.										

	Chronic Onsite	Chronic Offsite	Chronic Onsite	Chronic Offsite						
	Whole Body	Whole Body	Max. Organ	Max. Organ						
	Unit Doses	Unit Doses	Unit Doses	Unit Doses						
	(rem EDE/CI/ s/m3)	(rem EDE/CI/ s/m3)	(rem/CI/ s/m3)	(rem/CI/ s/m3)						
Isotope										
14C	1.60E-01	5.60E-01	2.00E-01	7.10E-01						
22Na	6.50E-01	2.40E+00	1.20E+00	4.00E+00						
40K	9.20E-01	3.20E+00	1.40E+00	4.70E+00						
60Co	1.60E+01	5.50E+01	1.00E+02	3.50E+02						
90Sr	1.60E+01	5.70E+01	1.90E+02	6.50E+02						
99Tc	6.90E-01	2.40E+00	4.90E+00	1.70E+01						
137Cs	2.30E+00	8.20E+00	2.70E+00	9.20E+00						
152Eu	1.60E+01	5.70E+01	9.70E+01	3.40E+02						
154Eu	2.10E+01	7.40E+01	1.50E+02	5.30E+02						
155Eu	3.10E+00	1.10E+01	4.30E+01	1.50E+02						
226Ra	2.40E+03	8.50E+03	1.70E+04	6.10E+04						
228Th	2.70E+04	9.40E+04	2.00E+05	7.10E+05						
232Th	1.30E+05	4.50E+05	3.10E+06	1.10E+07						
233U/234U	1.00E+04	3.60E+04	8.60E+04	3.00E+05						
235U	9.40E+03	3.30E+04	8.00E+04	2.80E+05						
238U	9.20E+03	3.20E+04	7.70E+04	2.70E+05						
238Pu	3.10E+04	1.10E+05	5.40E+05	1.90E+06						
239Pu/240Pu	3.40E+04	1.20E+05	6.30E+05	2.20E+06						
241Am	3.40E+04	1.20E+05	6.30E+05	2.20E+06						

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	Whole Body Dose			Organ Dose					
	(rem EDE)	(rem EDE)	(rem EDE)	(rem)	(rem)	(rem)			
Isotope	(100 m ESE)	(550 m E)	(22,700 m E)	(100 m ESE)	(550 m E)	(22,700 m E)			
14C	3.77E-08	1.60E-09	1.82E-11	4.72E-08	2.00E-09	2.31E-11			
22Na	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
40K	7.13E-03	3.03E-04	3.42E-06	1.09E-02	4.60E-04	5.02E-06			
60Co	1.08E+00	4.58E-02	5.10E-04	6.74E+00	2.86E-01	3.25E-03			
90Sr	1.62E-01	6.86E-03	7.94E-05	1.92E+00	8.15E-02	9.05E-04			
99Tc	2.00E-07	8.48E-09	9.58E-11	1.42E-06	6.03E-08	6.78E-10			
137Cs	7.75E-01	3.29E-02	3.81E-04	9.10E-01	3.86E-02	4.27E-04			
152Eu	1.89E-02	8.01E-04	9.26E-06	1.14E-01	4.85E-03	5.52E-05			
154Eu	3.89E-01	1.65E-02	1.89E-04	2.78E+00	1.18E-01	1.35E-03			
155Eu	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
226Ra	1.94E+00	8.24E-02	9.47E-04	1.37E+01	5.83E-01	6.79E-03			
228Th	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
232Th	3.50E-01	1.49E-02	1.67E-04	8.36E+00	3.55E-01	4.08E-03	WB Dose Guidance Compliant?		
233U/234U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Worker	Onsite	Offsite
235U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	<2 rem	<100 mrem	<10 mrem
238U	7.75E-05	3.29E-06	3.71E-08	6.49E-04	2.75E-05	3.13E-07	yes	yes	yes
238Pu	5.22E-01	2.22E-02	2.55E-04	9.10E+00	3.86E-01	4.41E-03	WB Dose Limit Compliant?		
239Pu/240Pu	3.44E-01	1.46E-02	1.67E-04	6.37E+00	2.70E-01	3.06E-03	Worker	Onsite	Offsite
241Am	3.44E-01	1.46E-02	1.67E-04	6.37E+00	2.70E-01	3.06E-03	<5 rem	<5 rem	<10 mrem
Max Dose	1.94E+00	8.24E-02	9.47E-04	1.37E+01	5.83E-01	6.79E-03	yes	yes	yes
(rem)									
Note: Where the WAC states <MDA, zero value was substituted.									
In cases where the WAC is below the max. ave. conc., the WAC value is in bold face type.									

000131

		Acute 99.5% Max. Sector or 95% Site Wide X/Q w/o Plume Meander (s/m3)								
			100 m Site	550 m E	15,100 m W					
			3.44E-02	1.86E-03	1.27E-05					
			Acute Dust Concentration (mg/m3)							
			347	19	0					
				Instant Concentration at Receptor			Permissible			
Inorganic	Max. Ave.	WAC	Quantity		(mg/m3)		Exposure	Worker	Onsite	Offsite
Element/	Conc.	Conc.	Released	Facility	Onsite	Offsite	Limits	Compliant	Compliant	Compliant
Compound	(mg/kg)	(mg/kg)	(mg/y)	(100 m Site)	(550 m E)	(15,100 m W)	(mg/m3)	(yes/no)	(yes/no)	(yes/no)
Aluminum	20470.5	20470.5	2.52E+09	2.74E+00	1.48E-01	1.01E-03	1.50E+01	yes	yes	yes
Antimony	18.6	0.6	7.37E+04	8.04E-05	4.35E-06	2.97E-08	5.00E-01	yes	yes	yes
Arsenic	11.8	0.005	6.15E+02	6.70E-07	3.62E-08	2.47E-10	1.00E-02	yes	yes	yes
Barium	3095	3095	3.80E+08	4.15E-01	2.24E-02	1.53E-04	5.00E-01	yes	yes	yes
Beryllium	0.9	0.4	4.92E+04	5.36E-05	2.90E-06	1.98E-08	2.00E-03	yes	yes	yes
Cadmium	25.5	0.5	6.15E+04	6.70E-05	3.62E-06	2.47E-08	2.00E-01	yes	yes	yes
Calcium	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E+00	yes	yes	yes
Chromium	1765	10	1.23E+06	1.34E-03	7.25E-05	4.95E-07	1.00E+00	yes	yes	yes
Cobalt	12.2	41	5.04E+06	5.50E-03	2.97E-04	2.03E-06	1.00E-01	yes	yes	yes
Copper	2853.7	100	1.23E+07	1.34E-02	7.25E-04	4.95E-06	1.00E+00	yes	yes	yes
Iron	98316.7	98316.7	1.21E+10	1.32E+01	7.13E-01	4.87E-03	1.00E+00	NO	yes	yes
Lead	250	250	3.07E+07	3.35E-02	1.81E-03	1.24E-05	5.00E-02	yes	yes	yes
Magnesium	3630	3630	4.46E+08	4.87E-01	2.63E-02	1.80E-04	1.50E+01	yes	yes	yes
Manganese	462	5	6.15E+05	6.70E-04	3.62E-05	2.47E-07	5.00E+00	yes	yes	yes
Mercury	35.55	0.2	2.46E+04	2.68E-05	1.45E-06	9.90E-09	1.00E-01	yes	yes	yes
Nickel	83.1	10	1.23E+06	1.34E-03	7.25E-05	4.95E-07	1.00E+00	yes	yes	yes
Potassium	2965	2965	3.64E+08	3.98E-01	2.15E-02	1.47E-04	2.00E+00	yes	yes	yes
Selenium	3.9	1	1.23E+05	1.34E-04	7.25E-06	4.95E-08	2.00E-01	yes	yes	yes
Silver	169.2	10	1.23E+06	1.34E-03	7.25E-05	4.95E-07	1.00E-02	yes	yes	yes
Sodium	274	274	3.37E+07	3.67E-02	1.99E-03	1.36E-05	2.00E+00	yes	yes	yes
Thallium	4.5	0.078	9.59E+03	1.05E-05	5.65E-07	3.86E-09	1.00E-01	yes	yes	yes
Vanadium	119	7.8	9.59E+05	1.05E-03	5.65E-05	3.86E-07	5.00E-01	yes	yes	yes
Zinc	5120	500	6.15E+07	6.70E-02	3.62E-03	2.47E-05	5.00E+00	yes	yes	yes
Note: Where WAC values are unlimited, Max. Ave. Conc. are substituted and indicated by bold entries.										

Note: Where WAC values are unlimited, Max. Ave. Conc. are substituted and indicated by bold entries.

000182

				Instant Concentration at Receptor			Permissible			
	Max. Ave.	WAC	Quantity		(mg/m3)		Exposure	Worker	Onsite	Offsite
Organic	Conc.	Conc.	Released	Facility	Onsite	Offsite	Limits	Compliant	Compliant	Compliant
Chemical	(µg/kg)	(µg/kg)	(mg/y)	(100 m Site)	(550 m E)	(15,100 m W)	(mg/m3)	(yes/no)	(yes/no)	(yes/no)
Acetone	2800	28000	3.44E+06	3.75E-03	2.03E-04	1.39E-06	2.50E+03	yes	yes	yes
Benzene	190	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.25E+00	yes	yes	yes
2-Butanone (Methyl Ethyl Ketone)	5	33000	4.06E+06	4.42E-03	2.39E-04	1.63E-06	5.90E+02	yes	yes	yes
Carbonyl Sulfide	36	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.32E+01	yes	yes	yes
1,2-Dichloroethane	0	10000	1.23E+06	1.34E-03	7.25E-05	4.95E-07	2.02E+02	yes	yes	yes
4-Methyl-2-Pentanone	5	278000	3.42E+07	3.73E-02	2.02E-03	1.38E-05	4.10E+02	yes	yes	yes
Methylene Chloride	18	20800	2.56E+06	2.79E-03	1.51E-04	1.03E-06	1.77E+03	yes	yes	yes
Tetrachloroethene	29	112800	1.39E+07	1.51E-02	8.18E-04	5.58E-06	3.50E+01	yes	yes	yes
Toluene	30	185600	2.28E+07	2.49E-02	1.35E-03	9.19E-06	7.66E+02	yes	yes	yes
Trichloroethylene	36	57800	7.10E+06	7.75E-03	4.19E-04	2.86E-06	5.46E+02	yes	yes	yes
Vinyl Chloride	120	30800	3.79E+06	4.13E-03	2.23E-04	1.52E-06	2.60E+00	yes	yes	yes
Acenaphthene	81	2805000	3.45E+08	3.76E-01	2.03E-02	1.39E-04	N/A	not evaluated	not evaluated	not evaluated
Aroclor-1248	159	1000	1.23E+05	1.34E-04	7.25E-06	4.95E-08	N/A	not evaluated	not evaluated	not evaluated
Aroclor-1254	678	1000	1.23E+05	1.34E-04	7.25E-06	4.95E-08	5.00E-02	yes	yes	yes
Aroclor-1260	600	1000	1.23E+05	1.34E-04	7.25E-06	4.95E-08	N/A	not evaluated	not evaluated	not evaluated
Anthracene	6300	14000000	1.72E+09	1.88E+00	1.01E-01	6.93E-04	N/A	not evaluated	not evaluated	not evaluated
Benzo(a)anthracene	900	900	1.11E+05	1.21E-04	6.52E-06	4.45E-08	N/A	not evaluated	not evaluated	not evaluated
Benzo(a)pyrene	470	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
Benzo(b)fluoranthene	1200	1200	1.47E+05	1.61E-04	8.70E-06	5.94E-08	N/A	not evaluated	not evaluated	not evaluated
Benzo(ghi)perylene	230	500000000	6.15E+10	6.70E+01	3.62E+00	2.47E-02	N/A	not evaluated	not evaluated	not evaluated
Benzo(k)fluoranthene	190	850000000	1.04E+11	1.14E+02	6.16E+00	4.21E-02	N/A	not evaluated	not evaluated	not evaluated
Benzoic Acid	850	850	1.04E+05	1.14E-04	6.16E-06	4.21E-08	N/A	not evaluated	not evaluated	not evaluated
Bis (2-ethylhexyl)sebacate	16780	15000000	1.84E+09	2.01E+00	1.09E-01	7.42E-04	5.00E+00	yes	yes	yes
Butylbenzylphthalate	1300	206000	2.53E+07	2.76E-02	1.49E-03	1.02E-05	N/A	not evaluated	not evaluated	not evaluated
Carbazole	170	500	6.15E+04	6.70E-05	3.62E-06	2.47E-08	N/A	not evaluated	not evaluated	not evaluated
Carbon Tetrachloride	3	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.39E+01	yes	yes	yes
4-Chloro-3-methylphenol	170	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
2-Chlorophenol	170	601000	7.39E+07	8.06E-02	4.36E-03	2.97E-05	N/A	not evaluated	not evaluated	not evaluated
Chloroform	1	700	8.60E+04	9.38E-05	5.07E-06	3.46E-08	2.48E+02	yes	yes	yes
4-Chloroaniline	3150	3150	3.87E+05	4.22E-04	2.28E-05	1.56E-07	N/A	not evaluated	not evaluated	not evaluated
Chrysene (C18H12)	460	380000000	4.67E+10	5.09E+01	2.75E+00	1.88E-02	2.00E-01	NO	NO	yes
Di-n-octyl-phthalate	170	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
Di-n-butyl-phthalate	1472	1472	1.81E+05	1.97E-04	1.07E-05	7.29E-08	5.00E+00	yes	yes	yes
Dibenzofuran	60	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
1,3-Dichlorobenzene	170	400	4.92E+04	5.36E-05	2.90E-06	1.98E-08	4.58E+02	yes	yes	yes
1,4-Dichlorobenzene	170	101400	1.25E+07	1.36E-02	7.35E-04	5.02E-06	4.58E+02	yes	yes	yes
Diethyl phthalate	170	325000	3.99E+07	4.36E-02	2.36E-03	1.61E-05	5.00E+00	yes	yes	yes

•Norm Calc-WAC4-Golder r1

Ethylbenzene	330	70000	8.60E+06	9.38E-03	5.07E-04	3.46E-06	4.41E+02	yes	yes	yes
Fluoranthene	1450	16500000	2.03E+09	2.21E+00	1.20E-01	8.17E-04	N/A	not evaluated	not evaluated	not evaluated
Fluorene	1700	1251000	1.54E+08	1.68E-01	9.07E-03	6.19E-05	N/A	not evaluated	not evaluated	not evaluated
Indeno(1,2,3-	240	20000000	2.46E+09	2.68E+00	1.45E-01	9.90E-04	N/A	not evaluated	not evaluated	not evaluated
2-Hexanone	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.17E+02	yes	yes	yes
2-Methylnap	13000	13000	1.60E+06	1.74E-03	9.42E-05	6.43E-07	N/A	not evaluated	not evaluated	not evaluated
4-Methylphe	500	500	6.15E+04	6.70E-05	3.62E-06	2.47E-08	1.90E+01	yes	yes	yes
Naphthalene	4100	1400000	1.72E+08	1.88E-01	1.01E-02	6.93E-05	5.00E+01	yes	yes	yes
2-Nitrophenol	170	170	2.09E+04	2.28E-05	1.23E-06	8.41E-09	N/A	not evaluated	not evaluated	not evaluated
N-Nitrosodip	37	37	4.55E+03	4.96E-06	2.68E-07	1.83E-09	N/A	not evaluated	not evaluated	not evaluated
Pentachlorop	850	850	1.04E+05	1.14E-04	6.16E-06	4.21E-08	5.00E-01	yes	yes	yes
Phenathrene	2500	24000000	2.95E+09	3.22E+00	1.74E-01	1.19E-03	N/A	not evaluated	not evaluated	not evaluated
Phenol	170	71600	8.80E+06	9.60E-03	5.19E-04	3.54E-06	1.90E+01	yes	yes	yes
1,1,1-Trichlo	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E+01	yes	yes	yes
Pyrene	1350	12000000	1.47E+09	1.61E+00	8.70E-02	5.94E-04	N/A	not evaluated	not evaluated	not evaluated
Xylenes	1300	1300	1.60E+05	1.74E-04	9.42E-06	6.43E-08	4.41E+02	yes	yes	yes
2,4-D	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+01	yes	yes	yes
4,4'-DDD	6	20500000	2.52E+09	2.75E+00	1.49E-01	1.01E-03	N/A	not evaluated	not evaluated	not evaluated
4,4'-DDE	41	12500000	1.54E+09	1.68E+00	9.06E-02	6.19E-04	N/A	not evaluated	not evaluated	not evaluated
Aldrin	4	4	4.92E+02	5.36E-07	2.90E-08	1.98E-10	2.50E-01	yes	yes	yes
Beta-BHC-L	4	1500000	1.84E+08	2.01E-01	1.09E-02	7.42E-05	N/A	not evaluated	not evaluated	not evaluated
Dieldrin	8	0.5	6.15E+01	6.70E-08	3.62E-09	2.47E-11	2.50E-01	yes	yes	yes
Endrin	8	8	9.83E+02	1.07E-06	5.80E-08	3.96E-10	1.00E-01	yes	yes	yes
gamma-Chlor	9	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-01	yes	yes	yes
Heptachlor	4	4	4.92E+02	5.36E-07	2.90E-08	1.98E-10	5.00E-01	yes	yes	yes
Methoxychlor	none listed	10000	1.23E+06	1.34E-03	7.25E-05	4.95E-07	1.00E+01	yes	yes	yes
Dibenzo(a,h)	none listed	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
1,1,2,2-Tetra	none listed	unlimited	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E+01	yes	yes	yes

Note: Where WAC values are unlimited, Max. Ave. Conc. are substituted and indicated by bold entries. Where WAC values are TBD, zero is substituted and indicated by bold italics entries.

000184

•75 mph Wind-WAC4-Golder r1

Golder		Release Rate	Duration of	Total Release	Soil Lofting Rate	Respirable				
Release rate for 75 mph		(lb/h)	Windstorm	(lb)	(lb/s)	Fraction Factor				
extrapolated from Table 5-2		1.60E+03	(h)	3.84E+04	4.44E-01	0.68				
adjusted from 0.6 acres		(kg/h)	24	(kg)	(kg/s)					
to 6 acres exposed surface		7.27E+02		1.75E+04	2.02E-01					
X/Q for 75 mph		Windspeed	Acute X/Q w/o Plume Meander (s/m3)							
		(mph)	100 m ESE	550 m E	13,300 m E					
		75	2.18E-04	1.07E-05	7.67E-08					
√gfl	20-May-94				Total					
√mm	30-Jul-94				Respirable					
		DRAFT	CAI-Modified		Contaminant	Instant Concentration at Receptor			Whole Body	Max. Organ
	Max. Ave.	WAC	WAC	Contaminant	Released		(Ci/m3)		Unit Doses	Unit Doses
	Soil Conc.	as published	Soil Conc.	Soil Conc.	Quantity	Facility	Onsite	Offsite	(rem EDE/CV	(rem/CV
Isotope	(Ci/kg)	(Ci/g)	(Ci/g)	(Ci/kg)	(Ci)	(100 m ESE)	(550 m E)	(13,300 m E)	s/m3)	s/m3)
14C	1.99E-07	7.00E-12	7.00E-12	7.00E-09	8.31E-05	2.10E-13	1.03E-14	7.38E-17	6.80E-01	8.70E-01
22Na	5.40E-09	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.80E+00	4.80E+00
40K	1.60E-08	2.30E-07	2.30E-07	2.30E-04	2.73E+00	6.89E-09	3.38E-10	2.42E-12	4.00E+00	5.70E+00
60Co	1.58E-07	2.00E-06	2.00E-06	2.00E-03	2.37E+01	5.99E-08	2.94E-09	2.11E-11	6.70E+01	4.30E+02
90Sr	2.67E-07	3.00E-07	3.00E-07	3.00E-04	3.56E+00	8.99E-09	4.41E-10	3.16E-12	7.00E+01	8.00E+02
99Tc	5.00E-10	8.60E-12	8.60E-12	8.60E-09	1.02E-04	2.58E-13	1.26E-14	9.07E-17	3.00E+00	2.10E+01
137Cs	4.49E-07	1.00E-05	1.00E-05	1.00E-02	1.19E+02	3.00E-07	1.47E-08	1.05E-10	1.00E+01	1.10E+01
152Eu	9.25E-07	3.50E-08	3.50E-08	3.50E-05	4.16E-01	1.05E-09	5.15E-11	3.69E-13	6.90E+01	4.20E+02
154Eu	2.08E-07	5.50E-07	5.50E-07	5.50E-04	6.53E+00	1.65E-08	8.09E-10	5.80E-12	9.10E+01	6.50E+02
155Eu	1.80E-08	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+01	1.80E+02
226Ra	9.40E-09	2.40E-08	2.40E-08	2.40E-05	2.85E-01	7.19E-10	3.53E-11	2.53E-13	1.00E+04	7.50E+04
228Th	1.10E-09	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+05	8.60E+05
232Th	1.74E-09	8.00E-11	8.00E-11	8.00E-08	9.50E-04	2.40E-12	1.18E-13	8.43E-16	5.50E+05	1.40E+07
233U/234U	3.60E-07	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E+04	3.70E+05
235U	5.00E-09	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.10E+04	3.40E+05
238U	4.51E-07	2.50E-13	2.50E-13	2.50E-10	2.97E-06	7.49E-15	3.68E-16	2.64E-18	3.90E+04	3.20E+05
238Pu	2.90E-09	5.00E-10	5.00E-10	5.00E-07	5.94E-03	1.50E-11	7.35E-13	5.27E-15	1.30E+05	2.30E+06
239Pu/240Pu	6.22E-08	3.00E-10	3.00E-10	3.00E-07	3.56E-03	8.99E-12	4.41E-13	3.16E-15	1.40E+05	2.60E+06
241Am	1.56E-08	3.00E-10	3.00E-10	3.00E-07	3.56E-03	8.99E-12	4.41E-13	3.16E-15	1.50E+05	2.70E+06
Note: Where the WAC states <MDA, zero value was substituted.										
In cases where the WAC is below the max. ave. conc., the WAC value is in bold face type.										
Only value given for Uranium is U-238, none given for other isotopes, so <MDA substituted.										

000185

Isotope	Whole Body Dose			Organ Dose					
	1 shift only	1 shift only	3 shifts	1 shift only	1 shift only	3 shifts			
	(rem EDE)	(rem EDE)	(rem EDE)	(rem)	(rem)	(rem)			
	(100 m ESE)	(550 m E)	(13,300 m E)	(100 m ESE)	(550 m E)	(13,300 m E)			
¹⁴ C	4.11E-09	2.02E-10	4.34E-12	5.26E-09	2.58E-10	5.55E-12			
²² Na	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
⁴⁰ K	7.94E-04	3.90E-05	8.38E-07	1.13E-03	5.55E-05	1.19E-06			
⁶⁰ Co	1.16E-01	5.68E-03	1.22E-04	7.42E-01	3.64E-02	7.83E-04			
⁹⁰ Sr	1.81E-02	8.89E-04	1.91E-05	2.07E-01	1.02E-02	2.19E-04			
⁹⁹ Tc	2.23E-08	1.09E-09	2.35E-11	1.56E-07	7.65E-09	1.64E-10			
¹³⁷ Cs	8.63E-02	4.24E-03	9.11E-05	9.49E-02	4.66E-03	1.00E-04			
¹⁵² Eu	2.08E-03	1.02E-04	2.20E-06	1.27E-02	6.23E-04	1.34E-05			
¹⁵⁴ Eu	4.32E-02	2.12E-03	4.56E-05	3.08E-01	1.51E-02	3.26E-04			
¹⁵⁵ Eu	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
²²⁶ Ra	2.07E-01	1.02E-02	2.19E-04	1.55E+00	7.62E-02	1.64E-03			
²²⁸ Th	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
²³² Th	3.80E-02	1.86E-03	4.01E-05	9.66E-01	4.74E-02	1.02E-03	WB Dose Guidance Compliant?		
²³³ U/ ²³⁴ U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Worker	Onsite	Offsite
²³⁵ U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	<2 rem	<100 mrem	<10 mrem
²³⁸ U	8.41E-06	4.13E-07	8.88E-09	6.90E-05	3.39E-06	7.29E-08	yes	yes	yes
²³⁸ Pu	5.61E-02	2.75E-03	5.92E-05	9.92E-01	4.87E-02	1.05E-03	WB Dose Limit Compliant?		
²³⁹ Pu/ ²⁴⁰ Pu	3.62E-02	1.78E-03	3.83E-05	6.73E-01	3.30E-02	7.10E-04	Worker	Onsite	Offsite
²⁴¹ Am	3.88E-02	1.91E-03	4.10E-05	6.99E-01	3.43E-02	7.36E-04	<5 rem	<5 rem	<10 mrem
Max Dose	2.07E-01	1.02E-02	2.19E-04	1.55E+00	7.62E-02	1.64E-03	yes	yes	yes
(rem)									

000186

		Windspeed	Acute X/Q w/o Plume Meander (s/m3)							
		(mph)	100 m ESE	550 m E	13,300 m E					
		75	2.18E-04	1.07E-05	7.67E-08					
				Instant Concentration at Receptor			Permissible			
Inorganic	Max. Ave.	WAC	Quantity		(mg/m3)		Exposure	Worker	Onsite	Offsite
Element/	Conc.	Conc.	Released	Facility	Onsite	Offsite	Limits	Compliant	Compliant	Compliant
Compound	(mg/kg)	(mg/kg)	(mg/s)	(100 m ESE)	(550 m E)	(13,300 m E)	(mg/m3)	(yes/no)	(yes/no)	(yes/no)
Aluminum	20470.5	20470.5	4.14E+03	9.02E-01	4.42E-02	3.17E-04	1.50E+01	yes	yes	yes
Antimony	18.6	0.6	1.21E-01	2.64E-05	1.30E-06	9.30E-09	5.00E-01	yes	yes	yes
Arsenic	11.8	0.005	1.01E-03	2.20E-07	1.08E-08	7.75E-11	1.00E-02	yes	yes	yes
Barium	3095	3095	6.25E+02	1.36E-01	6.69E-03	4.80E-05	5.00E-01	yes	yes	yes
Beryllium	0.9	0.4	8.08E-02	1.76E-05	8.65E-07	6.20E-09	2.00E-03	yes	yes	yes
Cadmium	25.5	0.5	1.01E-01	2.20E-05	1.08E-06	7.75E-09	2.00E-01	yes	yes	yes
Calcium	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.60E+00	yes	yes	yes
Chromium	1765	10	2.02E+00	4.40E-04	2.16E-05	1.55E-07	1.00E+00	yes	yes	yes
Cobalt	12.2	41	8.28E+00	1.81E-03	8.86E-05	6.35E-07	1.00E-01	yes	yes	yes
Copper	2853.7	100	2.02E+01	4.40E-03	2.16E-04	1.55E-06	1.00E+00	yes	yes	yes
Iron	98316.7	98316.7	1.99E+04	4.33E+00	2.13E-01	1.52E-03	1.00E+00	NO	yes	yes
Lead	250	250	5.05E+01	1.10E-02	5.40E-04	3.87E-06	5.00E-02	yes	yes	yes
Magnesium	3630	3630	7.33E+02	1.60E-01	7.85E-03	5.62E-05	1.50E+01	yes	yes	yes
Manganese	462	5	1.01E+00	2.20E-04	1.08E-05	7.75E-08	5.00E+00	yes	yes	yes
Mercury	35.55	0.2	4.04E-02	8.81E-06	4.32E-07	3.10E-09	1.00E-01	yes	yes	yes
Nickel	83.1	10	2.02E+00	4.40E-04	2.16E-05	1.55E-07	1.00E+00	yes	yes	yes
Potassium	2965	2965	5.99E+02	1.31E-01	6.41E-03	4.59E-05	2.00E+00	yes	yes	yes
Selenium	3.9	1	2.02E-01	4.40E-05	2.16E-06	1.55E-08	2.00E-01	yes	yes	yes
Silver	169.2	10	2.02E+00	4.40E-04	2.16E-05	1.55E-07	1.00E-02	yes	yes	yes
Sodium	274	274	5.54E+01	1.21E-02	5.92E-04	4.25E-06	2.00E+00	yes	yes	yes
Thallium	4.5	0.078	1.58E-02	3.44E-06	1.69E-07	1.21E-09	1.00E-01	yes	yes	yes
Vanadium	119	7.8	1.58E+00	3.44E-04	1.69E-05	1.21E-07	5.00E-01	yes	yes	yes
Zinc	5120	500	1.01E+02	2.20E-02	1.08E-03	7.75E-06	5.00E+00	yes	yes	yes
Note: Where WAC values are unlimited, Max. Ave. Conc. are substituted and indicated by bold entries.										

000187

Organic Chemical	Max. Ave.	WAC	Quantity	Instant Concentration at Receptor			Permissible	Worker Compliant	Onsite Compliant	Offsite Compliant
	Conc.	Conc.	Released	Facility	(mg/m3)		Exposure			
	(µg/kg)	(µg/kg)	(mg/s)	(100 m ESE)	(550 m E)	(13,300 m E)	Limits (mg/m3)			
Acetone	2800	28000	5.66E+00	1.23E-03	6.05E-05	4.34E-07	2.50E+03	yes	yes	yes
Benzene	190	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.25E+00	yes	yes	yes
2-Butanone (Meth	5	33000	6.67E+00	1.45E-03	7.13E-05	5.11E-07	5.90E+02	yes	yes	yes
Carbondisulfide	36	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.32E+01	yes	yes	yes
1,2-Dichloroethan	0	10000	2.02E+00	4.40E-04	2.16E-05	1.55E-07	2.02E+02	yes	yes	yes
4-Methyl-2-Penta	5	278000	5.62E+01	1.22E-02	6.01E-04	4.31E-06	4.10E+02	yes	yes	yes
Methylene Chloride	18	20800	4.20E+00	9.16E-04	4.50E-05	3.22E-07	1.77E+03	yes	yes	yes
Tetrachloroethene	29	112800	2.28E+01	4.97E-03	2.44E-04	1.75E-06	3.50E+01	yes	yes	yes
Toluene	30	185600	3.75E+01	8.17E-03	4.01E-04	2.88E-06	7.66E+02	yes	yes	yes
Trichloroethene (E	36	57800	1.17E+01	2.55E-03	1.25E-04	8.96E-07	5.46E+02	yes	yes	yes
Vinyl Chloride	120	30800	6.22E+00	1.36E-03	6.66E-05	4.77E-07	2.60E+00	yes	yes	yes
Acenaphthene	81	2805000	5.67E+02	1.24E-01	6.06E-03	4.35E-05	N/A	not evaluated	not evaluated	not evaluated
Aroclor-1248	159	1000	2.02E-01	4.40E-05	2.16E-06	1.55E-08	N/A	not evaluated	not evaluated	not evaluated
Aroclor-1254	678	1000	2.02E-01	4.40E-05	2.16E-06	1.55E-08	5.00E-02	yes	yes	yes
Aroclor-1260	600	1000	2.02E-01	4.40E-05	2.16E-06	1.55E-08	N/A	not evaluated	not evaluated	not evaluated
Anthracene	6300	14000000	2.83E+03	6.17E-01	3.03E-02	2.17E-04	N/A	not evaluated	not evaluated	not evaluated
Benzo(a)anthracene	900	900	1.82E-01	3.96E-05	1.95E-06	1.39E-08	N/A	not evaluated	not evaluated	not evaluated
Benzo(a)pyrene (C	470	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
Benzo(b)fluoranth	1200	1200	2.42E-01	5.28E-05	2.59E-06	1.86E-08	N/A	not evaluated	not evaluated	not evaluated
Benzo(ghi)perylene	230	500000000	1.01E+05	2.20E+01	1.08E+00	7.75E-03	N/A	not evaluated	not evaluated	not evaluated
Benzo(k)fluoranth	190	850000000	1.72E+05	3.74E+01	1.84E+00	1.32E-02	N/A	not evaluated	not evaluated	not evaluated
Benzoic Acid	850	850	1.72E-01	3.74E-05	1.84E-06	1.32E-08	N/A	not evaluated	not evaluated	not evaluated
Bis (2-ethylhexyl)	16780	15000000	3.03E+03	6.61E-01	3.24E-02	2.32E-04	5.00E+00	yes	yes	yes
Butylbenzylphthal	1300	206000	4.16E+01	9.07E-03	4.45E-04	3.19E-06	N/A	not evaluated	not evaluated	not evaluated
Carbazole	170	500	1.01E-01	2.20E-05	1.08E-06	7.75E-09	N/A	not evaluated	not evaluated	not evaluated
Carbon Tetrachlor	3	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.39E+01	yes	yes	yes
4-Chloro-3-Methy	170	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
2-Chlorophenol	170	601000	1.21E+02	2.65E-02	1.30E-03	9.31E-06	N/A	not evaluated	not evaluated	not evaluated
Chloroform	1	700	1.41E-01	3.08E-05	1.51E-06	1.08E-08	2.48E+02	yes	yes	yes
4-Chloroaniline	3150	3150	6.36E-01	1.39E-04	6.81E-06	4.88E-08	N/A	not evaluated	not evaluated	not evaluated
Chrysene (Coal ta	460	380000000	7.68E+04	1.67E+01	8.21E-01	5.89E-03	2.00E-01	NO	NO	yes
Di-n-octyl-phthal	170	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
Di-n-butyl-phthal	1472	1472	2.97E-01	6.48E-05	3.18E-06	2.28E-08	5.00E+00	yes	yes	yes
Dibenzofuran	60	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated

000188

•75 mph Wind-WAC4-Golder r1

1,3 Dichlorobenze	170	400	8.08E-02	1.76E-05	8.65E-07	6.20E-09	4.58E+02	yes	yes	yes
1,4 Dichlorobenze	170	101400	2.05E+01	4.47E-03	2.19E-04	1.57E-06	4.58E+02	yes	yes	yes
Diethyl phthalate	170	325000	6.57E+01	1.43E-02	7.03E-04	5.04E-06	5.00E+00	yes	yes	yes
Ethylbenzene	330	70000	1.41E+01	3.08E-03	1.51E-04	1.08E-06	4.41E+02	yes	yes	yes
Fluoranthene	1450	16500000	3.33E+03	7.27E-01	3.57E-02	2.56E-04	N/A	not evaluated	not evaluated	not evaluated
Fluorene	1700	1251000	2.53E+02	5.51E-02	2.70E-03	1.94E-05	N/A	not evaluated	not evaluated	not evaluated
Indeno(1,2,3-cd)py	240	20000000	4.04E+03	8.81E-01	4.32E-02	3.10E-04	N/A	not evaluated	not evaluated	not evaluated
2-Hexanone	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.17E+02	yes	yes	yes
2-Methylnaphthal	13000	13000	2.63E+00	5.73E-04	2.81E-05	2.01E-07	N/A	not evaluated	not evaluated	not evaluated
4-Methylphenol	500	500	1.01E-01	2.20E-05	1.08E-06	7.75E-09	1.90E+01	yes	yes	yes
Naphthalene	4100	1400000	2.83E+02	6.17E-02	3.03E-03	2.17E-05	5.00E+01	yes	yes	yes
2-Nitrophenol	170	170	3.43E-02	7.49E-06	3.67E-07	2.63E-09	N/A	not evaluated	not evaluated	not evaluated
N-Nitrosodipheny	37	37	7.47E-03	1.63E-06	8.00E-08	5.73E-10	N/A	not evaluated	not evaluated	not evaluated
Pentachloropheno	850	850	1.72E-01	3.74E-05	1.84E-06	1.32E-08	5.00E-01	yes	yes	yes
Phenathrene	2500	24000000	4.85E+03	1.06E+00	5.19E-02	3.72E-04	N/A	not evaluated	not evaluated	not evaluated
Phenol	170	71600	1.45E+01	3.15E-03	1.55E-04	1.11E-06	1.90E+01	yes	yes	yes
1,1,1-Trichloroeth	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E+01	yes	yes	yes
Pyrene	1350	12000000	2.42E+03	5.28E-01	2.59E-02	1.86E-04	N/A	not evaluated	not evaluated	not evaluated
Xylenes	1300	1300	2.63E-01	5.73E-05	2.81E-06	2.01E-08	4.41E+02	yes	yes	yes
2,4-D	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+01	yes	yes	yes
4,4'-DDD	6	20500000	4.14E+03	9.03E-01	4.43E-02	3.18E-04	N/A	not evaluated	not evaluated	not evaluated
4,4'-DDE	41	12500000	2.53E+03	5.51E-01	2.70E-02	1.94E-04	N/A	not evaluated	not evaluated	not evaluated
Aldrin	4	4	8.08E-04	1.76E-07	8.65E-09	6.20E-11	2.50E-01	yes	yes	yes
Beta-BHC-Lindan	4	1500000	3.03E+02	6.61E-02	3.24E-03	2.32E-05	N/A	not evaluated	not evaluated	not evaluated
Dieldrin	8	0.5	1.01E-04	2.20E-08	1.08E-09	7.75E-12	2.50E-01	yes	yes	yes
Endrin	8	8	1.62E-03	3.52E-07	1.73E-08	1.24E-10	1.00E-01	yes	yes	yes
gamma-Chlordane	9	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-01	yes	yes	yes
Heptachlor	4	4	8.08E-04	1.76E-07	8.65E-09	6.20E-11	5.00E-01	yes	yes	yes
Methoxychlor	none listed	10000	2.02E+00	4.40E-04	2.16E-05	1.55E-07	1.00E+01	yes	yes	yes
Dibenzo(a,h)anthr	none listed	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
1,1,2,2-Tetrachlor	none listed	unlimited	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E+01	yes	yes	yes

Note: Where WAC values are unlimited, Max. Ave. Conc. are substituted and indicated by bold entries. Where WAC values are TBD, zero is substituted and indicated by bold italics entries.

000189

•Spill Calc-WAC4-Golder

Golder Emissions Values				Total Release	Spill Lofting Rate	Cleanup Lofting Rate	Event Duration (s)	Respirable Fraction Factor		
Container volume 32 yd3 filled to 27 yd3				(lb)	(lb/s)	(lb/s)	7.20E+03	0.68		
Untreated waste soil w/1% moisture yields										
70 lb/h dumping, 70 lb/h with 1 dozer operating				1.42E+02	7.07E-02	1.94E-02				
Assuming 215 container dumps/shift of 6.5 h				(kg)	(g/s)	(g/s)				
the dust generation rate is 2.12 lb/container dump (for 30 s) or 7.07E-2 lb/s				6.46E+01	3.21E-05	8.82E-06				
Assuming 2 h for cleanup at 70 lb/h =140 lb total or 1.94E-2 lb/s										
Use the dump/spill rate for the entire inventory to simplify the calculation										
99.5% Max. Sector or 95% Site Wide X/Q w/Plume Meander (s/m3)										
				100 m ESE	550 m E	15,100 m W		OSHA		
				1.13E-02	5.94E-04	1.07E-05		PEL (respirable)		
				Dust Concentration (mg/m3)				(mg/m3)		
√ gfl	20-May-94			0.00	0.00	0.00		5		
√ mmm	31-Jul-94				Instant					
		DRAFT	CAI-Modified		Respirable	Instant Concentration at Receptor			Whole Body Unit Doses	Max. Organ Unit Doses
	Max. Ave.	WAC	WAC	Contaminant	Quantity		(CI/m3)		(rem EDE/CI)	(rem/CI)
	Soil Conc.	as published	Soil Conc.	Soil Conc.	Released	Facility	Onsite	Offsite		
Isotope	(CI/kg)	(CI/g)	(CI/g)	(CI/kg)	(CI)	(100 m ESE)	(550 m E)	(15,100 m W)		s/m3)
14C	1.99E-07	7.00E-12	7.00E-12	7.00E-09	1.53E-16	1.73E-18	9.09E-20	1.64E-21	6.80E-01	8.70E-01
22Na	5.40E-09	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.80E+00	4.80E+00
40K	1.60E-08	2.30E-07	2.30E-07	2.30E-04	5.03E-12	5.68E-14	2.99E-15	5.38E-17	4.00E+00	5.70E+00
60Co	1.58E-07	2.00E-06	2.00E-06	2.00E-03	4.37E-11	4.94E-13	2.60E-14	4.68E-16	6.70E+01	4.30E+02
90Sr	2.67E-07	3.00E-07	3.00E-07	3.00E-04	6.56E-12	7.41E-14	3.90E-15	7.02E-17	7.00E+01	8.00E+02
99Tc	5.00E-10	8.60E-12	8.60E-12	8.60E-09	1.88E-16	2.12E-18	1.12E-19	2.01E-21	3.00E+00	2.10E+01
137Cs	4.49E-07	1.00E-05	1.00E-05	1.00E-02	2.19E-10	2.47E-12	1.30E-13	2.34E-15	1.00E+01	1.10E+01
152Eu	9.25E-07	3.50E-08	3.50E-08	3.50E-05	7.65E-13	8.65E-15	4.55E-16	8.19E-18	6.90E+01	4.20E+02
154Eu	2.08E-07	5.50E-07	5.50E-07	5.50E-04	1.20E-11	1.36E-13	7.14E-15	1.29E-16	9.10E+01	6.50E+02
155Eu	1.80E-08	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E+01	1.80E+02
226Ra	9.40E-09	2.40E-08	2.40E-08	2.40E-05	5.25E-13	5.93E-15	3.12E-16	5.61E-18	1.00E+04	7.50E+04
228Th	1.10E-09	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E+05	8.60E+05
232Th	1.74E-09	8.00E-11	8.00E-11	8.00E-08	1.75E-15	1.98E-17	1.04E-18	1.87E-20	5.50E+05	1.40E+07
233U/234U	3.60E-07	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E+04	3.70E+05
235U	5.00E-09	<MDA	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.10E+04	3.40E+05
238U	4.51E-07	2.50E-13	2.50E-13	2.50E-10	5.47E-18	6.18E-20	3.25E-21	5.85E-23	3.90E+04	3.20E+05
238Pu	2.90E-09	5.00E-10	5.00E-10	5.00E-07	1.09E-14	1.24E-16	6.49E-18	1.17E-19	1.30E+05	2.30E+06
239Pu/240Pu	6.22E-08	3.00E-10	3.00E-10	3.00E-07	6.56E-15	7.41E-17	3.90E-18	7.02E-20	1.40E+05	2.60E+06
241Am	1.56E-08	3.00E-10	3.00E-10	3.00E-07	6.56E-15	7.41E-17	3.90E-18	7.02E-20	1.50E+05	2.70E+06
Note: Where the WAC states <MDA, zero value was substituted.										
In cases where the WAC is below the max. ave. conc., the WAC value is in bold face type.										
Only value given for Uranium is U-238, none given for other isotopes, so <MDA substituted.										

000190

Isotope	Whole Body Dose			Organ Dose					
	(100 m ESE)	(rem EDE)	(15,100 m W)	(rem)	(rem)	(rem)			
	(100 m ESE)	(550 m E)	(15,100 m W)	(100 m ESE)	(550 m E)	(15,100 m W)			
14C	8.47E-15	4.45E-16	8.02E-18	1.08E-14	5.69E-16	1.03E-17			
22Na	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
40K	1.64E-09	8.60E-11	1.55E-12	2.33E-09	1.23E-10	2.21E-12			
60Co	2.38E-07	1.25E-08	2.26E-10	1.53E-06	8.04E-08	1.45E-09			
90Sr	3.74E-08	1.96E-09	3.54E-11	4.27E-07	2.24E-08	4.04E-10			
99Tc	4.59E-14	2.41E-15	4.35E-17	3.21E-13	1.69E-14	3.04E-16			
137Cs	1.78E-07	9.35E-09	1.68E-10	1.96E-07	1.03E-08	1.85E-10			
152Eu	4.30E-09	2.26E-10	4.07E-12	2.61E-08	1.37E-09	2.48E-11			
154Eu	8.90E-08	4.68E-09	8.43E-11	6.36E-07	3.34E-08	6.02E-10			
155Eu	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
226Ra	4.27E-07	2.24E-08	4.04E-10	3.20E-06	1.68E-07	3.03E-09			
228Th	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			
232Th	7.83E-08	4.11E-09	7.41E-11	1.99E-06	1.05E-07	1.89E-09	WB Dose Guidance Compliant?		
233U/234U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Worker	Onsite	Offsite
235U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	<2 rem	<100 mrem	<10 mrem
238U	1.73E-11	9.12E-13	1.64E-14	1.42E-10	7.48E-12	1.35E-13	yes	yes	yes
238Pu	1.16E-07	6.08E-09	1.09E-10	2.05E-06	1.08E-07	1.94E-09	WB Dose Limit Compliant?		
239Pu/240Pu	7.47E-08	3.93E-09	7.07E-11	1.39E-06	7.29E-08	1.31E-09	Worker	Onsite	Offsite
241Am	8.00E-08	4.21E-09	7.58E-11	1.44E-06	7.57E-08	1.36E-09	<5 rem	<5 rem	<10 mrem
Maximum	4.27E-07	2.24E-08	4.04E-10	3.20E-06	1.68E-07	3.03E-09	yes	yes	yes

000191

99.5% Max. Sector or 95% Site Wide X/Q w/o Plume Meander (s/m3)										
			100 m Site	550 m E	15,100 m W					
			3.44E-02	1.86E-03	1.27E-05					
			Dust Concentration (mg/m3)							
			1.11E-03	5.98E-05	4.08E-07					
			Instant Concentration at Receptor			Permissible				
Inorganic	Max. Ave.	WAC	Quantity	(mg/m3)		Exposure	Worker	Onsite	Offsite	
Element/	Conc.	Conc.	Released	Facility	Onsite	Offsite	Compliant	Compliant	Compliant	
Compound	(mg/kg)	(mg/kg)	(mg/s)	(100 m Site)	(550 m E)	(15,100 m W)	Limits	(yes/no)	(yes/no)	(yes/no)
Aluminum	20470.5	20470.5	6.58E-04	2.26E-05	1.22E-06	8.35E-09	1.50E+01	yes	yes	yes
Antimony	18.6	0.6	1.93E-08	6.63E-10	3.59E-11	2.45E-13	5.00E-01	yes	yes	yes
Arsenic	11.8	0.005	1.61E-10	5.53E-12	2.99E-13	2.04E-15	1.00E-02	yes	yes	yes
Barium	3095	3095	9.95E-05	3.42E-06	1.85E-07	1.26E-09	5.00E-01	yes	yes	yes
Beryllium	0.9	0.4	1.29E-08	4.42E-10	2.39E-11	1.63E-13	2.00E-03	yes	yes	yes
Cadmium	25.5	0.5	1.61E-08	5.53E-10	2.99E-11	2.04E-13	2.00E-01	yes	yes	yes
Calcium	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E+00	yes	yes	yes
Chromium	1765	10	3.21E-07	1.11E-08	5.98E-10	4.08E-12	1.00E+00	yes	yes	yes
Cobalt	12.2	41	1.32E-06	4.53E-08	2.45E-09	1.67E-11	1.00E-01	yes	yes	yes
Copper	2853.7	100	3.21E-06	1.11E-07	5.98E-09	4.08E-11	1.00E+00	yes	yes	yes
Iron	98316.7	98316.7	3.16E-03	1.09E-04	5.88E-06	4.01E-08	1.00E+00	yes	yes	yes
Lead	250	250	8.03E-06	2.76E-07	1.49E-08	1.02E-10	5.00E-02	yes	yes	yes
Magnesium	3630	3630	1.17E-04	4.01E-06	2.17E-07	1.48E-09	1.50E+01	yes	yes	yes
Manganese	462	5	1.61E-07	5.53E-09	2.99E-10	2.04E-12	5.00E+00	yes	yes	yes
Mercury	35.55	0.2	6.43E-09	2.21E-10	1.20E-11	8.16E-14	1.00E-01	yes	yes	yes
Nickel	83.1	10	3.21E-07	1.11E-08	5.98E-10	4.08E-12	1.00E+00	yes	yes	yes
Potassium	2965	2965	9.53E-05	3.28E-06	1.77E-07	1.21E-09	2.00E+00	yes	yes	yes
Selenium	3.9	1	3.21E-08	1.11E-09	5.98E-11	4.08E-13	2.00E-01	yes	yes	yes
Silver	169.2	10	3.21E-07	1.11E-08	5.98E-10	4.08E-12	1.00E-02	yes	yes	yes
Sodium	274	274	8.81E-06	3.03E-07	1.64E-08	1.12E-10	2.00E+00	yes	yes	yes
Thallium	4.5	0.078	2.51E-09	8.62E-11	4.66E-12	3.18E-14	1.00E-01	yes	yes	yes
Vanadium	119	7.8	2.51E-07	8.62E-09	4.66E-10	3.18E-12	5.00E-01	yes	yes	yes
Zinc	5120	500	1.61E-05	5.53E-07	2.99E-08	2.04E-10	5.00E+00	yes	yes	yes
Note: Where WAC values are unlimited, Max. Ave. Conc. are substituted and indicated by bold entries.										

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•Spill Calc-WAC4-Golder

				Instant Concentration at Receptor						
					(mg/m3)		Permissible			
	Max. Ave.	WAC	Quantity				Exposure	Worker	Onsite	Offsite
Organic	Conc.	Conc.	Released	Facility	Onsite	Offsite	Limits	Compliant	Compliant	Compliant
Chemical	(µg/kg)	(µg/kg)	(mg/s)	(100 m Site)	(550 m E)	(15,100 m W)	(mg/m3)	(yes/no)	(yes/no)	(yes/no)
✓ Acetone	2800	28000	9.00E-07	3.10E-08	1.67E-09	1.14E-11	2.50E+03	yes	yes	yes
✓ Benzene	190	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.25E+00	yes	yes	yes
✓ 2-Butanone (Meth	5	33000	1.06E-06	3.65E-08	1.97E-09	1.35E-11	5.90E+02	yes	yes	yes
✓ Carbondisulfide	36	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.32E+01	yes	yes	yes
✓ 1,2-Dichloroethan	0	10000	3.21E-07	1.11E-08	5.98E-10	4.08E-12	2.02E+02	yes	yes	yes
✓ 4-Methyl-2-Penta	5	278000	8.93E-06	3.07E-07	1.66E-08	1.13E-10	4.10E+02	yes	yes	yes
✓ Methylene Chlorid	18	20800	6.68E-07	2.30E-08	1.24E-09	9.49E-12	1.77E+03	yes	yes	yes
✓ Tetrachloroethene	29	112800	3.62E-06	1.25E-07	6.74E-09	4.60E-11	3.50E+01	yes	yes	yes
✓ Toluene	30	185600	5.96E-06	2.05E-07	1.11E-08	7.57E-11	7.66E+02	yes	yes	yes
✓ Trichloroethene (1	36	57800	1.86E-06	6.39E-08	3.45E-09	2.36E-11	5.46E+02	yes	yes	yes
✓ Vinyl Chloride	120	30800	9.90E-07	3.40E-08	1.84E-09	1.26E-11	2.60E+00	yes	yes	yes
✓ Acenaphthene	81	2805000	9.01E-05	3.10E-06	1.68E-07	1.14E-09	N/A	not evaluated	not evaluated	not evaluated
✓ PCB Aroclor-124	159	1000	3.21E-08	1.11E-09	5.98E-11	4.08E-13	N/A	not evaluated	not evaluated	not evaluated
✓ PCB Aroclor-125	678	1000	3.21E-08	1.11E-09	5.98E-11	4.08E-13	5.00E-02	yes	yes	yes
✓ PCB Aroclor-126	600	1000	3.21E-08	1.11E-09	5.98E-11	4.08E-13	N/A	not evaluated	not evaluated	not evaluated
✓ Anthracene	6300	14000000	4.50E-04	1.55E-05	8.37E-07	5.71E-09	N/A	not evaluated	not evaluated	not evaluated
✓ Benzo(a)anthracene	900	900	2.89E-08	9.95E-10	5.38E-11	3.67E-13	N/A	not evaluated	not evaluated	not evaluated
✓ Benzo(a)pyrene (C	470	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
✓ Benzo(b)fluoranth	1200	1200	3.86E-08	1.33E-09	7.17E-11	4.90E-13	N/A	not evaluated	not evaluated	not evaluated
✓ Benzo(ghi)perylene	230	500000000	1.61E-02	5.53E-04	2.99E-05	2.04E-07	N/A	not evaluated	not evaluated	not evaluated
✓ Benzo(k)fluoranth	190	850000000	2.73E-02	9.40E-04	5.08E-05	3.47E-07	N/A	not evaluated	not evaluated	not evaluated
✓ Benzoic Acid	850	850	2.73E-08	9.40E-10	5.08E-11	3.47E-13	N/A	not evaluated	not evaluated	not evaluated
✓ Bis (2-ethylhexyl)	16780	15000000	4.82E-04	1.66E-05	8.97E-07	6.12E-09	5.00E+00	yes	yes	yes
✓ Butylbenzylphthal	1300	206000	6.62E-06	2.28E-07	1.23E-08	8.41E-11	N/A	not evaluated	not evaluated	not evaluated
✓ Carbazole	170	500	1.61E-08	5.53E-10	2.99E-11	2.04E-13	N/A	not evaluated	not evaluated	not evaluated
✓ Carbon Tetrachlor	3	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.39E+01	yes	yes	yes
✓ 4-Chloro-3-Methy	170	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
✓ 2-Chlorophenol	170	601000	1.93E-05	6.64E-07	3.59E-08	2.45E-10	N/A	not evaluated	not evaluated	not evaluated
✓ Chloroform	1	700	2.25E-08	7.74E-10	4.18E-11	2.86E-13	2.48E+02	yes	yes	yes
✓ 4-Chloroaniline	3150	3150	1.01E-07	3.48E-09	1.88E-10	1.29E-12	N/A	not evaluated	not evaluated	not evaluated
✓ Chrysene (Coal ta	460	380000000	1.22E-02	4.20E-04	2.27E-05	1.55E-07	2.00E-01	yes	yes	yes
✓ Di-n-octyl-phthal	170	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
✓ Di-n-butyl-phthal	1472	1472	4.73E-08	1.63E-09	8.80E-11	6.01E-13	5.00E+00	yes	yes	yes
✓ Dibenzofuran	60	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	no data	yes	yes	yes
✓ 1,3 Dichlorobenze	170	400	1.29E-08	4.42E-10	2.39E-11	1.63E-13	4.58E+02	yes	yes	yes
✓ 1,4 Dichlorobenze	170	101400	3.26E-06	1.12E-07	6.06E-09	4.14E-11	4.58E+02	yes	yes	yes

•Spill Calc-WAC4-Golder

✓ Diethyl phthalate	170	325000	1.04E-05	3.59E-07	1.94E-08	1.33E-10	5.00E+00	yes	yes	yes
✓ Ethylbenzene	330	70000	2.25E-06	7.74E-08	4.18E-09	2.86E-11	4.41E+02	yes	yes	yes
✓ Fluoranthene	1450	16500000	5.30E-04	1.82E-05	9.86E-07	6.73E-09	N/A	not evaluated	not evaluated	not evaluated
✓ Fluorene	1700	1251000	4.02E-05	1.38E-06	7.48E-08	5.11E-10	N/A	not evaluated	not evaluated	not evaluated
✓ Indeno(1,2,3-cd)py	240	20000000	6.43E-04	2.21E-05	1.20E-06	8.16E-09	N/A	not evaluated	not evaluated	not evaluated
✓ 2-Hexanone	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.17E+02	yes	yes	yes
✓ 2-Methylnaphthal	13000	13000	4.18E-07	1.44E-08	7.77E-10	5.31E-12	N/A	not evaluated	not evaluated	not evaluated
✓ 4-Methylphenol	500	500	1.61E-08	5.53E-10	2.99E-11	2.04E-13	1.90E+01	yes	yes	yes
✓ Naphthalene	4100	1400000	4.50E-05	1.55E-06	8.37E-08	5.71E-10	5.00E+01	yes	yes	yes
✓ 2-Nitrophenol	170	170	5.46E-09	1.88E-10	1.02E-11	6.94E-14	N/A	not evaluated	not evaluated	not evaluated
✓ N-Nitrosodipheny	37	37	1.19E-09	4.09E-11	2.21E-12	1.51E-14	N/A	not evaluated	not evaluated	not evaluated
✓ Pentachloropheno	850	850	2.73E-08	9.40E-10	5.08E-11	3.47E-13	5.00E-01	yes	yes	yes
✓ Phenathrene	2500	24000000	7.71E-04	2.65E-05	1.43E-06	9.80E-09	N/A	not evaluated	not evaluated	not evaluated
✓ Phenol	170	71600	2.30E-06	7.92E-08	4.28E-09	2.92E-11	1.90E+01	yes	yes	yes
✓ 1,1,1-Trichloroeth	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E+01	yes	yes	yes
✓ Pyrene	1350	12000000	3.86E-04	1.33E-05	7.17E-07	4.90E-09	N/A	not evaluated	not evaluated	not evaluated
✓ Xylenes	1300	1300	4.18E-08	1.44E-09	7.77E-11	5.31E-13	4.41E+02	yes	yes	yes
✓ 2,4-D	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+01	yes	yes	yes
✓ 4,4'-DDD	6	20500000	6.59E-04	2.27E-05	1.23E-06	8.37E-09	N/A	not evaluated	not evaluated	not evaluated
✓ 4,4'-DDE	41	12500000	4.02E-04	1.38E-05	7.47E-07	5.10E-09	N/A	not evaluated	not evaluated	not evaluated
✓ Aldrin	4	4	1.29E-10	4.42E-12	2.39E-13	1.63E-15	2.50E-01	yes	yes	yes
✓ Beta-BHC-Lindan	4	1500000	4.82E-05	1.66E-06	8.97E-08	6.12E-10	N/A	not evaluated	not evaluated	not evaluated
✓ Dieldrin	8	0.5	1.61E-11	5.53E-13	2.99E-14	2.04E-16	2.50E-01	yes	yes	yes
✓ Endrin	8	8	2.57E-10	8.84E-12	4.78E-13	3.27E-15	1.00E-01	yes	yes	yes
✓ gamma-Chlordane	9	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.00E-01	yes	yes	yes
✓ Heptachlor	4	4	1.29E-10	4.42E-12	2.39E-13	1.63E-15	5.00E-01	yes	yes	yes
✓ Methoxychlor	none listed	10000	3.21E-07	1.11E-08	5.98E-10	4.08E-12	1.00E+01	yes	yes	yes
✓ Dibenzo(a,h)anthr	none listed	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A	not evaluated	not evaluated	not evaluated
✓ 1,1,2,2-Tetrachlor	none listed	unlimited	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E+01	yes	yes	yes

Note: Where WAC values are unlimited, Max. Ave. Conc. are substituted and indicated by bold entries. Where WAC values are TBD, zero is substituted and indicated by bold italics entries.

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•DAC Comparison

	DAC (5480.11)												
	Values	Normal Ops.			Wind Storm			Wind Storm		Wind Storm		Spill Event	
	($\mu\text{Ci/mL}$	Facility			Facility			Onsite		Offsite		Facility	
Isotope	or Ci/m^3)	(100 m ESE)			(100 m ESE)			(550 m E)		(13,300 m E)		(100 m ESE)	
14C	1.00E-06	1.94E-14	0%	yes	2.10E-13	0%	yes	1.03E-14	yes	7.38E-17	yes	1.73E-18	yes
22Na	3.00E-07	0.00E+00	0%	yes	0.00E+00	0%	yes	0.00E+00	yes	0.00E+00	yes	0.00E+00	yes
40K	2.00E-07	6.37E-10	0%	yes	6.89E-09	3%	yes	3.38E-10	yes	2.42E-12	yes	5.68E-14	yes
60Co	1.00E-08	5.54E-09	55%	yes	5.99E-08	599%	no	2.94E-09	yes	2.11E-11	yes	4.94E-13	yes
90Sr	2.00E-09	8.31E-10	42%	yes	8.99E-09	449%	no	4.41E-10	yes	3.16E-12	yes	7.41E-14	yes
99Tc	3.00E-07	2.38E-14	0%	yes	2.58E-13	0%	yes	1.26E-14	yes	9.07E-17	yes	2.12E-18	yes
137Cs	7.00E-08	2.77E-08	40%	yes	3.00E-07	428%	no	1.47E-08	yes	1.05E-10	yes	2.47E-12	yes
152Eu	1.00E-08	9.69E-11	1%	yes	1.05E-09	10%	yes	5.15E-11	yes	3.69E-13	yes	8.65E-15	yes
154Eu	8.00E-09	1.52E-09	19%	yes	1.65E-08	206%	no	8.09E-10	yes	5.80E-12	yes	1.36E-13	yes
155Eu	4.00E-08	0.00E+00	0%	yes	0.00E+00	0%	yes	0.00E+00	yes	0.00E+00	yes	0.00E+00	yes
226Ra	3.00E-10	6.65E-11	22%	yes	7.19E-10	240%	no	3.53E-11	yes	2.53E-13	yes	5.93E-15	yes
228Th	4.00E-12	0.00E+00	0%	yes	0.00E+00	0%	yes	0.00E+00	yes	0.00E+00	yes	0.00E+00	yes
232Th	5.00E-13	2.22E-13	44%	yes	2.40E-12	479%	no	1.18E-13	yes	8.43E-16	yes	1.98E-17	yes
233U/234U	2.00E-11	0.00E+00	0%	yes	0.00E+00	0%	yes	0.00E+00	yes	0.00E+00	yes	0.00E+00	yes
235U	2.00E-11	0.00E+00	0%	yes	0.00E+00	0%	yes	0.00E+00	yes	0.00E+00	yes	0.00E+00	yes
238U	2.00E-11	6.92E-16	0%	yes	7.49E-15	0%	yes	3.68E-16	yes	2.64E-18	yes	6.18E-20	yes
238Pu	3.00E-12	1.38E-12	46%	yes	1.50E-11	499%	no	7.35E-13	yes	5.27E-15	yes	1.24E-16	yes
239Pu/240Pu	2.00E-12	8.31E-13	42%	yes	8.99E-12	449%	no	4.41E-13	yes	3.16E-15	yes	7.41E-17	yes
241Am	2.00E-12	8.31E-13	42%	yes	8.99E-12	449%	no	4.41E-13	yes	3.16E-15	yes	7.41E-17	yes

WRC-511-M250-SAL-001, REV 0

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WHC-SD-W296-SAD-001, REV 0

**WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

APPENDIX B1

PROJECT W296

TECHNICAL SAFETY REQUIREMENTS

000196

PREFACE

These Technical Safety Requirements (TSRs) for the Environmental Restoration Disposal Facility (ERDF) define acceptable conditions, safe boundaries, bases thereof, and management or administrative controls required to ensure safe operation of the ERDF.

The format and content for this TSR is based on DOE Order 5480.22 (DOE 1992) and Westinghouse Hanford Company (WHC) policy on TSRs. This TSR and its appendices constitute an agreement or contract between the Department of Energy (DOE) and WHC regarding safe operation of the ERDF. As such, they cannot be changed without the approval of the Program Secretarial Officer (PSO), or designee.

The scope of this TSR is based on the ERDF draft Preliminary Safety Analysis Report (PSAR) [TBD] (WHC 1994).

The ERDF TSR is to be a separate document, however, until the ERDF FSAR has been reviewed and approved this TSR has been included in the PSAR package [TBD].

The numbering and wording of the TSR sections have been maintained for consistency with the WHC policy on TSRs. The sections that are not applicable to the ERDF are noted throughout the TSR.

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APP B

List of Terms

AC	Administrative Control
ALARA	As Low As Reasonably Achievable
CAM	continuous air monitor
CH	Contact-Handled
DOE	U.S. Department of Energy
FSAR	Final Safety Analysis Report
ISB	Interim Safety Basis
LCO	Limiting Condition for Operation
LCS	Limiting Control Setting
NA	Not Applicable
OSR	Operational Safety Requirement
PRC	Plant Review Committee
PSAR	Preliminary Safety Analysis Report
PSO	Program Secretarial Officer
SAR	Safety Analysis Report
SL	Safety Limit
SR	Surveillance Requirement
TRU	Transuranic
TRUSAF	Transuranic Storage and Assay Facility
TSR	Technical Safety Requirement
WHC	Westinghouse Hanford Company
WRAP	Waste Receiving and Processing Facility

App B

SECTION 1
USE AND APPLICATION

07/01/94 11:29am

1-1

Rev. A1 Draft
June 1994

000201

Section 1 USE AND APPLICATION

1.1 Definitions

-----NOTE-----

The defined terms of this section are unique definitions. They appear in CAPITALIZED type and are applicable throughout these TSRs and BASES. Some terms refer the user to another Section for the definition. This has been provided to prevent a shortened definition from being supplied and used out of context.

<u>Term</u>	<u>Definition</u>
BASES	BASES shall be pertinent information and details supporting TSR elements and specific values or characteristics (see Appendix B, BASES).
DESIGN FEATURES	See Appendix A, DESIGN FEATURES.
MODE	See Section 1.6, MODES.
OPERABLE/OPERABILITY	A system, subsystem, train, component, or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified safety function(s), and: a) actuation points are within limits, b) operating parameters are within limits, and c) when all necessary attendant equipment, instrumentation, controls, electrical power sources, cooling water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its specified function(s) are also capable of performing their related support function(s).
VERIFY/VERIFIED/ VERIFICATION	A qualitative assessment to confirm or substantiate that specific facility conditions exist, and if not in this condition, ensure that a response is taken to satisfy the requirements. This may include collecting sample data or quantitative data; taking instrument readings; adjusting instrumentation set points; recording data and information on logs, data sheets or electronic media; and evaluating data and information in accordance with approved and controlled procedures.
VIOLATION	See Section 5.4, TSR VIOLATIONS.

1.2 Logical Connectors

NA for ERDF.

[Not applicable to the ERDF since there are no Limiting Conditions for Operation and Surveillance Requirements]

1.3 Completion Times

NA for ERDF.

[Not applicable to the ERDF since there are no Limiting Conditions for Operation and Surveillance Requirements]

1.4 Frequency

NA for ERDF.

[Not applicable to the ERDF since there are no Limiting Conditions for Operation and Surveillance Requirements]

1.5 Notes

NA for ERDF.

[Not applicable to the ERDF since there are no Limiting Conditions for Operation and Surveillance Requirements]

1.6 Modes

The MODES identified below are to be applied to the Environmental Restoration Disposal Facility.

The MODES defined for the ERDF are:

OPERATION MODE

The facility is conducting normal activities such as receiving, transferring, transporting, dumping, spreading, and compacting waste soils. Container decontamination, maintenance, and surveillance will also be occurring. In addition collection of leachate from the trench and treatment of decontamination liquid waste and leachate may be occurring.

STANDBY MODE

Receipt of additional waste soil in containers may be allowed depending on available staging space. Placement of waste soil into the trench is not allowed. Application of fixant to close operations for a shift may occur. Workers must not occupy the trench working face. Facility maintenance and surveillance may be occurring, but not in the vicinity of the trench working face. Collection of leachate from the trench and treatment of decontamination liquid waste and leachate may be occurring.

STABLE MODE

No activities or operations involving waste soil receipt, handling or placement are occurring. The trench working face has been covered with clean soil and soil fixant has been applied. The ERDF is considered to be in its most safe and stable configuration. No facility personnel are required to be present in this MODE.

RESTRICTED MODE

No operations or activities involving radioactive material may be conducted unless specifically required by an approved Recovery Plan. Leachate may continue to be collected and stored, and airborne sampling or monitoring may continue to be conducted. Interim cover placement on the working face may be allowed if long-term inactivity is expected.

Documentation of MODE status for the ERDF shall be maintained current as required in Section 5.18, MODE Changes.

1.7 Safety Limits (SLs)

SLs are limits on process variables associated with those primary physical barriers, generally passive, that are necessary for the intended facility function and which are found to be required to guard against the uncontrolled release of radioactivity which would result in a dose consequence of greater than 0.5 rem to the offsite public.

[There are no SLs identified for the ERDF, based upon this selection and the conclusions found in the ERDF PSAR (WHC 1994)]

1.8 Limiting Control Settings (LCSs)

LCSs are settings on safety systems that control process variables to prevent exceeding Safety Limits (SLs).

[Since there are no SLs identified for the ERDF there are no LCSs, based upon this selection criteria.]

1.9 Limiting Conditions for Operation (LCOs)

LCOs are the lowest functional capability or performance level of safety-related structures, systems, components and their support systems required for normal safe operation.

LCOs shall be based upon maintaining the systems and structures OPERABLE or conditions within specified limits which are required for the protection of the public from radiological consequences which would exceed 0.5 rem.

[Protection from radiological consequences for onsite workers is based upon Administrative Controls (ACs). Therefore there are no LCOs identified for the ERDF based upon this selection criteria and the conclusions found in the ERDF PSAR (WHC 1994).]

1.10 Surveillance Requirements (SRs)

SRs are requirements relating to testing, calibration, or inspection to ensure that the necessary OPERABILITY and quality of safety-related structures, systems, components and their support systems, or specified conditions required for safe operation of the facility, are maintained.

[Since there are no LCOs identified for the ERDF there are no associated SRs, based upon this selection criteria. Verification that the ERDF is operated safely and that the appropriate operating controls are performed is addressed as AC program key elements.]

1.11 Administrative Controls (ACs)

ACs are the provisions relating to organization and management, procedures, recordkeeping, reviews, and audits necessary to ensure safe operation of the facility.

Two types of administrative control programs are included. General and facility specific.

General programs are established to ensure the safe operation of the facility. These programs include procedures, change control, training, reviews and audits, radiation protection, effluent monitoring and criticality safety.

Facility specific programs and provisions are established as committed to in the ERDF PSAR (WHC 1994) as being necessary to ensure the safe operation of the ERDF. These programs include access control and various operational controls.

SECTION 2
SAFETY LIMITS

07/01/94 11:29am

2-1

Rev. A1 Draft
June 1994

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Section 2 SAFETY LIMITS

2.0 Safety Limits (SLs)

There are no Safety Limits (SLs) identified for the ERDF based upon the selection criteria defined in Section 1.7, Safety Limits. Additionally, there are no Limiting Control Settings (LCSs) since there are no SLs, based on the selection criteria defined in Section 1.8, Limiting Control Settings.

SECTION 3
LIMITING CONDITIONS FOR OPERATION
AND
SURVEILLANCE REQUIREMENTS

Section 3 LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS

3.0 Limiting Conditions for Operation (LCO) and Surveillance Requirements (SRs)

There are no LCOs and SRs identified for the ERDF based on the selection criteria defined in Sections 1.9, Limiting Conditions for Operation, and 1.10, Surveillance Requirements. Additionally, the General Rules of Applicability for LCOs and SRs are not applicable.

SECTION 4
SURVEILLANCE REQUIREMENTS

07/01/94 11:29am

4-1

Rev. A1 Draft
June 1994

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Section 4 SURVEILLANCE REQUIREMENTS

There are no Surveillance Requirements identified for the ERDF since there are no LCOs based upon the selection criteria defined in Section 1.10, Surveillance Requirements.

SECTION 5
ADMINISTRATIVE CONTROLS

Section 5 ADMINISTRATIVE CONTROLS

5.1 Purpose

- 5.1.1 The purpose of Administrative Controls (ACs) is to state the provisions relating to organization and management, procedures, record keeping, review and audit, reporting and safety control programs necessary to ensure safe operation of the ERDF.
- 5.1.2 Unless otherwise noted, these ACs are applicable for the ERDF during OPERATION, STANDBY, STABLE and RESTRICTED MODES.

5.2 Contractor Responsibility

- 5.2.1 • Westinghouse Hanford Company (WHC), the Operations and Engineering contractor of facilities at the Hanford Site, is responsible to the Department of Energy (DOE) for the safe operation of the DOE-owned Environmental Restoration Disposal Facility in accordance with the TSR as approved by the Program Secretarial Officer (PSO), or designee, including any modification by the PSO. The contractor shall be responsible for maintaining the current DOE approved TSR as a controlled document.

The contractor is responsible to take emergency actions that depart from the approved Technical Safety Requirements when no actions consistent with the Technical Safety Requirements are immediately apparent, and when these actions are needed to protect the public health and safety. Such contractor actions shall be approved, a minimum, by an operator or supervisor qualified through an approved training program. If emergency actions are taken which are not covered by existing emergency procedures (as required in AC 5.9.1.b) verbal notifications shall be made to the Head of the Field Element within two hours and by written reports to the PSO, or designee within 24 hours.

5.2.1.1 **Environmental Restoration Disposal Facility Manager [TBD]**

The ERDF Manager shall be responsible for the overall safe operation of the ERDF and shall delegate in writing the succession to this responsibility during absences.

5.2.1.2 **ERDF Shift Manager [TBD]**

The ERDF Shift Manager shall be responsible for the local command function. During any absence of the Manager from the area, a designated, qualified individual shall assume the command function.

5.3 Compliance

- 5.3.1 The contractor is responsible for ensuring that the requirements of the ERDF TSR are met. Compliance shall be demonstrated by:
- a. Operating within the Safety Limits (SLs) [NA for ERDF],
 - b. Operating within the Limiting Conditions for Operation (LCOs), Limiting Control Settings (LCSS) and the associated Surveillance Requirements (SRs) during their Applicability [NA for ERDF],
 - c. Operating within the ACTIONS of LCOs and LCSS when required [NA for ERDF],
 - d. Performing all SRs as required [NA for ERDF],
 - e. Establishing, implementing and maintaining the required ACs, and
 - f. Maintaining required DESIGN FEATURES. [NA for ERDF]

5.4 TSR VIOLATIONS

5.4.1 VIOLATION Criteria

VIOLATIONS of the TSR occur as the result of four circumstances:

- a. Exceeding a SL [NA for ERDF].
- b. Failure to take the ACTIONS required within the required time limit following:
 1. Exceeding a LCS [NA for ERDF].
 2. Failure to meet a LCO [NA for ERDF].
 3. Failure to successfully meet a SR [NA for ERDF].
- c. Failure to perform a Surveillance within the required time limit [NA for ERDF].
- d. Failure to comply with an AC requirement.

5.4.2 Response to a Safety Limit VIOLATION

[Not applicable to the ERDF]

5.4.3 Response to a Limiting Condition for Operation and Limiting Control Setting VIOLATION.

[Not applicable to the ERDF]

5.4.4 Response to a Surveillance Requirement VIOLATION

[Not applicable to the ERDF]

5.4.5 Response to an Administrative Control VIOLATION

If a VIOLATION of an AC occurs, proceed as follows:

- a. Notify the DOE of the VIOLATION in accordance with DOE occurrence reporting requirements.
- b. Prepare an Occurrence Report in accordance with DOE occurrence reporting requirements.
- c. Prepare a Recovery Plan describing the steps leading to compliance with the AC.
- d. Perform and document a technical evaluation, if appropriate, of the AC VIOLATION to determine if any damage may have occurred.

5.5 Occurrence Reporting

5.5.1 Requirement for Occurrence Reporting

A program shall be established, implemented and maintained for occurrence reporting of events and conditions which may involve safety, health, quality, safeguards, security, or environmental implications. It is the policy of WHC to encourage a positive attitude toward reporting occurrences and that occurrences be consistently reported to assure that both DOE and WHC line management, are kept fully and currently informed of all events which could: (1) affect the health and safety of the public; (2) seriously impact the intended purpose of DOE facilities; (3) have a noticeable adverse effect on the environment; or (4) endanger the health and safety of workers.

5.5.2 Program Key Elements

The program key elements include the following:

- a. Timely identification, categorization, notification, and reporting to DOE and contractor management of all Reportable Occurrences.
- b. Timely evaluation of and implementation of appropriate corrective actions.
- c. Maintenance of a data base containing all ERDF Occurrences Reports.
- d. Review of Reportable Occurrences to assess significance, root causes, generic implications and the basis for any corrective actions taken to prevent recurrence.
- e. Dissemination of Occurrence Reports.

5.5.3 Reporting requirements for TSR VIOLATIONS are described in AC 5.4, TSR VIOLATIONS.

5.6 Revisions to the TSR

- 5.6.1 All proposed revisions to the TSR or its Appendices shall be submitted to the PSO, or designee, for approval prior to implementation of the revision. Such submittals shall include the basis for the proposed revision.

5.7 TSR Basis Control

- 5.7.1 Any revisions made to the implementing procedures identified in the TSR Compliance Program (see AC 5.20) shall be evaluated to confirm that the intent of the TSR is met.

5.8 Organization

- 5.8.1 Lines of authority, responsibility, and communication shall be established and defined for the highest management levels through intermediate levels to and including all safety and operating organization positions. These relationships shall be documented and updated, as appropriate, in the form of organization charts, functional descriptions of departmental responsibilities and relationships, and job descriptions for key personnel positions, or in equivalent forms of documentation.

The individuals who train the operating staff and those who carry out safety and quality assurance functions shall have sufficient organizational freedom to ensure their independence from operating pressures.

5.8.1.1 Environmental Restoration Disposal Facility Manager [TBD]

The ERDF Manager shall be responsible for safe operation of the ERDF. Safe operation shall include, as necessary, interface requirements with other onsite organizations and facilities.

5.8.1.2 Minimum Operations Shift Complement

The number of qualified shift managers and operators available shall be adequate to operate and support ERDF activities safely. Abnormal conditions shall be considered in determining operator assignments. Management shall provide additional personnel, as necessary, to support other activities.

The minimum operations shift complement per shift for the ERDF shall be as follows:

MODE	Shift Manager	Operators	HPT
OPERATION	1	1 [TBD]	as required*
STANDBY	1	1	as required*
STABLE	0	0	0
RESTRICTED	as required**	as required**	as required**
<p>* Whenever ERDF activities which involve handling waste containers is occurring, an HPT must be present [TBD].</p> <p>** Staffing requirements shall be defined in the specific Recovery Plan prepared when ERDF has been placed in RESTRICTED MODE.</p>			

5.8.1.3 The minimum complement can be 1 less than the required number for a period of time not to exceed 2 hours to accommodate unexpected absences, provided immediate action is taken to restore the shift complement to within the minimum shift requirements.

5.8.1.4 Engineers or managers who are also qualified as operators through an approved training program, may be substituted for qualified operators.

5.9 Procedures

5.9.1 Requirement for Procedures

A program shall be established, implemented and maintained to provide approved and controlled procedures, as necessary to facilitate safe operation of the ERDF.

5.9.2 Program Key Elements

The program key elements include the following:

- a. Startup, normal operation and shutdown of activities and equipment. Included are procedures that require periodic monitoring of conditions and specify actions when conditions are found to be out of limits.

- b. Abnormal and emergency procedures that define actions for abnormal and accident conditions (e.g., vehicle fires).
- c. Alarm response procedures that define corrective actions when equipment alarms as required. Included are actions to respond to a condition out of limits.
- d. Routine maintenance, inspection, calibration and testing activities.
- e. Equipment control (e.g., Lock and Tag).
- f. Operating specifications.
- g. TSR compliance program procedures.

5.10 Facility Change Control

5.10.1 Requirement for Facility Change Control

A program shall be established, implemented and maintained to control changes made to ERDF equipment, DESIGN FEATURES, configuration, and operating documentation.

5.10.2 Program Key Elements

The program key elements include the following:

- a. Review and approval at appropriate levels of proposed changes, which includes the Unreviewed Safety Question process.
- b. Preparation and approval of revised safety documentation before implementing a proposed change classified as an Unreviewed Safety Question.
- c. Documentation to reflect changes or modifications.
- d. Control of activities while the change is being made.
- e. Testing, if necessary, to ensure that modified equipment or components perform as designed and as required by the TSR.
- f. Control of installing and removing temporary changes.

5.11 Unreviewed Safety Question

5.11.1 Requirement for Unreviewed Safety Question Evaluations

A program shall be established, implemented and maintained for evaluation of potential Unreviewed Safety Questions (USQ).

5.11.2 Program Key Elements

The program key elements include the following:

- a. A process which ensures that discoveries that represent conditions outside the safety basis or TSR are identified.
- b. A process which allows facility management to make physical and procedural changes and conduct tests and experiments without prior DOE approval as long as these do not explicitly or implicitly affect the safety basis of the facility or result in a change to a TSR.

5.12 Personnel Qualifications and Training

5.12.1 Requirement for Personnel Qualification and Training

A program shall be established, implemented and maintained to qualify personnel performing or supporting ERDF operations.

5.12.2 Program Key Elements

The program key elements include the following:

- a. Define a process for selection of personnel based on the ability to meet job performance requirements.
- b. Ensure personnel maintain physical and emotional fitness to safely and effectively perform their assigned responsibilities.
- c. Specify minimum job qualification requirements for all positions with duties that could affect the safe conduct of the ERDF.
- d. Specify management training as appropriate to their assigned responsibilities.
- e. Establish a qualification program for operators, maintenance and technical support positions.

- f. Develop retraining and replacement training programs to ensure personnel meet job performance requirements.
- g. Ensure sufficient qualified operation and support staff is available to ensure safe operations.
- h. Formally document qualification, requalification, initial, retraining and replacement training programs.
- i. Maintain auditable records of training programs and personnel qualifications and training.

5.13 Reviews and Audits

5.13.1 Requirement for Reviews and Audits

A program shall be established, implemented and maintained for ERDF independent reviews and audits of activities affecting safety.

5.13.2 Roles of Key Organizations

Organizational responsibilities are as follows:

a. ERDF Activities

Operations personnel shall be responsible for performing reviews to ensure that day-to-day activities are conducted in a safe manner.

b. Westinghouse Hanford Company Safety

WHC shall be responsible for maintaining organizations responsible for detailed safety analyses, providing independent safety overview, conducting audits and appraisals of ERDF operations and periodically validating the ACs.

c. Westinghouse Hanford Company Quality Assurance

WHC shall be responsible for providing independent overview of TSR activities by a quality assurance organization, which reviews and approves selected documents, and verifies that selected activities are in compliance with the ERDF TSR.

d. Plant Review Committee

A Plant Review Committee (PRC) shall be established. The PRC shall be responsible for reviewing and approving Recovery Plans and USQs.

5.14 Records Retention

5.14.1 Requirement for Records Retention

A program shall be established, implemented, and maintained for records retention.

5.14.2 Program Key Elements

The program includes requirements for records retention for the following:

- a. TSR Compliance Program procedures
- b. Records and logs of ERDF activities
- c. ERDF reviews
- d. Independent reviews
- e. Technical reviews
- f. Audits
- g. Assessments
- h. USQ evaluations
- i. Training programs and personnel qualifications and training.

5.15 Nuclear Criticality Safety

5.15.1 Requirement for Nuclear Criticality Safety

A program shall be established, implemented and maintained to assure that an accidental criticality cannot occur at the ERDF.

Program Key Elements

The program key elements include the following:

- a. Approved and controlled criticality safety analyses, operating specifications, Criticality Prevention Specifications and procedures
- b. Double contingency principle [NA]
- c. Mass, distribution, geometry and spacing controls [NA]
- d. The use of neutron poisons [NA]
- e. Nuclear criticality safety training [NA]
- f. Posting of criticality control limits [NA?]
- g. Provisions for written recovery plans to be utilized when criticality control limits are exceeded
- h. Provision for notifying DOE when criticality control limits are exceeded.

5.16 Radiation Protection

5.16.1 Requirement for Radiation Protection

A program shall be established, implemented and maintained for radiation protection.

5.16.2 Program Key Elements

The program key elements include the following:

- a. Radiation safety training
- b. Dose limits for employees, subcontractors, visitors and members of the general public
- c. Dosimetry
- d. Internal dose measurements
- e. Radiological entry requirements
- f. Radiological posting and labeling requirements
- g. Measurement and control of radiation
- h. Contamination and airborne radioactivity controls
- i. Radioactive effluent controls
- j. Integration of As Low As Reasonably Achievable (ALARA) principals into designs and the workplace
- k. Control of calibration and test sources
- l. Calibration of instrumentation
- m. Radiation generating devices and radiography
- n. Recordkeeping.

5.17 Effluent Monitoring and Sampling

5.17.1 Requirement for Effluent Monitoring and Sampling

A program shall be established, implemented and maintained for effluent monitoring and sampling.

5.17.2 Program Key Elements

The program key elements include the following:

- a. Approved and controlled effluent monitoring plans, operating specifications and procedures.
- b. Ensure effluent monitoring and sampling instrumentation is installed and maintained.

5.18 MODE Changes

5.18.1 Requirements for MODE Change Control

A program shall be established, implemented and maintained that requires the MODE status of ERDF facilities to be documented and maintained current.

5.19 TSR Interfaces With Other Facilities5.19.1 Requirement for TSR Interfaces with other Facilities

A program shall be established and implemented to maintain compliance between the ERDF TSR and the OSR/IOSR/TSR of interfacing facilities when radioactive material transfers are involved through the use of approved and controlled operating specifications and procedures.

5.19.2 Program Key Elements

The program key elements include the following:

- a. SWBG waste package acceptance criteria.
- b. CWC package acceptance criteria.
- c. WRAP package acceptance criteria.
- d. [TBD] other facilities receiving material from ERDF.

5.20 TSR Compliance Program5.20.1 Requirement for TSR Compliance Program

A program shall be established, implemented and maintained that identifies each TSR requirement and documents how compliance with that requirement is demonstrated.

5.20.2 Program Key Elements

The program key elements include the following:

- a. Compliance Matrix for each AC which defines the documents and auditable records necessary to show compliance
- b. Definition of the safety function(s) of Safety Class 1 and 2 systems and necessary support system boundaries
- c. Approved and controlled TSR Compliance Program procedures.

5.21 Access Control5.21.1 Requirement for Access Control

A program shall be established, implemented and maintained to provide intruder protection at ERDF facilities during OPERATION, STANDBY, STABLE and RESTRICTED MODES.

5.21.2 Program Key Elements

The program key elements include the following:

- a. Hanford Site access control
- b. ERDF access control
- c. Evacuation control
- d. Warning signs and postings

5.22 ERDF Operational Controls5.22.1 Requirement for ERDF Operational Controls

A program shall be established, implemented and maintained for ERDF operational control. The program shall be based upon maintaining the operating conditions within ERDF such that off-site public exposure does exceed .5 rem.

5.22.2 Program Key Elements

The program includes procedures and auditable records that assure the ERDF is operated in a safe manner using the following operational requirements and controls:

- a. Container Waste Acceptance Criteria
- b. Container Receipt Inspection
- c. Container Manifest Verification
- d. Container Staging, Tracking and Logging Criteria
- e. Container Dose Rate Monitoring
- f. Stop Work Criteria for high wind speeds and high dose rates
- g. Soil Fixant Application Criteria
- h. Trench Air Monitoring Criteria
- i. Trailer Tipper Water Spray Criteria
- j. Dozer Water Spray Mister Criteria
- k. Interim Cover Installation Criteria
- l. Trench and Building Liner Monitoring
- m. Leachate Collection and Monitoring
- n. Support Facilities Contamination Control
- o. Facility and Vehicle Fire Protection
- p. Industrial Safety and Hygiene

Refer to the ERDF PSAR (WHC 1994) for the basis for these controls.

If it is discovered that a failure or non-compliance of one or more of these program elements results in an off-site radiological release a potential USQ shall be declared and the appropriate analysis performed (see AC 5.11).

If it is discovered that the off-site public exposure to radioactive material results in the ERDF exceeding the off site public exposure guidelines, a TSR AC VIOLATION shall be declared and the appropriate actions taken as described in AC 5.4.5.

SECTION 6
REFERENCES

Section 6 REFERENCES

These references are for the TSR and its Appendices.

DOE 1992, *Technical Safety Requirements*, DOE Order 5480.22, U.S. Department of Energy, Washington, D.C.

WHC 1994, *Environmental Restoration Disposal Facility (Project W-296) Preliminary Safety Analysis Report*, WHC-SD-W296-PSAR-001 (draft June 1994), Westinghouse Hanford Company, Richland, Washington.

APPENDIX A
DESIGN FEATURES

Appendix A DESIGN FEATURES

As stated in DOE Order 5480.22 (DOE 1992), the purpose of the DESIGN FEATURES Appendix is to describe in detail those features not covered elsewhere in the TSR that, if altered or modified, would have a significant effect on safety. Until a facility has a DOE-approved SAR, a DESIGN FEATURES Appendix should be included with the TSR. After DOE approves a facility SAR, the Appendix may be eliminated, provided that assurance is made that the provisions of the Appendix are present in the approved SAR or elsewhere in the TSR. The four areas to be addressed are vital passive components, configuration and physical arrangement, and materials. The following definitions were taken from DOE Order 5480.22 (DOE 1992):

- a. Vital passive components are essentially piping, vessels, supports, structures (such as confinement) and packages.
- b. The DESIGN FEATURES Appendix should also address configuration and physical arrangement, where it is a safety concern.
- c. If safe operation of the facility is dependent on any component being constructed of a particular material, that requirement should be discussed in the DESIGN FEATURES Appendix.
- d. Site characteristics such as the locations of public access roads, collocated facilities, facility area boundaries, site boundaries, nearest residence distances, etc., should be presented in the DESIGN FEATURES Appendix.

Based on the above definitions and the information presented in the ERDF PSAR (WHC 1994) there are no DESIGN FEATURES for the ERDF.

The following Administrative Controls (ACs) ensure that changes made to the ERDF are controlled so that they do not adversely affect safety.

AC 5.7	TSR Basis Control
AC 5.10	Facility Change Control
AC 5.11	Unreviewed Safety Question
AC 5.21	Access Control
-

APPENDIX B
BASES

Appendix B BASES

[Not applicable to the ERDF since there are no SLs, LCSs, LCOs or SRs]

This Appendix provides summary statements of the reasons for the Safety Limits, Limiting Conditions for Operation and the associated Surveillance Requirements. The BASES describe how the limit(s), the Applicability, the Condition(s) and the Surveillance(s) will maintain operation within the safety envelope. The primary purpose for describing the BASES for these requirements is to provide the operations and engineering staff with the necessary information to maintain the facility within the safety envelope and to ensure that any future changes to these requirements will not affect their original intent or purpose.

WHC-SD-W296-SA-001, REV 0

**WHC ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
SAFETY ASSESSMENT**

APPENDIX B2

**TECHNICAL SAFETY REQUIREMENTS ADMINISTRATIVE CONTROLS
COMPLIANCE MATRIX**

000234

**ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (ERDF)
TSR ADMINISTRATIVE CONTROLS COMPLIANCE MATRIX
6/29/94**

AC	TITLE	DOE ORDER/CFR	WHC Policy/Program	ERDF SPECIFIC PROCEDURES
5.1	Purpose	5480.22-9.e(5) CFR 830.1		
5.2	Contractor Responsibility	5480.22-9.a; 9.f; 9.h; 9.i; II.2.4.a CFR 830.4 CFR 830.320(a); (h)		
5.3	Compliance	5480.22-9.a(3) CFR 830.4		
5.4	TSR Violations	5480.22-9.e(5); I.2 5000.3B CFR 830.350(b)(xii)	WHC-CM-1-5, Section 7.1 <i>Occurrence Reporting and Processing of Operations Information</i>	
5.5	Occurrence Reporting	5480.22-9.e(5); II.2.4.k 5000.3B CFR 830.350	WHC-CM-1-5, Section 7.1 <i>Occurrence Reporting and Processing of Operations Information</i>	
5.6	Revisions to the TSR	5480.22-9.g CFR 830.320(f)	WHC-CM-4-46	
5.7	TSR Basis Control	5480.22-9.f; II.2.4.1 CFR 830.320(e)	WHC-CM-4-46	

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AC	TITLE	DOE ORDER/CFR	NHC Policy/Program	ERDF SPECIFIC PROCEDURES
5.8	Organization	5480.22-9.e(5); II 2.4.c CFR 830.310(b) (1)	MRP 5.23 Nuclear Facility Safety	
5.9	Procedures	5480.22-9.e(5); II 2.4.c CFR 830.310(b) (16)	MRP 5.23 - Nuclear Facility Safety	
5.10	Facility Change Control	5480.22-9.f; II.2.4.d CFR 830.112(b) CFR 830.310(b) (8) CFR 830.111	MRP 5.23 - Nuclear Facility Safety WHC-CM-8-8 - Job Control System	
5.11	Unreviewed Safety Questions	5480.22-II.2.4.j; 5480.21 CFR 830.112	MRP 5.14 - Occurrence Reporting and Processing of Operating Information MRP 5.12 - Identification and Resolution of Unreviewed Safety Questions	
5.12	Personnel Qualifications and Training	5480.22-9.e(5); II.2.4.g 5480.18 CFR 830.330	MRP 5.23 - Nuclear Facility Safety	
5.13	Facility Reviews and Audits	5480.22-9.e(5); II.2.4.j CFR 830.310(b) (10) CFR 830.120	MRP 5.23 - Nuclear Facility Safety	

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AC	TITLE	DOE ORDER/CFR	WHC Policy/Program	ERDF SPECIFIC PROCEDURES
5.14	Records Retention	5480.22-9.e(5); 1324.2A CFR 830.6	WHC-CM-3-5, Document and Records Management Manual WHC-CM-4-2, Quality Assurance Manual - QR 17.0	
5.15	Nuclear Criticality Safety	5480.22-9.e(5); II.2.4.d 5480.24 CFR 830.320(d) (3) CFR 830.360	WHC-CM-4-29, Nuclear Criticality Safety Manual	
5.16	Radiation Protection	5480.22-II.2.4.d 5480.11 5483.1A 5400.5 CFR 835	WHC-CM-1-6, WHC Radiological Control Manual WHC-CM-4-11, ALARA Program Manual WHC-CM-4-12, Health Physics Practices Manual	
5.17	Effluent Monitoring and Sampling	5480.22-II.2.4.d 5480.4 5400.5	WHC-CM-7-5, Environmental Compliance	
5.18	MODE Changes	5480.22-II.2.1.c II.2.1.h(6) II.2.1.i(4) CFR 830.320(d) (4)	TSR Standard - Facility Specific	
5.19	TSR Interface With Other Facilities		TSR Standard - Facility Specific	

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AC	TITLE	DOE ORDER/CFR	NHC Policy/Program	ERDF SPECIFIC PROCEDURES
5.20	TSR Compliance Program	5480.22- 9.e(5) II.2.4.c CFR 830.320(a)(3) CFR 830.310	TSR Standard - Facility Specific	
5.21	Access Control			
5.22	ERDF Operational Controls			

Bold AC Titles = DOE Order 5480.22 - 9.x "shall"

CFR 830.XXX = Under proposed Rulemaking these topics will be subject to Enforcement Action (i.e., Fines and Penalties) even if they are not identified in the TSR Administrative Controls. By "flagging" them as TSR Administrative Controls appropriate facility management attention will be focussed on them. This would also keep DOE review and audits focussed on the programs important to safety.

NHC-SD-W296-SAD-001, REV 0

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CHECKLIST FOR PEER REVIEW

Document Reviewed: DRAFT "ENVIRONMENTAL RESTORATION DISPOSAL FACILITY (PROJECT W-296) SAFETY ASSESSMENT"

Scope of Review: WHOLE DOCUMENT TECHNICAL REVIEW

Yes	No	NA	
☐	☐	☒	* Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
☒	☐	☐	Problem completely defined.
☒	☐	☐	Accident scenarios developed in a clear and logical manner.
☒	☐	☐	Necessary assumptions explicitly stated and supported.
☒	☐	☒	Computer codes and data files documented.
☒	☐	☐	Data used in calculations explicitly stated in document.
☒	☐	☐	Data checked for consistency with original source information as applicable.
☒	☐	☐	Mathematical derivations checked including dimensional consistency of results.
☐	☒	☐	Models appropriate and used within range of validity or use outside range of established validity justified.
☐	☐	☒	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
☐	☐	☒	Software input correct and consistent with document reviewed.
☐	☐	☒	Software output consistent with input and with results reported in document reviewed.
☒	☐	☐	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
☒	☐	☐	Safety margins consistent with good engineering practices.
☒	☐	☐	Conclusions consistent with analytical results and applicable limits.
☒	☐	☐	Results and conclusions address all points required in the problem statement.
☐	☐	☒	Format consistent with appropriate NRC Regulatory Guide or other standards
☒	☐	☐	* Review calculations, comments, and/or notes are attached.
☒	☐	☐	Document approved.

Robert M Marusich

Reviewer (Printed Name and Signature)

7/22/94

Date

* Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

☐ ☐ ☐ Analysis entered into analysis database

(Printed Name and Signature)

Date

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**DATE
FILMED**

10/18/94

END

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