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ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

SAFETY ANALYSIS REPORT

APPENDIX H

DOCUMENTED SAFETY ANALYSIS

903 DRUM STORAGE AREA (IHSS 112)

REMEDIATION PROJECT

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DOCUMENTED SAFETY ANALYSIS

FOR

903 DRUM STORAGE AREA (IHSS 112) REMEDIATION PROJECT

Kaiser Hill Company L.L.C.
Nuclear Safety
Rocky Flats Environmental Technology Site

REVIEWED FOR CLASSIFICATION/UCNI
By: JN Conyers
Date: 9/9/02

PADC-2002-00361

REVIEW AND APPROVAL

FOR

903 DRUM STORAGE AREA (IHSS 112)

REMEDIATION PROJECT DOCUMENTED SAFETY ANALYSIS

Revision 0

September 2002

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DOCUMENTED SAFETY ANALYSIS FOR
903 DRUM STORAGE AREA (IHSS 112) REMEDIATION PROJECT
List of Effective Pages

Section	Effective Page	Subject	Revision	Date
Title Page	Non-paginated	Title Page	0	10/02
LOEP	LOEP-1	List of Effective Pages	0	10/02
Executive Summary	i-iv	Executive Summary	0	10/02
Table of Contents	v-vi	Table of Contents	0	10/02
Section 1	1-6	Introduction	0	10/02
Section 2	7-14	Project Characterization and Description	0	10/02
Section 3	15-24	Safety Management Programs	0	10/02
Section 4	25-40	Safety Analysis	0	10/02
Section 5	41-46	Technical Safety Requirements	0	10/02
References	47-48	References	0	10/02
Approval Letters/Reports		SP:NRD:DEF:02-01609	0	10/21/02
		Safety Evaluation Report for DSA	0	10/02

EXECUTIVE SUMMARY

Background

The 903 Pad is located south of Central Avenue in the southeast corner of the 900 area. The 903 Pad was originally used for the storage of drums containing radiologically contaminated liquids (*e.g.,* hydraulic fluids, lathe coolant, solvents, oils, etc.) from 1958 to 1967. The drums were exposed to the environment and began to deteriorate over time. An estimated 5,000 gallons of contaminated liquid, originally thought to contain approximately 86 grams of plutonium as well as some uranium, leaked at the location. Recent characterization data indicates that there is approximately 8 grams of ^{234}U, 2,900 grams of ^{235}U, 429,000 grams of ^{238}U, 367 grams of $^{239/240}Pu$, and 2 grams of ^{241}Am (KH, 2000). The drums were removed from the 903 Pad in 1968. Following the removal of the drums some of the radiologically contaminated material was removed. In 1969 a layer of clean stone fill material was placed over the area and capped with an asphalt cover. This was done to prevent further spreading of contamination. Wind and rain (stormwater erosion) spread contaminated soils to the east and southeast of the 903 Pad, creating the "903 Lip Area."

The 903 Drum Storage Area Remediation Project, hereinafter referenced as the 903 Pad Project, supports the Rocky Flats Environmental Technology Site (RFETS or Site) Kaiser-Hill Remediation, Industrial D&D, and Site Services (RISS) mission, which includes performing environmental remediation of the site in accordance with the Rocky Flats Cleanup Agreement (RFCA) (DOE, 1996).

Project Overview

The 903 Pad Project involves the remediation of approximately 13,000 cubic yards of contaminated material made up of approximately 6 inches of asphalt, 6 inches of stone fill material and 1 foot of native soil within a 3.4-acre area. All material contaminated above the Tier 1 subsurface soil action levels for radionulides, as specified in the RFCA will be removed. At the completion of the remediation activities, the project site will be restored to natural conditions. Major project activities include (1) placement, use, and movement of weather structures, (2) excavation of contaminated soils/materials, (3) in process characterization, (4) excavation verification sampling, (5) waste handling and staging/storage, (6) decontamination of equipment, (7) movement of equipment between weather structures, (8) on-site transportation of contaminated soils/materials, (9) refueling of diesel-fueled equipment, (10) excavation backfilling, and (11) site reclamation. Activities associated with the remediation/treatment of volatile organic compounds (VOCs) from excavated or non-excavated soils are beyond the scope of this DSA.

The 903 Pad remediation activities will be performed within a temporary weather structure that will allow work to continue during inclement weather. The weather structure is not categorized as a safety structure, system, or component (Safety-SSC) from a nuclear safety perspective. The 903 Pad Project will also utilize the 904 Pad and the 891 Temporary Waste Storage Area as waste staging/storage areas prior to offsite shipment of the contaminated materials.

The project will be conducted using appropriate soil disturbance permits; radiological works permits (RWPs), and as low as reasonable achievable (ALARA) job reviews. A project-specific addendum to the *Environmental Restoration Program Health and Safety Plan for the Rocky Flats Environmental Technology Site (ER HASP)* (Envirocon, 2002) supports 903 Pad

Project activities. The 903 Pad Project HASP addendum covers all project activities including working with and around heavy equipment, radioactive contamination, and hazardous chemical contamination.

Project Hazard Categorization

The 903 Pad Remediation Project Facility Hazard Categorization is Hazard Category 3 (HC-3) in accordance with DOE-STD-1027-92 (DOE, 1997) based on characterization data.

Safety Analysis Overview

This DSA is prepared for the Department of Energy (DOE), Rocky Flats Field Office (RFFO) in fulfillment of the requirements specified in 10 Code of Federal Regulations (CFR) Part 830, Subpart B, *Safety Basis Requirements* (CFR, 2001). This DSA utilizes a graded approach that is appropriate for the complexities and hazards associated with the 903 Pad Project.

Although categorized as a HC-3 Nuclear Facility, the hazards associated with the 903 Pad Project do not present adverse impacts to the collocated worker (CW), the public represented by the maximum [exposed] off-site individual (MOI), or the environment. Accident scenario results, discussed in Section 4.2, *Accident Analysis*, indicate that the accident scenarios postulated and analyzed for the project result in *low* radiological consequences to the CW and MOI without crediting mitigative controls. Additionally, all scenarios result in Risk Class III or less events without crediting preventive controls. No Safety-SSCs have been identified/credited for the project. Immediate worker (IW) safety is assured through implementation of site-specific hazard controls and compliance with the Site Environmental Restoration (ER) HASP and Site Safety Management Programs (SMPs). The Site SMPs described in Section 3 provide the infrastructure to meet the requirements of the Integrated Safety Management (ISM) philosophy as it is applied to all work activities at the Site.

The Technical Safety Requirements (TSRs) for the 903 Pad Project, included as Section 5, consist of administrative controls and a commitment to the Site SMPs.

Organizations

The organization and management structure at RFETS consists of five major closure projects, programmatic oversight, and administration. These projects are managed by Kaiser-Hill and staffed with a combination of Kaiser-Hill and subcontractor personnel. Kaiser Hill Company L.L.C. will manage the 903 Pad Project on behalf of the DOE, RFFO and provide project oversight.

As one of the major Kaiser Hill closure projects, RISS is responsible for safely decommissioning all office, industrial and south side buildings; performing environmental remediation of the site in accordance with the RFCA; and providing cost-effective site services in support of the overall closure mission. The RISS organization is responsible for ensuring the safe performance of the 903 Pad Project remediation activities including protection of the health and safety of the RFETS workers and the public and protection of the environment. Operations conducted at the 903 Pad are performed in accordance with this DSA as maintained by Kaiser-Hill. Kaiser-Hill management has assigned authority and responsibility for the operation of the 903 Pad Project to the KH ER Program Manager.

Subcontractor organizations that will perform work at the 903 Pad include Envirocon, Inc. and URS Group Inc. Envirocon will manage the 903 Pad Project field activities. Envirocon's waste management partner, E2 Consulting Engineers, Inc. will coordinate and provide support for project waste management and tracking activities. The URS Group will perform waste characterization sampling, confirmation sampling and sample analysis.

Kaiser Hill will supply heavy equipment operators, fuel for equipment, transportation of materials and supplies to the project site, transportation of empty waste packages to the site, and transportation of full waste packages to the offsite disposal location.

Envirocare has been designated as the receiver site for LLMW that meets their Waste Acceptance Criteria (WAC). The Nevada Test Site is the designated receiver for LLW. A planning team will develop options for handling waste streams without approved receiver sites (*i.e.,* transuranic [TRU] or transuranic mixed [TRM] wastes).

Safety Analysis Conclusions

Compliance with the TSRs specified in Section 5 assures that 903 Pad Project can be performed safely with respect to workers, the public, and the environment.

DSA Organization

The structure and content of the 903 Pad Project DSA parallels the format delineated in DOE-STD-3009 (DOE, 2000) as presented below:

Table 1 DOE-STD-3009-94 and 903 Pad Project DSA Section Comparison

DOE-STD-3009 Topic	DOE-STD-3009 Chapter	903 Pad Project DSA Section and Remarks
Executive Summary	Unnumbered	Executive Summary
Site Characteristics	1	Section 1 - Introduction
Facility Description	2	Section 2 – Project Characterization and Description
Hazard and Accident Analyses	3	Section 4 - Safety Analysis
Safety Structures, Systems, and Components	4	Section 4.6- Derivation of Technical Safety Requirements
Derivation of Technical Safety Requirements	5	Section 4.6 – Derivation of Technical Safety Requirements
Prevention of Inadvertent Criticality	6	Section 3 - Criticality Safety SMP Section 4 - Safety Analysis
Radiation Protection	7	Section 3 - Radiation Protection SMP
Hazardous Material Protection	8	Section 3 – Occupational Safety & Industrial Hygiene SMP, Nuclear Safety SMP, Waste Management SMP
Radioactive and Hazardous Waste Management	9	Section 3 - Nuclear Safety SMP, Waste Management SMP
Initial Testing, In-Service Surveillance, and Maintenance	10	Section 3 – Testing, Surveillance, and Maintenance SMP
Operational Safety	11	Section 3 - Occupational Safety & Industrial Hygiene SMP

Table 1 DOE-STD-3009-94 and 903 Pad Project DSA Section Comparison

DOE-STD-3009 Topic	DOE-STD-3009 Chapter	903 Pad Project DSA Section and Remarks
Procedures and Training	12	Section 3 – Integrated Work Control SMP, Training, SMP
Human Factors	13	Section 3 - Occupational Safety & Industrial Hygiene SMP
Quality Assurance	14	Section 3 – Quality Assurance SMP
Emergency Preparedness Program	15	Section 3 – Emergency Preparedness SMP
Provisions for Decontamination and Decommissioning	16	Section 3 – All SMPs
Management, Organization, and Institutional Safety Provisions	17	Section 3 – All SMPs

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FIGURES

TABLES

1. INTRODUCTION

1.1 Purpose

This DSA supports the activities associated with the remediation of the 903 Pad and is prepared for the Department of Energy (DOE), Rocky Flats Field Office (RFFO) in fulfillment of the requirements specified in 10 Code of Federal Regulations (CFR) Part 830, Subpart B, *Safety Basis Requirements* (CFR, 2001). Section 830.204, *Documented Safety Analysis*, requires that a DSA be submitted for a Hazard Category 1, 2, or 3 DOE Nuclear Facility. This DSA is the Authorization Basis (AB) for the 903 Pad Project.

1.2 Documented Safety Analysis Graded Approach

A graded approach was used to develop this DSA appropriate for the complexities and hazards associated with the 903 Pad Project. There are no complex processes or activities such as waste treatment, waste repackaging, or decontamination and decommissioning, associated with the 903 Pad Project.

Activities conducted as part of the 903 Pad Project, as described in Section 2.2 and analyzed in this DSA, are well characterized and understood. The 903 Pad Project activities are proceduralized in approved work control documents (*e.g.,* procedures, integrated work control packages, operations orders, etc.). Additionally, Kaiser-Hill RISS has demonstrated a record of safe performance of remediation activities that will be performed as part of the 903 Pad Project, as part of other Site environmental remediation projects (*e.g.,* Trench 1, Trench 3/4, etc.).

Table 2 lists the elements of the 903 Pad Project DSA, as required by CFR Part 830 §830.204, *Documented Safety Analysis,* and application of the graded approach for each.

Table 2 Graded Approach Development of the 903 Pad Project DSA

DSA Required Element of 10 CFR 830.204	Applicable DSA Section(s)	DSA Graded Approach
Description of the facility mission, activities, and building systems. §830.204 (b)(1)	ES, 1.3, 1.5, 2.1, 2.2, 2.3	The 903 Pad Project is described in appropriate detail in the Executive Summary and Section 1.3. Site/project characterization data is presented in Section 2.1. Remediation activities are listed in Section 1.3 and described in detail in Section 2.2. Project systems (*i.e.,* weather structures) are also described in Section 2.2.
Identification of both natural and man-made hazards associated with the facility. §830.204 (b)(2)	4.1	DSA Section 4.1, *Hazard Identification and Evaluation*, Table 5, *903 Pad Project Hazards*, identifies and lists the hazards (both natural and man-made) applicable to the 903 Pad Project. Specific hazard descriptions are contained in the Waste Management Activities Safety Analysis NSTR (KH, 2001), which is referenced.
Evaluation of normal, abnormal, and accident conditions, including consideration of natural and man-made external events, identification of energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials, and consideration of the	4.1, 4.2, 4.3	DSA Section 4.1, *Hazard Identification and Evaluation*, Table 5, *903 Pad Project Hazards*, identifies (via shaded portions of table) hazards and energy that required further evaluation in this DSA. Non-shaded portions of Table 5 are Standard Industrial Hazards (SIHs) (i.e., hazards that only lead to occupational injuries or illnesses, do not contribute to accident source terms, and are not accident precursors, initiators, or propagators) and are not further analyzed. Based on the results of Section 4.1, *Hazard Identification and Evaluation*, DSA Section 4.2, *Accident Analysis*, evaluates hazards and energy sources that can contribute to accident source terms or are identified as accident precursors, initiators, or propagators. Material fires and spills, postulated to result in a release of radioactive/

Table 2 Graded Approach Development of the 903 Pad Project DSA

DSA Required Element of 10 CFR 830.204	Applicable DSA Section(s)	DSA Graded Approach
need for analysis of accidents which may be beyond the design basis of the facility. §830.204 (b)(3)		hazardous material, are addressed or analyzed in this DSA. Normal (*e.g.,* routine project activities), abnormal (*e.g.,* failure of combustible controls), and accident (*e.g.,* seismic events) conditions were considered. Consideration of the need to analyze beyond design basis accidents is also discussed. The accident analysis section discusses scenario development/ progression, initial condition assumptions, frequency, material-at-risk, radiological consequences, and risk class as necessary.
Derive hazard controls necessary to ensure adequate protection of workers, the public, and the environment, demonstrate the adequacy of these controls to eliminate, limit, or mitigate identified hazards, and define the process for maintaining the hazard controls current at all times and controlling their use. §830.204 (b)(4)	4.2, 4.4, 4.6, 5,	Hazard controls are discussed/derived in Section 4.2, *Accident Analysis*. Some controls are relied upon to establish initial conditions in order to define meaningful "bounding" scenarios (*e.g.,* the maximum quantity of soil/material assumed per intermodal container). Hazard control preventive or mitigative function(s) are discussed when they are identified in the safety analysis. Because 903 Pad Project is a non-complex low hazard project, hazard controls consist of Administrative Controls (*e.g.,* work limitations, stabilizing conditions, hold points, and field investigation techniques) and a commitment to the Site Safety Management Programs (SMPs). The Site SMPs provide adequate protection of IW from all analyzed events in this DSA. A specific discussion on worker protection is in Section 4.4, *Worker Safety Evaluation,* of this DSA. Section 4.6, *Derivation of Technical Safety Requirements*, explains how the controls were developed from the hazard identification and accident evaluation processes (Sections 4.1 and 4.2 of this DSA) and discusses the control types used (*e.g.,* administrative control limits versus limiting conditions of operation for Systems, Structures and Components). Section 4.6 provides assurance that control coverage for the 903 Pad Project is complete. The 903 Pad Project TSRs are provided as Section 5, *Technical Safety Requirements*, of this DSA. The TSRs will be maintained current via revisions to this DSA, as necessary, and the Site Unreviewed Safety Question Determination (USQD) process (Nuclear Safety SMP).
Define the characteristics of the safety management programs necessary to ensure the safe operation of the facility, including (where applicable) quality assurance, procedures, maintenance, personnel training, conduct of operations, emergency preparedness, fire protection, waste management, and radiation protection. §830.204 (b)(5)	3	Characteristics of the Site SMPs are documented in Section 3, Safety Management Programs. SMPs include Conduct of Operations, Configuration Management, Criticality Safety, Document Control, Emergency Preparedness, Engineering, Environmental Management, Fire Protection, Integrated Work Control, Nuclear Safety, Occupational Safety & Industrial Hygiene, Quality Assurance, Radiological Protection, Testing, Surveillance, and Maintenance; Transportation Safety, Training; and Waste Management. Attributes important to Nuclear Safety are discussed for each SMP. Details of the Site SMPs are provided in the Site Safety Analysis Report (KH, 2002)
With respect to a nonreactor nuclear facility with fissionable material in a form and amount sufficient to pose a potential for criticality, define a criticality safety program that: (i) ensures that operations with fissionable	3	The Criticality Safety SMP is discussed in Section 3, *Safety Management Programs*. The Criticality Safety SMP assures that subcritical conditions are maintained under normal and credible abnormal conditions, identifies applicable nuclear criticality safety standards, and describes how the SMP meets applicable standards. Nuclear Criticality accident scenarios are addressed in Section 4.2.7, *Nuclear Criticality.*

Table 2 Graded Approach Development of the 903 Pad Project DSA

DSA Required Element of 10 CFR 830.204	Applicable DSA Section(s)	DSA Graded Approach
material remain subcritical under all normal and credible abnormal conditions, (ii) Identifies applicable nuclear criticality safety standards, and (iii) Describes how the program meets applicable nuclear criticality safety standards. §830.204 (b)(6)		

1.3 Project Overview

The 903 Pad is located south of Central Avenue in the southeast corner of the 900 area. A layout showing the physical boundaries of the project site is shown in Figure 1. Included within the project boundaries are (1) the entire 903 Pad (asphalt area), which is approximately 375 feet by 395 feet (148,125 ft^2 or 3.4 acres), (2) the 903 Lip Area to the east, (3) a backfill stockpile area to the south, (4) the 904 Pad to the west, (5) the 891 Temporary Waste Storage Area located to southwest, and (6) areas/roads inter-connecting the 903 Pad, 904 Pad, 891 Temporary Waste Storage Area, and the backfill stockpile area. The closest distance to the RFETS boundary is approximately 2,200 meters.

The 903 Pad Project involves the remediation of approximately 13,000 cubic yards (yd^3) of contaminated material at the 903 asphalt pad area, made up of approximately 6 inches of asphalt, 6 inches of stone fill material and 1 foot of native soil. All material contaminated above the Tier 1 subsurface soil action levels for radionulides, as specified in the RFCA will be removed. At the completion of the remediation activities, the project site will be restored to natural conditions by backfilling with clean import material and revegetation of the site. While it is not anticipated to encounter additional waste streams in the first two feet of material, additional materials will be appropriately sampled, packaged and staged for treatment and/or off-site shipment. Major project activities are listed below. Detailed descriptions of these activities are provided in Section 2, *Project Characterization and Description.*

- Placement, use, and movement of weather structures,
- Excavation of contaminated soils/materials,
- In process characterization,
- Excavation verification sampling,
- Waste handling and staging/storage,
- Decontamination of equipment,
- Movement of equipment between weather structures,
- On-site transportation of contaminated soils/materials,
- Refueling of diesel-fueled equipment,
- Excavation backfilling, and
- Site reclamation.

Activities associated with the remediation of volatile organic compounds (VOCs) from excavated or non-excavated soils are beyond the scope of this DSA and will be addressed separately. Additionally, contaminated soils associated with the 903 Lip Area to the east of the 903 Pad will be addressed separately.

Additional project support activities include (1) management of incidental water, (2) site erosion control (3) communications, and (4) visitor access. These activities will not be further discussed in this DSA. The project will be conducted using appropriate soil disturbance permits; radiological works permits (RWPs), and as low as reasonable achievable (ALARA) job reviews. A project-specific addendum to the *Environmental Restoration Program Health and Safety Plan for the Rocky Flats Environmental Technology Site (ER HASP)* (Envirocon, 2002) supports the 903 Pad Project activities. The 903 Pad Project HASP addendum covers all project activities including working with and around heavy equipment, radioactive contamination, and hazardous chemical contamination.

1.3.1 Waste Types

Expected waste streams include radionuclide contaminated soil, VOC contaminated soil, asphalt with fill stone embedded on the bottom, used Personal Protective Equipment (PPE), debris remaining from Geoprobe sampling, contaminated debris including wood, paper, metal, and trash, and sample returns. The 903 Pad Project has the potential to generate several waste types including sanitary waste, Low Level Waste (LLW)/Low Level Mixed Waste (LLMW), Transuranic (TRU)/Transuranic Mixed (TRM), and orphan waste. Orphan waste is defined as LLMW greater than 10 nCi/gram that has no clear disposal path due to treatment, storage and disposal (TSD) site Waste Acceptance Criteria (WAC).

Radioactive contamination includes ^{234}U, ^{235}U, ^{238}U, $^{239/240}Pu$, and ^{241}Am. The form of radioactive material from an accident analysis perspective is conservatively assumed to be powder (finely divided material within the fill material and soils). VOC contamination includes carbon tetrachloride (CCl_4), tetrachloroethene (PCE), trichloroethene (TCE), and 1,2-cis dichloroethylene (1,2-DCE).

1.3.2 Waste Container Types

Department of Transportation (DOT) certified Industrial Package 1 (IP-1) bulk material intermodal containers with lids or equivalent type containers will be used to package the contaminated soils and materials from the 903 Pad. The approximate capacity of each intermodal container is 25 cubic yards (yd^3) or 60,000 pounds of material. The containers are certified for shipment by flatbed truck, intermodal chassis or roll-off truck, or rail flatcar. A crane, sidelifter, forklift, roll-off truck or container handler can lift them.

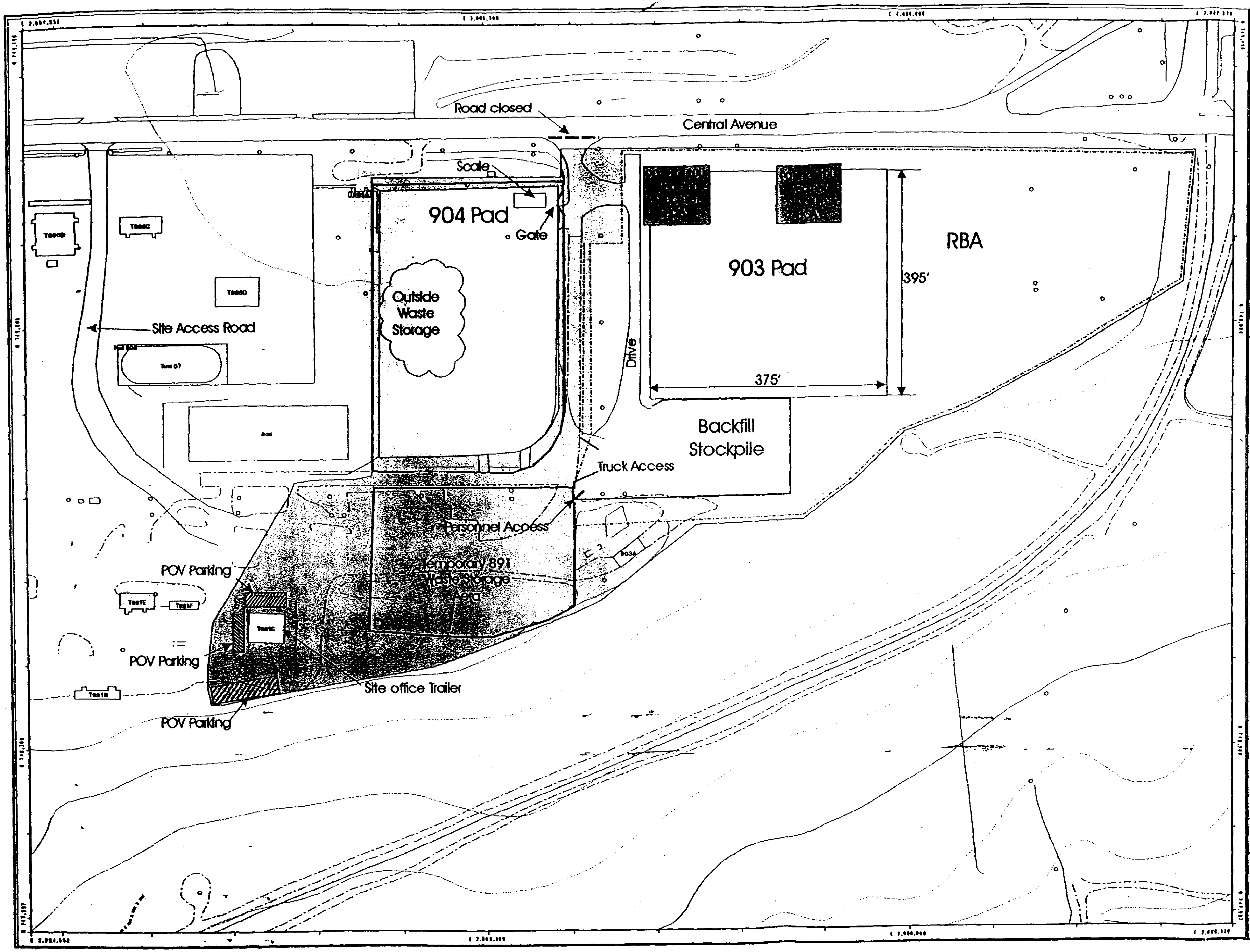
1.4 Project Hazard Categorization

The *Facility Safety Analysis for Environmental Restoration Projects* contained in the Site Safety Analysis Report (Site SAR) (KH, 2002) categorizes the 903 Pad as a *radiological* facility while the site is in a *static* condition (*i.e.,* no Pad/soil disturbance). In a static condition there is a lack of initiators/energy sources available that could cause a radiological release impacting the CW or public, represented as the MOI. In other words, the radioactive material is considered unreleasable unless disturbed.

The 903 Pad Remediation Project Facility Hazard Categorization is Hazard Category 3 (HC-3) in accordance with DOE-STD-1027-92. This categorization is based on (1) the inventory of radioactive material present in the Pad and underlying fill and soils, and (2) the planned remediation of the site which potentially results in a material-at-risk (MAR) greater than HC-3 levels specified in DOE-STD-1027-92.

903 Pad Site Layout Map

Figure 1



EXPLANATION

- Power Pole
- 903 Pad Site Boundary
- 903 Pad RBA

Standard Map Features

- 903 & 904 Pads
- Streams, ditches, or other drainage features
- Fences and other barriers
- Topographic Contour (20 Foot)
- Paved roads
- Dirt roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95
Topographic contours were derived from digital elevation model (DEM) data by Morrison Knudson (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

Scale = 1 : 1940
1 inch represents approximately 162 feet

50 0 100 200ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp

Prepared for: KAISER-HILL

August 21, 2002

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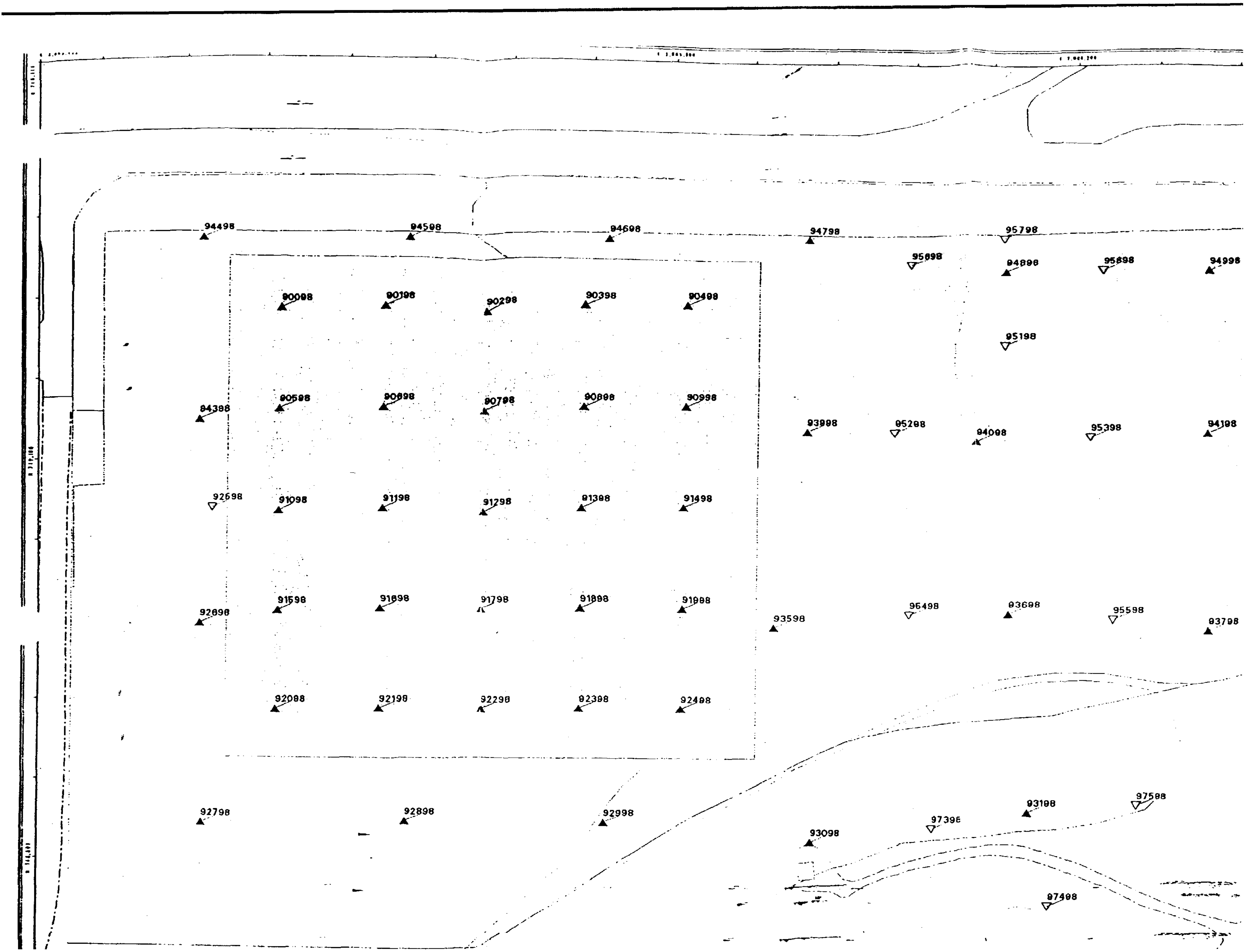
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2. PROJECT CHARACTERIZATION AND DESCRIPTION

2.1 Site/Project Characterization

The information presented in this section of the DSA reflects the current project characterization of the 903 Pad (KH, 2000). The characterization information presented in the following paragraphs does not discuss the presence of unanticipated hazards or conditions. The project will assure that unanticipated hazards or conditions are identified as the project progresses and controlled subsequent to discovery.

Radionuclides

Characterization data obtained at boring locations across the 903 Pad were used to develop estimates of the radionuclide inventory associated with material to be removed; these estimates are summarized by location and radionuclide in Table 3. The layers of material to be excavated include approximately 6 inches of asphalt (the 0-0.5 foot layer), 6 inches of stone fill material (the 0.5-1 foot layer) and 1 foot of native soil (the 1-1.5 foot and 1.5-2 foot layers). The volume of material (Column 2) represents the most contaminated layer of material based on the polygon associated with the identified boring location. The majority of the radionuclide contamination at the 903 Pad exists within the 1-1.5 foot and the 1.5-2 foot layers of native soil. The radionuclide inventories (Columns 3-7) were developed under the assumption that contaminant concentration levels measured at each borehole layer are representative of the entire soil volume within that layer. The total radionuclide inventory quantities in Table 3 indicate that the majority of the radionuclide contamination is contained in approximately 2,800 yd^3 of the 13,000 yd^3 of material that will be excavated. The remaining soil volume (10,200 yd^3) contains much lower concentrations and quantities of radionuclides that are bounded by those shown in Table 3. The purpose of Table 3 is to identify the most contaminated soil volumes to carry forward to the accident analysis in Section 4. Complete characterization data can be found in the Characterization Report for the 903 Pad Drum Storage Area, 903 Lip Area, and Americium Zone (KH, 2000).

Table 3 903 Pad Project Radionuclide Inventory Summary

Location No.	Volume (ft^3)	Radionuclide Inventory (grams)				
		Am-241[1]	Pu-239/240	U-233/234	U-235	U-238
90098	3,520	0.00	0.01	0.03	5.89	899.74
90198	2,462	0.00	1.24	0.03	22.27	711.65
90298	1,871	0.04	12.04	0.05	9.39	2,419.71
90398	2,444	0.00	0.00	0.01	1.50	322.47
90498	3,752	0.00	0.75	0.04	13.96	1,530.00
90598	2,551	0.00	0.26	0.02	2.28	617.01
90698	3,937	0.11	29.68	0.17	53.50	4,743.81
90798	3,911	0.00	0.72	0.03	12.35	1,136.68
90898	2,811	0.01	1.36	0.08	11.19	2,228.06
90998	3,162	0.01	2.70	0.28	42.15	12,893.52
91098	2,345	0.01	4.14	0.02	5.03	438.79
91198	2,250	0.00	0.20	0.02	1.70	527.24
91298	2,757	0.00	0.47	0.02	4.29	633.44
91398	2,794	0.05	13.03	4.06	1,112.06	331,550.64
91498	3,556	0.01	1.93	0.18	145.74	8,224.30

Table 3 903 Pad Project Radionuclide Inventory Summary

Location No.	Volume (ft^3)	Radionuclide Inventory (grams)				
		Am-241[1]	Pu-239/240	U-233/234	U-235	U-238
91598	2,498	1.18	268.73	0.40	423.63	10,717.97
91698	2,794	0.16	0.77	0.04	60.07	803.32
91798	2,776	0.02	15.61	0.02	2.94	726.43
91898	2,811	0.03	4.81	0.25	166.86	5,645.88
91998	2,766	0.01	2.89	0.26	428.02	3,581.28
92098	4,084	0.00	0.00	0.04	34.44	640.09
92198	3,075	0.00	0.23	0.03	3.62	385.49
92298	2,830	0.00	0.06	0.03	3.38	652.48
92398	3,053	0.00	0.02	0.02	5.24	320.47
92498	4,467	0.00	1.50	0.03	9.68	747.63
Total	75,277 ($2,788 yd^3$)	1.6	363.2	6.2	2,581.2	393,098

1. The ^{241}Am *quantities are assumed to be due to ingrowth during aging of the RFETS WG Pu isotopic mix and are consistent* with Am amounts found during previous RFETS environmental sampling activities. Additionally, the waste streams originally stored on the 903 Pad (e.g., hydraulic fluids, lathe coolant, solvents, oils, etc.) are not considered high Am waste streams.

Volatile Organic Compounds

Characterization data (KH, 2000) indicate that VOCs are the only chemical contaminants at the 903 Pad site. Subsurface soil contaminants include CCl_4, PCE, TCE, and 1,2-DCE. Maximum detected concentrations of these contaminants at the 903 Pad, along with the associated sampling locations are listed in Table 4.

Table 4 Maximum Detected VOC Concentrations

Contaminant	Maximum Detected Concentration (μg/kg)	Location (Borehole No./Depth[ft])
Carbon Tetrachloride (CCl4)	5.3	96798 (20.4 to 20.8)
Methylene Chloride	1,700	92598 (16 to 16.75)
Tetrachloroethene (PCE)	6,100	90998 (3.8 to 4.0)
Trichloroethene (TCE)	290	90998 (3.8 to 4.0)
1,2-cis-dichloroethylene (1,2-DCE)	4,400	90998 (3.8 to 4.0)

2.2 Project/Activity Descriptions

2.2.1 Placement, Use, and Movement of Weather Structures

The 903 Pad Project remediation activities will be performed within temporary weather structures, which allow work to continue during inclement weather. The structures provide a protected environment for excavating and managing the contaminated materials as well as protection from high winds and precipitation events common at the Site between October and April. The weather structures include negative ventilation systems with high efficiency particulate air (HEPA) filtration to contain airborne contaminates and electric power provided by gasoline/diesel generators. The weather structures are not categorized as a safety structure, system, or component (Safety-SSC) from a nuclear safety perspective.

Two temporary weather structures, each approximately 90 feet wide by 110 feet long, will be used. One structure will cover the "active" remediation area while backfill operations will be completed in the second structure. The structures are aluminum ribbed with a polyester reinforced vinyl fabric membrane. Figure 1 shows the temporary structure layout including the work areas controlled for radiological purposes.

After initial siting and construction, each weather structure will be moved from one excavation area to another to allow the entire 903 Pad site to be remediated within a weather structure. The primary method of weather structure location will be via diesel-fueled forklifts and loaders and a skid system attached to the weather structure base. Alternatively, a crane lift system will be attached to each structure and may be used under certain circumstances. Weather structure anchoring is attained via the use of concrete ballast; anchoring involving penetration of the 903 Pad is not used. The concrete ballasts, each weighing approximately 14,000 to 15,000 pounds, are sized to account for Site wind loading.

Upon completion of backfilling operations inside the weather structure, the structure will be prepared for relocation to the next excavation site. Preparations include placing bracing in the weather structure inside corners and all doorways and installing cables across the weather structure between the bases of each truss. Exterior preparations include attaching cables to manufacturer provided attachment points on the leading edge of each skid on both sides of the weather structure. To relocate a weather structure, forklifts will remove the concrete ballast and two four-wheel drive loaders will be attached to the cables that were previously attached to the leading edge of the structure. A forklift or loader will also be attached to cables on the trailing edge of the structure to serve as a guide for structure movement and as ballast should unexpectedly high winds occur. Spotters will be utilized as necessary. After relocation and anchoring, the weather structures will be inspected for integrity and declared available for the next remediation cycle.

Both during and at the completion of excavation activities in the active remediation weather structure, in-process radiological surveys will be conducted inside the structure. At the discretion of Site Radiological Engineering personnel and in accordance with approved procedures, decontamination of the weather structure will be conducted. If the weather structure is not found to be contaminated above Radiological Engineering acceptable levels, it will be relocated to the next excavation site. At the conclusion of the 903 Pad Project, the weather structures will be sampled, radiologically scanned, and decontaminated as necessary prior to release for conditional/unrestricted use.

2.2.2 Excavation of Contaminated Soils/Materials

Excavation activities will consist of removal and packaging of the 6-inch asphalt cap material into intermodal containers per approved procedure. It is anticipated that the asphalt cap material can be shipped offsite as LLW for disposal. The remaining stone fill material and native soils will be loaded together into additional intermodal containers. The 903 Pad contents will be excavated with a diesel-fueled, track-mounted excavator. The excavator bucket capacity is assumed to be 3 yd^3. Excavation will proceed from east to west within the active weather structure with the excavator sitting on unexcavated asphalt. A designated spotter will assist the excavator operator, from the side of the excavation and watch for unanticipated hazards or conditions. The spotter will communicate with the operator using a hand-held radio and/or hand signals.

The excavation is primarily limited to the area covered by the asphalt cap in area and to a depth of two feet below the asphalt surface or to a depth at which the RFCA Tier 1 radionuclide cleanup requirements are met. Removal of soils with VOC contamination will be incidental to the remediation of the radionuclide content and is not part of the 903 Pad Project's work scope.

The HASP addendum outlines the personal exposure and environmental monitoring that will be conducted during excavation, material handling, and stockpiling activities. Decontamination and radiological surveying of excavation equipment and personnel will be performed to procedures outlined in the HASP and applicable RWPs.

While historical information and recent sampling results have not indicated the presence of any materials other than the asphalt, stone, and soil content, should any unanticipated material be encountered it will be segregated, sampled, and packaged appropriately. If the unknown material presents an "unanticipated hazard or condition," project activities will pause to assess the potential hazard or condition. The situation will be evaluated to determine the severity or significance of the hazard or condition and whether the existing project TSRs are sufficient to address the hazard or condition. Based on this initial evaluation, a determination will be made whether to proceed with controls currently in place, segregate the condition or hazard from the project activity, if this can be done safely, or curtail operations to address the unexpected hazard or condition. Concurrence to proceed down the selected path must be obtained from the Kaiser-Hill ER Program Manager. In addition, the resumption of field activities involving radiological issues will be in accordance with the Site Radiological Control Manual. The process of managing unanticipated hazards and conditions is documented in the *Environmental Restoration Program Field Implementation Plan for the Rocky Flats Environmental Technology Site* (ER FIP) (Envirocon, 2001), the *Field Implementation Plan Addendum for the 903 Pad Remediation Project (IHSS 112)* (Envirocon, 2002a), the *Environmental Restoration Program Health and Safety Plan for the Rocky Flats Environmental Technology Site (ER HASP)* (Envirocon, 2001a), and the *Health and Safety Plan Addendum for Remediation of IHSS Group 900-11* (Envirocon, 2002).

Unanalyzed hazards and conditions or any modification to project activities or work that fall outside the bounds of this safety analysis shall be assessed through the Unreviewed Safety Question Determination (USQD) process. Modifications to project activities or work could result from a change in project scope or discovery of unanticipated hazards or conditions. The USQD process assures that modified or additional project activities or work, not previously analyzed, can be safely performed with the existing set of controls; or that additional controls have been identified, verified to be those necessary and sufficient to conduct the planned activities or work, and have been documented and implemented. Positive USQ determinations will be transmitted to DOE, RFFO for approval.

2.2.3 In Process Characterization

It is not anticipated that the asphalt cap material will require further characterization (radiological and/or VOCs). However, the stone fill material and the native soils will be initially sampled directly from the excavator bucket before loading into the intermodal containers. This process precludes having to sample material in the intermodal containers.

Gamma-spectroscopy will be used to verify the radiological activity of the soils. An Organic Vapor Analyzer (OVA), or similar instrument, with a Flame Ionization Detector (FID) and Photo Ionization Detector (PID) will be used to screen for VOC contamination.

Material excavated from the 903 Pad will be characterized for TSD site WAC. Radionuclide contaminated material found to be above 10 nano-curries/gram (nCi/g) may be returned to the active remediation weather structure and re-mixed with clean fill until acceptable, or stored as orphan waste, or shipped as transuranic (TRU) waste. This determination will be made at a later date depending on the volume of material generated during the 903 Pad Project.

2.2.4 Excavation Verification Sampling

At the completion of excavation activities, for each section, confirmation soil samples will be collected at the base of the excavation to determine the post-action condition of the subsurface soils. The sampling will be performed upon achieving the depth of 2 feet below the top of the asphalt. Excavated areas will not be backfilled until onsite gamma-spectroscopy analysis results have verified that cleanup levels have been achieved. If sample analytical results indicate that radioactive contamination is present above cleanup target levels, further excavation in 6-inch deep increments and sampling will continue until target levels are achieved or until groundwater or bedrock is encountered. Upon completion of all excavation and sampling activities the exposed surfaces of the excavation will be covered with plastic to prevent cross contamination during subsequent excavation activities.

2.2.5 Waste Handling and Staging/Storage

All material removed (asphalt, stone fill, and soil) will be packaged in intermodal containers or other approved containers. LLW and LLMW with radioactivity levels less than 10 nCi/g have approved receiver sites and will be shipped offsite for treatment (if needed) and/or disposal. TRU/TRM and orphan waste may be blended down for radiological purposes to attain LLW/LLMW levels that can also be shipped offsite for treatment and/or disposal at approved receiver sites. Orphan waste may also be stored on-site until an approved receiver site is identified.

After the loading is complete, the filled intermodal container will be closed while still in the weather structure and, using a diesel-fueled forklift, will be moved out of the structure for relocation to the intermodal container staging/storage area (*i.e.*, 904 Pad Area, 891 Temporary Waste Storage Area). Upon receipt and approval of verification samples from each container, offsite shipment will take place directly from the 904 Pad and/or the 891 Temporary Waste Storage Area. Any required repackaging would be performed inside the currently active weather structure.

2.2.6 Decontamination of Equipment/Personnel

Decontamination activities will be performed as described in the ER HASP (Envirocon, 2001a). Equipment moving between the weather structures upon completion of remediation activities will be scanned for radionuclide contamination as it will be moving from a High Contamination Area (HCA) to a Radiological Buffer Area (RBA).

Decontamination methods will vary depending on the location and extent of contamination. Visual inspection, radiological monitoring, and VOC monitoring will determine decontamination effectiveness. It is anticipated that only the bucket of the excavator will be exposed to contamination, as equipment will generally be working on the asphalt pad. Items may be decontaminated in the field or be transferred to the decontamination facility (Building 903 A/B) adjacent to the south of the 903 Pad.

2.2.7 Movement of Equipment Between Weather Structures

Upon completion of remediation activities in the active weather structure, equipment including air monitors and the negative air system will be shut down and prepared for movement to the second weather structure. Construction equipment will be gross decontaminated and radiologically scanned, as discussed above, before being mobilized to the second weather structure.

2.2.8 On-Site Transportation of Contaminated Soils/Materials

The on-site transportation of contaminated soils/materials will be compliant with DOT requirements for off-site transportation. Kaiser Hill will assure that testing and certification data are provided to document that all containers meet DOT packaging criteria.

2.2.9 Refueling of Diesel-Fueled Equipment

No storage of flammable or combustible liquids will be allowed within the temporary weather structures. Diesel fuel will be allowed within the structures only in the tanks of the diesel-fueled equipment working within the tent. Refueling operations will be conducted in accordance with the requirements of NFPA 30A, *Automotive and Marine Service Station Code*, using a diesel tanker parked outside the tent with a service hose extending within the tent to a specified equipment fueling area. Fueling operations will be conducted with none of the equipment operating, and only at the beginning of an operating shift or when equipment to be fueled has been idle for at least two hours, which will ensure that elevated engine temperatures do not pose an ignition source. Equipment will be grounded to ensure that static electricity does not pose an ignition source. A Fire Safety Officer with hands-on fire extinguisher training will be present during all fueling operations. Any release of diesel fuel will be immediately remediated.

2.2.10 Excavation Backfilling

Upon completion of remediation activities in the active weather structure and receipt of all confirmation sampling data with no results above the RFCA Tier 1 action levels for radionuclides, backfill will be placed in the excavation to the previous elevation of the asphalt. Clean backfill material will be hauled to the 903 Pad from an offsite source. Backfill material will be dumped in the backfill stockpile area. Backfill material will be moved from the stockpile to the weather structure being backfilled by a front-end loader. The front-end loader will place, level, and compact the backfill material.

2.2.11 Site Reclamation

Upon completion of all remediation and backfill activities at the 903 Pad, the weather structures will be dismantled and the area will be filled with 5 inches of topsoil and revegetated with an appropriate seed mixture.

2.3 Utilities and Services

The 903 Project requires only two utilities, electrical (for lighting and ventilation) and fire hydrants/water supply for fire suppression.

2.3.1 Electrical Systems

Electrical power for the 903 Project will be via three diesel powered generators. Two 6-kW generators will supply power for rollup door openers, air samplers, and small hand tools if needed. One 100-kW generator will supply power for the air movers used to provide negative pressure ventilation and heaters in the stepoff pad. Generators will be located outside the tents, positioned at least 10 feet from the exterior tent wall. Measures used to control the hazards associated with the use of these generators will include the control and inspection of extension cords, the use of only extension cords intended for outdoor use, the use of ground-fault circuit interrupters, appropriate grounding of generators, and the location of a fire extinguisher at each generator.

2.3.2 Fire Hydrants and Water Supply

Treated water is supplied to the 903 Project by gravity pressure from an elevated storage tank by the water treatment plant, Building 124, through the Site's main piping system to fire hydrants located in the area of the 903 Pad Project.

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3. SAFETY MANAGEMENT PROGRAMS

This section summarizes the Safety Management Programs (SMPs) that comprise the safety infrastructure at the Rocky Flats Environmental Technology Site (RFETS or Site) that is implemented for the 903 Pad Project. It provides information to assist in understanding the programs or aspects thereof that affect the licensing (*i.e.*, authorization of performance) of 903 Pad Project activities. These programs address practices that are common in the Department of Energy (DOE) nuclear complex and ensure operations and activities are performed in a responsible manner with regard to human health and safety and environmental protection. The SMPs described in this section form the safety basis for all work performed at the Site and at the 903 Pad.

Kaiser-Hill Company, L.L.C. (KH) is committed to the implementation of SMPs and recognizes that related programmatic deficiencies require evaluation against this facility AB. Failure of any program in those aspects relied upon to support the nuclear safety basis can be considered a violation of the AB.

The AB process for the 903 Pad Project as well as the Site relies on implementation of the SMPs to provide specific safety functions. Compliance and implementation of these SMPs are required by the 903 Pad Project TSRs and as such are governed by the Price Anderson Amendment Act (PAAA). However, inspection discrepancies in a program will not constitute violation of the safety basis unless the discrepancies are so significant as to render the premise of the summary invalid (*i.e.*, an SMP programmatic deficiency as defined in the Site Safety Analysis Report Section 7.4.1 [Kaiser Hill, 2002a]) followed by failure to take the Required Action specified in Administrative Control 5.4 of the 903 Pad Project TSRs.

3.1 Introduction

SMPs provide formal and disciplined methods of conducting business and operations while minimizing the potential for harm to the public and workers. The SMPs described in this section provide the infrastructure to meet the requirements of the Integrated Safety Management (ISM) philosophy as it is applied to all work activities at the Site. The primary objective of ISM is to perform work safely (*i.e.*, protection of the workers, the public, and the environment is a fundamental part of work planning and execution processes). The Site's commitment to the SMPs described in this section supports the seven guiding principles of ISM. These principles are:

1. Line management is responsible for the protection of the public, the workers, and the environment, and is responsible for establishing the environment to accomplish work safely;
2. Clear and unambiguous lines of authority and responsibility for ensuring safety are established and maintained at organizational levels within K-H and its subcontractors;
3. Personnel possess the experience, knowledge, skills, and abilities that are necessary to safely discharge their responsibilities;
4. Resources are effectively allocated to address safety, programmatic, and operational considerations as a priority whenever activities are planned and performed;
5. Before work is performed, the associated hazards are evaluated and an agreed-upon set of safety standards and requirements are established which, if properly implemented,

provide adequate assurance that the public, the workers, and the environment are protected from adverse consequences;

6. Administrative and engineering controls to prevent and mitigate hazards are tailored to the hazards presented by the work being performed; and
7. Conditions and requirements to initiate and conduct operations are clearly established and agreed-upon.

The SMPs address three major areas: (1) appropriate control of radiological and hazardous material hazards; (2) regulatory compliance with federal and state requirements, codes and standards, and standard industrial health and safety practices; and (3) good engineering and management practices. These programs are implemented on a Site-wide basis to assure the protection of workers, the public, and the environment.

The Site SMPs address the following disciplines:

- Conduct of Operations (COOP)
- Configuration Management (CM)
- Criticality Safety (CRIT)
- Document Management (DOC)
- Emergency Preparedness (EP)
- Engineering (ENG)
- Environmental Management (EM)
- Fire Protection (FIRE)
- Integrated Work Control (IWCP)
- Nuclear Safety (NS)
- Occupational Safety & Industrial Hygiene (OS&IH)
- Quality Assurance (QA)
- Radiological Protection (RAD)
- Testing, Surveillance, and Maintenance (TSM)
- Transportation Safety (TRAN)
- Training (TRAIN)
- Waste Management (WM)

Key functional elements for each SMP are defined as a limited number of broad categories representing the significant components of the program. Individual topics associated with the programs are expected to fit into one of the broad categories. As a minimum, the key functional elements for each SMP will include (a) internal program organization and administration with defined scope, roles, responsibilities, and staffing; and (b) specific training and qualifications for program personnel commensurate with responsibilities. In addition, key functional elements highlight the principles advocated by the SMP to conduct activities in a responsible manner with regard to human health, safety and environmental protection.

Within the interrelated topics of the key functional elements, specific attributes are identified to assist with the implementation of authorization basis requirements. The term "attribute" is defined as a specific aspect, principle, or concept that is important to Nuclear Safety in that it is recognized either inherently or explicitly in nuclear safety accident analyses. Therefore, implementation and periodic evaluation of these attributes are required to maintain the validity of the nuclear safety analysis. Evaluation of these attributes is typically in the form of performance indicators and through routine assessments.

The attributes identified in the Site SAR and specifically in this DSA address the hazards existing at the 903 Pad Project. These hazards range from Standard Industrial Hazards (SIHs) to unique hazards associated with the storage and handling of nuclear waste (see Table 5). SIHs are defined as (1) hazards that are routinely encountered in general industry and construction, (2) hazards for which national consensus codes and/or standards (*e.g.*, OSHA, transportation safety) exist to guide safe design and operation without the need for special analysis to define safe design and/or operational parameters, (3) hazards that only lead to occupational injuries or illnesses, and (4) hazards that do not contribute to accident source terms, and are not accident precursors, initiators, or propagators.

The range of hazards leads to implementation of SMPs using a graded-approach based upon the severity of the hazard. However, it is not the intent of safety analysis development to expend extensive resources on those hazards for which national consensus (*i.e.*, standards and codes, for example, Occupational Safety and Health Administration (OSHA), and NFPA, and Radiological Protection) already defines and regulates appropriate practices without the need for special analysis. SIHs are identified through the hazards analysis process and the interfaces with the safety analysis are discussed therein. Death, serious injury, and significant radiological or chemical exposures are not SIHs and are evaluated through the safety analysis, as appropriate.

The SMPs address the SIHs and are applicable to the 903 Pad Project and other Site facilities. OSHA compliance is demonstrated through the SMPs, which addresses the vast number of worker safety issues typically found in industrial settings, as well as during 903 Pad Project activities.

As part of the 903 Pad Project TSRs, the SMPs are under the scrutiny of the PAAA process, which identifies, reports, and tracks nuclear safety non-compliances. Under the PAAA, DOE contractors, sub-contractor, and suppliers are subject to civil penalties for violations of nuclear safety requirements, and individuals are subject to criminal penalties for knowing and willful violation of nuclear safety requirements.

Program oversight for the SMPs consists of formal evaluations of Site infrastructure program areas by the Site program managers, as well as less formal reviews. These evaluations may include Site-wide implementation effectiveness and assurance of compliance with established program area requirements and expectations. These assessments are conducted as necessary and often take the form of trending assessments of performance indicators, readiness demonstrations or activity oversight. These assessments are performed as a good management practice to determine the overall effectiveness of the programs and their implementation within the facility.

All 17 SMPs are established and implemented for the 903 Pad Project consistent with the discussion provided in the Site SAR. There are no facility-specific differences in implementation. No further discussion is warranted in this DSA in the case of those SMPs where:

1. The Site SAR fully addresses the program and its implementation for the 903 Pad Project;
2. No facility specific exemptions or differences exist; and
3. No specific nuclear safety attributes exist that support the facility specific accident analysis.

In these cases, the Site SAR should be consulted for the discussion of the particular SMP. The 903 Pad Project has no facility specific exemptions to the Site SMPs. Any future applicable exemptions will be noted as appropriate.

In Section 4.1 of this DSA, *Hazard Identification and Evaluation*, many 903 Pad Project hazards were determined to be a SIH. These types of hazards posed no direct or indirect risk to the CW or MOI. In all cases, there were SMPs identified that maintained the facility "configuration" to keep the corresponding hazard a SIH. For example, the "Direct Radiation Sources, Radiation from Stored/Staged Waste Containers" hazard is associated with the 903 Pad Project waste inventory at the staging/storage area. Properly containerized waste poses negligible risk to the CW and MOI due to low energies, shielding provided by waste containers, and separation distance. The WM SMP is credited with ensuring that packaged waste is properly configured (configuration control). The RAD SMP is credited with ensuring that receptors are protected from direction radiation hazards by assuring waste is properly packaged and by applying the As Low As Reasonably Achievable (ALARA) process to occupational exposures. IW protection includes container configurations, shielding, protective clothing, dosimetry, monitoring, postings, ALARA, etc., all elements of the RAD SMP. SIHs controlled by SMPs appear in Table 5, *903 Pad Project Hazards*.

The accident scenarios discussed in Section 4.2, *Accident Analysis*, of this DSA pose some risk to the CW and MOI. Each of the accident scenarios was evaluated as "unmitigated" and no specific hardware controls are necessary to prevent the accidents and/or mitigate the consequences of the accidents. Therefore, the 903 Pad Project TSRs do not include any Limiting Conditions for Operation (LCOs). Administrative Controls (ACs) and Site SMPs are relied upon to protect the safety analysis presented in this DSA.

3.2 Conduct of Operations

The Conduct of Operations Program (COOP) provides a disciplined and formal method for safely performing work and operating Site facilities wherein individuals seek and accept responsibility in conducting operations and work, which is the premise of the Site's safety culture. COOP is based upon the concept that workers are provided with adequate knowledge of requirements and are disciplined in observing these requirements. COOP is founded upon minimum staffing, training, qualification, and use of procedures.

3.2.1 Nuclear Safety Attributes

The COOP SMP is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

3.3 Configuration Management

Configuration management (CM) at the Site is an integration of various functions within specific SMPs that ensure authorization bases, physical configurations, and supporting documents remain accurate based on changes in any or all of these factors. The purpose of the CM Program is to ensure that each contributing function is performing as required and effective integration is occurring amongst the functions.

3.3.1 Nuclear Safety Attributes

The 903 Pad Project DSA hazard identification and evaluation process/accident analysis (see Section 4, *Safety Analysis*) does not specifically identify attributes of the CM SMP for both SIH maintenance and accident prevention/mitigation. However, the program is recognized as an element of maintaining the currently evaluated SIH configuration providing protection to all receptors. Based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

3.4 Criticality Safety

The Criticality Safety (CRIT) Program establishes nuclear criticality safety requirements for all personnel at the Site. The program provides general emergency response requirements for all personnel and visitors at the Site and details specific requirements for facilities that handle, process, store, stage, transfer, and/or transport a significant quantity of fissionable material.

3.4.1 Nuclear Safety Attributes

The 903 Pad Project DSA hazard identification and evaluation process/accident analysis (see Section 4.2.7, *Nuclear Criticality*) does specifically identify attributes of the CRIT SMP for accident prevention/mitigation (via protection of accident analysis assumptions). The CRIT SMP helps ensure, via compliance with the Site Nuclear Criticality Safety Manual (KH, 2000a), that criticality accidents at the 903 Pad Project remain *incredible* (less than 10^{-6}/yr), and therefore do not require further evaluation.

3.5 Document Management

The Document Management (DOC) Program provides for the generation of accurate and consistent work control documents to ensure activities at the Site are conducted in a safe and consistent manner complying with appropriate regulations. This program provides the framework to ensure that personnel are knowledgeable of the hazards and appropriate responses to upset conditions (*e.g.,* unanticipated hazards or conditions). A result of this program is that the appropriate collective knowledge of technical, safety, and operations professionals is provided to the worker for the performance of activities.

3.5.1 Nuclear Safety Attributes

The DOC SMP is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

3.6 Emergency Preparedness

The Emergency Preparedness (EP) Program establishes the Site-wide and building specific emergency response requirements to hazards as defined in the hazards basis of the Site SAR and building authorization basis documents. Emergency planning is founded in the Emergency Preparedness Hazards Assessments (EPHAs) for buildings and operating systems containing hazards that, when involved in an upset condition, could result in the declaration of an operational emergency. Emergency operations are established to provide the infrastructure to respond to events involving the identified hazards. Emergency operations include the provision of a Site Emergency Response Organization and offsite interfaces through agreements and joint response requirements. The capability for emergency response is tested periodically through a formal drill and exercise program, both at the site-wide level and building level.

3.6.1 Nuclear Safety Attributes

The EP SMP will facilitate an appropriate response to emergency conditions, and that response may mitigate the consequences of accidents to the public and to workers. The Site PHA recognizes the importance of providing notification and egress to limit exposure to the IW in an upset condition, as well as the benefit derived from emergency response to contain spills and fires. These features will be managed and monitored by the program. The program is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

Based on the Emergency Preparedness Organization's review of this DSA, it has been determined that an Emergency Preparedness Hazards Assessment (EPHA) in accordance with DOE O 151.1, *Comprehensive Emergency Management System* (DOE, 2000a) is not required.

3.7 Engineering

The Engineering (ENG) Program provides the requirements and controls for new designs and modifications to existing designs. Reviews of these activities both internal and external ensure (a) design accuracy, (b) proper application of regulatory, industry, and Site requirements, and (c) adherence to design basis requirements. The program requires analysis of hazards involved in the affected areas through the Integrated Work Control Program. Rigid qualification requirements of ENG Program personnel also add to a defense-in-depth philosophy to maintain nuclear and criticality safety. Design documentation is also specified and controlled through the ENG Program.

3.7.1 Nuclear Safety Attributes

The ENG SMP is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

3.8 Environmental Management

The Environmental Management (EM) Program is focused on protecting, preserving, and enhancing the environment by complying with governing laws, permits, and compliance agreements. For authorization basis considerations, complying with the requirements for environmental management by regulatory agencies, protection is provided to the public and workers. Thus, a process to identify and assess environmental protection associated with project activities provides the knowledge needed to develop an appropriate set of controls for work activities.

3.8.1 Nuclear Safety Attributes

The EM EMP is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

3.9 Fire Protection

The Fire Protection (FIRE) Program provides a balanced approach for achieving pre-designated fire safety goals for Site facilities and workers, the public, and the environment.

This basic principal, as embodied in the FIRE Program, provides sufficient fire protection to ensure (a) the health and life safety of the employees in the event of a fire, (b) any fire that may occur will not threaten the public health and welfare, (c) unacceptable delays in vital DOE programs will not occur, and (d) damage to DOE buildings and equipment will be maintained below specific dollar loss values should a fire occur.

3.9.1 Nuclear Safety Attributes

The 903 Pad Project DSA hazard identification and evaluation process/accident analysis (see Section 4, *Safety Analysis*) does specifically identify attributes of the FIRE SMP for accident prevention/mitigation (via protection of accident analysis assumptions). The FIRE SMP is associated with all fire scenarios. Important elements include combustible control, safe equipment refueling operations, fire department response, and fire prevention inspections. A 903 Drum Storage Area Fire Hazards Analysis (FHA) has been prepared that evaluates the fire hazards associated with the project (KH, 2002a).

3.10 Integrated Work Control

The Integrated Work Control Program (IWCP) establishes the planning requirements and process controls for all work conducted at the Site, including emergency work. The IWCP ensures that work is screened and planned consistently to uniform criteria and that hazards are appropriately analyzed and controlled. Integrated work control is an integral part of daily operations, construction, decontamination and decommissioning, and maintenance within the facilities and is an effective tool for preventing accidents by ensuring that no unanalyzed or unauthorized work is performed.

3.10.1 Nuclear Safety Attributes

The IWCP SMP is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

The IWCP SMP was credited with the development of a project-specific Field Implementation Plan and HASP to address and control project hazards that could impact the IW. The IWCP SMP is also relied upon to implement the Job Hazard Analysis (JHA) process. The JHA process will be utilized during the development of 903 Pad Project work control documents to identify and analyze the hazards and controls related to specific work activities. Compliance with the JHA process protects workers, the public, and the environment, either directly or indirectly.

3.11 Nuclear Safety

The Site is a DOE-owned, contractor-operated nuclear complex and thus facilities are enveloped by the Nuclear Safety Program, which provides processes to evaluate the risk associated with performing activities involving or impacting nuclear materials. The purpose of the Nuclear Safety Program is to ensure all activities performed at the Site are evaluated and/or analyzed to identify mitigative and preventive measures and to determine their risk to workers, public, and environment. The Nuclear Safety Program also mandates the requirements for Authorization Basis (AB) development, review, approval, revision, and implementation.

3.11.1 Nuclear Safety Attributes

The NS SMP is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

The 903 Pad Project DSA hazard identification and evaluation process/accident analysis (see Section 4 4, *Safety Analysis*) does specifically identify attributes of the NS SMP for both SIH maintenance and accident prevention/mitigation (via protection of accident analysis assumptions). NS is associated with each accident scenario for which any controls are credited since NS defines the control.

The NS SMP also defines the USQD process that will be used to analyze unanticipated hazards and conditions or any modification to project activities or work that fall outside the bounds of this safety analysis. The USQD process assures that modified or additional project activities or work, not previously analyzed, can be safely performed with the existing set of controls; or that additional controls have been identified, verified to be those necessary and sufficient to conduct the planned activities or work, and have been documented and implemented.

3.12 Occupational Safety and Industrial Hygiene

The OS&IH Program is responsible for ensuring that applicable Federal health and safety practices are effectively implemented at the Site. The OS&IH Program ensures that hazard analyses and routine surveys are performed to anticipate, identify, evaluate, and control facility- or activity-specific health and safety hazards. JHAs are implemented via the IWCP process. Health and safety hazards may be associated with facilities, processes, materials, equipment, tools, and operations. Types of hazards assessed include chemical, physical, biological, and ergonomic. Engineered or administrative controls may be implemented, as appropriate, to eliminate, or control the identified hazards or potential hazards.

3.12.1 Nuclear Safety Attributes

The accident analysis assumes that the OS&IH SMP will provide primary protection to workers from SIHs and from hazards that may be unique to work in the 903 Pad Project. However, OS&IH are not identified as a credited or defense-in-depth control in the accident analysis. The program may reduce the frequency and consequences of accidents and protect workers from standard industrial hazards. The program is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

The 903 Pad Project DSA hazard identification and evaluation process/accident analysis (see Section 4, *Safety Analysis*) does specifically identify attributes of the OS&IH SMP for SIH maintenance. OS&IH SMP was identified as protection for 903 Pad Project hazards that were determined to be SIH (i.e., not further evaluated for radiological release). The OS&IH SMP was credited with development of a project-specific HASP to address and control project hazards that could impact the IW.

3.13 Quality Assurance

Site facilities and activities with the potential for radiological harm are required to be operated in accordance with a DOE-approved quality assurance program. At the Site, the Quality Assurance (QA) Program is a shared interdisciplinary function. It involves management and individual contributors from several organizations responsible for producing items, performing activities and services, and independently verifying that items, activities, and services comply with specified standards and requirements.

3.13.1 Nuclear Safety Attributes

The QA SMP is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

3.14 Radiological Protection

The goal of the Radiological Protection (RAD) Program is to establish and maintain adequate radiological protection, as it applies to Site activities (e.g. design, construction, operations, maintenance, and decontamination and decommissioning activities) and to comply with all applicable requirements. The RAD Program provides a balanced approach for achieving pre-designated radiological safety goals for the Site facilities and workers. This basic principle provides sufficient radiological protection commensurate with the nature of the activities performed by applying the As Low As Reasonably Achievable (ALARA) process to occupational exposure. Furthermore, the Site endeavors to ensure radiation exposures to workers and the public, and releases of radioactivity to the environment, are maintained below regulatory limits.

3.14.1 Nuclear Safety Attributes

The RAD SMP is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level. The weather structure (tent) and negative ventilation/HEPA filtration system provide a defense-in-depth confinement function that will protect collocated workers, the public, and the environment.

The 903 Pad Project DSA hazard identification and evaluation process/accident analysis (see Section 4, *Safety Analysis*) does specifically identify attributes of the RAD SMP for both SIH maintenance and accident prevention/mitigation (via protection of accident analysis assumptions). RAD was identified as protection for 903 Pad Project hazards that were determined to be SIH (i.e., not further evaluated for radiological releases).

3.15 Testing, Surveillance and Maintenance

The purpose of the Testing, Surveillance, and Maintenance (TSM) Program is to ensure that safety SSCs continue to perform their intended functions by conducting (a) periodic surveillances of equipment performance, (b) predictive and/or preventative maintenance on a predetermined schedule, and (c) corrective maintenance upon discovery of conditions that render SSCs inoperable. The TSM Program applies to both nuclear and non-nuclear facilities based upon the appropriate DOE order and the appropriate codes and standards. The TSM Program uses a graded approach taking credit for RFETS being a closure site.

3.15.1 Nuclear Safety Attributes

Testing, surveillance, and maintenance is performed to meet the requirements specified in the SMPs since there are no TSR Surveillance Requirements. The TSM SMP is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

3.16 Training

The objective of the Training (TRAIN) Program is to provide well-trained and qualified personnel to perform work in a safe, efficient and environmentally sound manner. The program is designed to ensure qualified personnel are properly trained to perform specific job assignments.

3.16.1 Nuclear Safety Attributes

The TRAIN SMP is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level. The 903 Pad Project has a List of Qualified Individuals (LOQI) to perform work based on project-specific training.

3.17 Waste Management

The Waste Management (WM) Program establishes the Site processes to generate, characterize, package, configure, and control hazardous, radioactive and mixed waste. The program identifies the requirements to be followed that will ensure non-radioactive hazardous, radioactive, and mixed waste from the Site meets TSD sites' WAC and that while wastes are on-Site they are managed in compliance with applicable regulations.

3.17.1 Nuclear Safety Attributes

The WM SMP is recognized to provide protection to all receptors. However, based on the results of Section 4, no worker or public protection controls were identified that warrant elevation to the TSR level.

The 903 Pad Project DSA hazard identification and evaluation process/accident analysis (see Section 4, *Safety Analysis*) does specifically identify attributes of the WM SMP for both SIH maintenance and accident prevention/mitigation (via protection of accident analysis assumptions). The WM SMP was credited with maintaining containment (*i.e.*, containers) of radiological hazards.

4. SAFETY ANALYSIS

The 903 Pad Project is a *low* hazard facility as compared to other Site HC-3 Nuclear Facilities. The accident analysis shows the potential for only significant localized consequences (*i.e.*, within or near the project boundary but excluding the CW). As such this DSA utilizes a graded approach. Section 1.2 discusses application of the graded approach.

4.1 Hazard Identification and Evaluation

Nuclear Safety Technical Report, NSTR-007-01 (KH, 2001a), performed an exhaustive Site Preliminary Hazards Analysis (PHA) to support Hazard Category 2 and 3 Nuclear Facilities' Authorization Basis (AB) development. The Site PHA, which identifies and assesses a comprehensive set of hazards associated with configurations and activities at RFETS, was reviewed for applicability to the 903 Pad Project. Based on a review of the Site PHA, as well as the ER and project HASPs (Envirocon, 2001a and Envirocon, 2002), the project FHA (KH, 2002a), and the ALARA Job Review (KH, 2002b), a list of applicable hazards/energy sources was developed and is presented as Table 5. Specific hazard descriptions are contained in the Site PHA, the HASPs, the FHA, and the ALARA Job Review and are not repeated here.

Table 5 903 Pad Project Hazards

Electrical Hazards 480/240/120 V Distribution Temporary Power (e.g., diesel generators) Low Voltage	**Kinetic Energy** Rotating Equipment (e.g., fans, air movers, electric motors) Vehicles/Transport Devices, Material Handling Equipment
Loss of Electrical Energy Loss of Differential Pressure (e.g., loss of HEPA filtration in weather structure) Loss of Ventilation (accumulation of hazardous vapors)	**Potential Energy** Compressed Air (e.g., breathing air systems and backup bottles Compressed Gas Cylinders (e.g., propane tanks) Raised Loads on Forklifts/Cranes/other equipment
Radiant Energy / Radioactive Materials Stored/Staged Waste Containers(e.g., intermodals) Newly Generated Radioactive Waste (e.g., excavated materials) General Contamination	**Pressure Sources** Hydraulic Equipment **Mechanical Energy (ME)** Crush, Shear, Pinch (e.g., forklifts, motors, fans)
Thermal Combustible Solids Flammable/Combustible Liquids (e.g., fuels, oils) Flammable/Explosive Gases (e.g., propane) High Temperature Environment (e.g., working in weather structure with multiple layers of PPE) Hot Work (involving flammable gases) Low Temperature Environment (e.g., cold stress) Portable Lighting Transport Vehicles	**Toxic, Hazardous, or Noxious Chemicals** General Industrial Chemicals below Thresholds of Concern **Material Handling** Handling, Transfer, and Shipment of Waste Containers **Other Hazards** Natural Phenomena and External events Excavations Temporary Weather Structure (e.g., polyester reinforced vinyl fabiric)

The hazards/energy sources shaded in Table 5 are those hazards that require further evaluation for the 903 Pad Project. The remaining hazards/energy sources listed in the table are considered Standard Industrial Hazards (SIHs). SIHs are defined as (1) hazards that are routinely encountered in general industry and construction, (2) hazards for which national consensus codes and/or standards (*e.g.*, OSHA, transportation safety) exist to guide safe design and operation without the need for special analysis to define safe design and/or operational parameters, (3) hazards that only lead to occupational injuries or illnesses, and (4) hazards that do not contribute to accident source terms, and are not accident precursors, initiators, or propagators. SIHs are sufficiently controlled by the Site SMPs listed in Section 3 of this DSA and are not further evaluated. However, the preventive and mitigative controls identified in the Site PHA to protect the public and workers from SIHs were reviewed to determine if any warranted elevation to the TSR level based.

4.2 Accident Analysis

Radiological hazards associated with the 903 Pad Project activities are judged to present *low* radiological dose consequences to the CW and MOI (*i.e.*, the accident analysis shows the potential for only significant localized consequences). However, based on the identified hazards/energy sources identified for the 903 Pad Project, several accident scenarios are qualitatively evaluated to determine any potential risk to the CW or MOI. Accident scenario types discussed below include (1) fires, (2) spills, (3) explosions, (4) nuclear criticality, (5) natural phenomena and external events, and (6) chemical releases.

4.2.1 Risk Classification Methodology

The risks associated with evaluated accident scenarios can be categorized according to a combination of the scenario frequencies and consequences, as shown in Table 6. The categorization bins accident scenario risk into one of four risk classes. For the purpose of this DSA, risks associated with Risk Class I accident scenarios are considered *major*, risks associated with Risk Class II scenarios are *serious*, Risk Class III accident scenario risks are *marginal*, and Risk Class IV accident scenario risks are considered *negligible*. In addition, Risk Class I and II accident scenarios are considered to be *high-risk* scenarios, and Risk Class III and IV scenarios are considered to be *low-risk* scenarios. The risk class associated with each of the accident scenarios identified and evaluated in the remainder of this DSA was determined based on the Table 6 categorization scheme (KH, 2001b).

Table 6 Risk Classes - Frequency vs. Consequences

	FREQUENCY OF OCCURRENCE (per year)		
CONSEQUENCE	**Extremely Unlikely $<10^{-4}$**	**Unlikely 10^{-4} - 10^{-2}**	**Anticipated $>10^{-2}$**
HIGH	II	I	I
MODERATE	III	II	I
LOW	IV	III	III

Preventive and mitigative features (including inherent <u>and</u> credited controls) required to be in place in order to maintain Risk Class III and IV accident scenarios identified in the hazard evaluation tables as low-risk scenarios are carried forward with corresponding accident scenarios. Postulated accident scenarios identified in the hazard evaluation tables as Risk Class I or II scenarios are further evaluated to determine if additional preventive or mitigative features exist, which if implemented, could reduce the scenario risk to a Risk Class III or IV category. The collection of preventive and mitigative features associated with all accident scenario evaluations is carried forward into the development of a set of 903 Pad Project TSRs (Section 5).

The application of Table 6 requires frequency bin and consequence bin assignments. Frequency bin assignments are in accordance with DOE-STD-3011-94 (DOE, 1994); *i.e.*, events more frequent than 10^{-2} per year are classified as *anticipated*, those with frequencies between 10^{-4} per year and 10^{-2} per year are classified as *unlikely,* and those less frequent than 10^{-4} per year are classified as *extremely unlikely*. These frequency bin terms and assignments are consistent with DOE-STD-3009-94 qualitative likelihood classifications. Estimates of scenario frequency are qualitative.

4.2.2 Radiological Risk

Radiological dose consequence evaluations are performed using the following equation:

$$\text{Dose} = \text{MAR} * \text{DR} * \text{ARRF} * \text{LPF} * \chi/Q * \text{BR} * \text{DCF} / \text{PDC}$$

where MAR is the radioactive material-at-risk (in grams, varies with scenario);

DR is the MAR damage ratio (varies with scenario);

ARRF is the airborne respirable release fraction (varies with form of radioactive material and scenario);

LPF is the facility leakpath factor (initially set to 1.0, varies with scenario);

χ/Q is the atmospheric dispersion factor (in s/m^3, varies with receptor and scenario);

BR is the receptor breathing rate (in m^3/s, set for heavy activity);

DCF is the radiological material dose conversion factor (in rem/gram, varies with material type); and

PDC is the plume duration correction factor (varies with scenario).

The PDC value is used for accident scenarios with a duration longer than 10 minutes (*e.g.*, large fires). The PDC value is used to modify the atmospheric dispersion value to correct for plume meander during the scenario. The formula used for determining plume meander for longer duration releases is as follows:

$$\text{PDC} = (\text{plume duration in minutes / time base})^n$$

where the time base is 10 minutes; "n" has a value of 0.2 if the plume duration is less than or equal to 60 minutes; otherwise, "n" has a value of 0.25.

The atmospheric dispersion factors (χ/Q values) used in the radiological dose consequence evaluations are based on the receptor (*i.e.*, distance from the point of release), the type of accident scenario (*i.e.*, non-lofted plume or lofted plume), and modeling assumptions (*i.e.*, use of conservative 95^{th} percentile values or median (50^{th} percentile) values). In most cases, the atmospheric dispersion factors represent 95^{th} percentile χ/Q values developed from an analysis of actual Site weather data. Two receptors are identified for analysis: the CW and the MOI.

The shortest distances from the 903 Pad Project to the MOI located at the Site boundary were determined using tables found in RFP-5098, *Safety Analysis and Risk Assessment Handbook* (SARAH) (KH, 2001b). For the purpose of evaluating scenario consequences in this DSA, a least distance to the Site boundary of 2,200 meters is used. The CW distance from the point of release has been set at 100 meters.

The term "in-facility worker" or "immediate worker" (IW) is used to describe the individual who could be located in close proximity to the postulated accident scenario release location (*i.e.,* workers within the weather structure).

Radiological dose consequences corresponding to the *high*, *moderate*, and *low* consequence bins identified in Table 6 are defined by the comparison criteria shown in Table 7 as accepted by DOE-RFFO (DOE, 2000b). Radiological dose consequence bin thresholds for the MOI and CW are defined in terms of 50-year, Committed Effective Dose Equivalent (CEDE) radiological doses. Sections 4.2.5 through 4.2.9 of the accident analysis determined the need for TSR level controls based on radiological dose consequences. Radiological hazards/radiological dose consequences to the IW and controls are discussed in Section 4.4, *Worker Safety Evaluation.*

Table 7 Radiological Dose Consequence Bin Thresholds

CONSEQUENCE	MOI DOSE CONSEQUENCE BIN THRESHOLD	CW DOSE CONSEQUENCE BIN THRESHOLD	IW CONSEQUENCE
HIGH	dose > 5 rem	dose >25 rem	prompt death
MODERATE	5 rem ≥ dose > 0.5 rem	25 rem ≥ dose > 5 rem	serious injury or significant radiological exposure
LOW	0.5 rem ≥ dose	5 rem ≥ dose	< MODERATE

Radiological doses are calculated using the *Radiological Dose Template* (KH, 2001c) and are presented in the accident scenario discussions as appropriate. The scenario MAR for accident analysis purposes is assumed to be the RFETS aged weapons grade (WG) Pu isotopic mix from SARAH. By modeling accident MAR as aged WG Pu, the ingrowth amounts of ^{241}Am listed in Table 3 are accounted for in the radiological dose calculations. The radiological dose contribution from the uranium isotopes is considered negligible and is therefore not included. The least distance to the Site boundary (distance to the MOI), assumed for all accident scenarios, is 2,200 meters.

4.2.3 Immediate Worker

Because risk is the product of the *frequency of occurrence* of an accident scenario of concern and its *consequences*, these two parameters must be estimated before the resultant risk can be evaluated. In evaluating the IW risk associated with postulated accident scenarios in Sections 4.2.5 through 4.2.9, the following potential contributing elements were important considerations:

- Timing of radiological release. Hazard scenarios involving fires can develop quickly, but not so rapidly as to preclude evacuation as an effective mitigative measure; other scenarios, like criticality or explosion can entail significantly more rapid radiological exposure.
- Hazard warning. The availability of reliable hazard warning and its timing relative to significant radiological exposure may impact IW consequences; warning may be provided by engineered systems [e.g., Continuous Air Monitors (CAMs), fire alarms] or by the event itself (e.g., fire smoke, drum lid displacement).

- Scenario impact on protective action capability. Accident scenarios involving explosions can cause damage to structures or injury to personnel impeding egress; thus, increasing potential radiological consequences.
- Preventive or mitigative controls. The only effective controls to protect the IW who might "attend" a criticality are preventive. While mitigative controls may help other workers in the facility; consequences to the attending worker in such an instance may not be a useful test of the adequacy of proposed mitigative controls.
- Potential exposure magnitude. Severity of radiological injury is a function of the magnitude of the scenario release and the pathways for transport to and absorption by workers; inhalation is typically the dominant exposure pathway.
- Consequence uncertainty. The radiological threshold for prompt death varies among individuals and for evaluation must be compared with localized doses that would be difficult to calculate and that are beyond the scope of this effort. Thus, the qualitative evaluation of IW consequences employs conservatism which, when combined with the effectiveness of imposed controls, can result in more effective worker protection than the consequence thresholds require.

Based on these guidelines, unmitigated scenarios that lead to *high* IW consequences include all criticalities, explosions leading to a moderate or high release, and fires causing a large release. *Moderate* IW consequences are expected for unmitigated fires causing moderate releases, unmitigated spills causing moderate to high releases, and unmitigated explosions causing small releases. Lesser fires or spills (unmitigated) lead to *low* IW consequences. Table 8 summarizes these unmitigated consequence level for the IW.

Table 8 Qualitative Guidelines for IW Consequences

CONSEQUENCE LEVEL	QUALITATIVE EVENT DESCRIPTION
HIGH (prompt death)	Criticalities Explosions causing moderate to large releases Fires causing large releases
MODERATE (serious injury, or significant radiological or chemical exposure)	Fires causing moderate releases Explosions causing small releases Spills causing moderate to large releases
LOW (<Moderate)	Any event causing minor contamination

4.2.4 Chemical Risk

The chemical risk can be qualitatively determined by comparing the 903 Pad Project chemical inventory to the Threshold Quantities (TQs) in OSHA Standard 29 CFR 1910.119 (CFR, 2002), the TQs in EPA Rule 40 CFR 68 (CFR, 2002a), the Threshold Planning Quantities (TPQs) in 40 CFR 355 (CFR, 2002b), and the potential for an airborne release of a hazardous material. If any of these thresholds are exceeded, additional analysis may be required to determine the consequences of an airborne release of a hazardous material to workers, the public, and the environment. Chemical dose consequences corresponding to the *high*, *moderate*, and *low* consequence bins identified in Table 6 are defined by the comparison criteria shown in Table 9. Section 4.2.10 of the accident analysis determined the need for TSR level controls based on the chemical dose consequences. Chemical hazards/chemical dose consequences to the IW and controls are discussed in Section 4.4, *Worker Safety Evaluation.*

Table 9 Chemical Accident Consequence Levels

CONSEQUENCE	MOI DOSE CONSEQUENCE BIN THRESHOLD	CW DOSE CONSEQUENCE BIN THRESHOLD	IW CONSEQUENCE
HIGH	> ERPG-2**	>ERPG-3**	prompt death
MODERATE	N/A*	N/A*	serious injury or significant chemical exposure
LOW	≤ ERPG-2**	≤ ERPG-3**	< MODERATE

* N/A means Not Applicable

** ERPG refers to the Emergency Response Planning Guidelines published by the American Industrial Hygiene Association. ERPG-2 and ERPG-3 define the air concentrations for each chemical corresponding to low, moderate, and severe health effects in humans exposed for greater than one hour.

4.2.5 Fires

Fire scenarios associated with the 903 Pad Project include (1) an *anticipated* operational fire scenario that could occur during the performance of routine project activities, and (2) a representative bounding fire scenario that involves a large spill of fossil fuel into the active excavation with a subsequent major fire (*i.e.,* greater than 10 MW).

Operational Fire Scenario (Fire-1)

An *anticipated* small fire scenario (*i.e.,* ~1MW) is postulated to occur during any of the 903 Pad Project activities described in Section 2.2, *Project/Activity Descriptions.* The operational fire involves fossil-fueled (*i.e.,* gasoline or diesel fuel) equipment and/or hydraulic equipment that will be routinely used by the project. It is postulated that a spill/leak (*e.g.,* less than a gallon) of fuel or hydraulic fluid occurs and is ignited. A small fire could also occur if combustibles accumulate and are ignited. This operational fire event could potentially result in a small radiological release if the fire occurs on or near contaminated soils/materials. Since the postulated fire is assumed to involve only a small amount of fuel or hydraulic fluid it is not expected to involve contaminated soils/materials in the active excavation. As such, the radiological release and associated dose consequences to the CW and MOI would be negligible. The radiological dose consequences for this operational fire event would be bounded by those for Fire-2, discussed below, as much less MAR is postulated to be involved.

Representative Bounding Fire Scenario - Fire at the Excavation Area (Fire –2)

An *unlikely* major fire scenario is postulated to occur during excavation activities within the weather structure. The weather structure is not credited to provide any containment nor is it considered to alter the accident consequences if it were consumed by fire. A large fuel spill (*e.g.,* multiple gallons) from the excavator or other project vehicles is postulated to flow into the active excavation area and onto exposed contaminated soil. Based on the radionuclide inventory summary in Table 3, the largest quantity of $^{239/240}Pu$ is approximately 270 grams around sampling location number 91598. The volume of soils containing the 270 grams is approximately 2,500 ft^3 (approximately 75 feet x 75 feet x 0.5 feet deep). Conservatively assuming that the scenario MAR is 270 grams Pu, it can be shown that the radiological dose consequences are *low* to the CW and MOI (See Table 10). This fire scenario is consistent with the Maximum Possible Fire Loss (MPFL) scenario evaluated in the 903 Drum Storage Area FHA (KH, 2002a)

A damage ratio (DR) of 1.0 is conservatively assumed, as it is unlikely that a burning fuel on top of soil would impact radioactive material more than a few inches from the surface. The airborne release fraction (ARF) and the respirable fraction (RF) are the bounding values for "air-dried salts under a gasoline fire on a porous or otherwise absorbing surface" per DOE-HDBK-3010-94 (DOE, 1994). Based on a review of DOE-HDBK-3010-94, the selected release fractions are most representative of fossil fuel burning on a soil surface. A leakpath factor (LPF) of 1.0 was assumed since the weather structure is not credited to provide any containment. The fire is assumed to be a *major* fire with a release duration of 30 minutes.

Table 10 Fire-2 Dose Consequence Results

MAR (g)	DR	ARF	RF	LPF	χ/Q (CW)	χ/Q (MOI)	BR	DCF	CW Dose (rem)	MOI Dose (rem)	CW	MOI
270	1.0	5E-03	0.4	1.0	7.94E-03	5.56E-06	3.6E-04 (heavy)	9.70E+06	1.5E-01	1.0E-02	Low	Low

It is judged that this fire scenario bounds all other *unlikely* fire scenarios that could occur during excavation, in process characterization, sampling, waste handling and staging/storage, decontamination of equipment, movement of equipment between weather structures, on-site transportation of contaminated soils/materials, refueling of diesel-fueled equipment, excavation backfilling, or site reclamation.

Controls Summary

Based on the *low* unmitigated radiological dose consequences and corresponding *low* risk (Risk Class III/IV) associated with the analyzed fire scenarios, no CW or public protection controls were identified that warrant elevation to the TSR level. The Site SMPs, as described in Section 3, are recognized to provide protection to all receptors. IW controls are discussed in Section 4.4, *Worker Safety Evaluation*.

4.2.6 Spills

Spill scenarios associated with the 903 Pad Project include (1) an *anticipated* operational spill scenario that could occur during the performance of routine project activities, and (2) a representative bounding spill scenario that is assumed to occur less frequently and not as part of normal project activities.

Operational Spill Scenario (Spill – 1)

An *anticipated* operational spill scenario is postulated to occur during excavation activities within the protective weather structure. The weather structure is not credited to provide any containment. The operational spill scenario involves spilling, or intentionally dumping, contaminated soil/materials from the excavator bucket/shovel into an intermodal container, onto the asphalt pad, or back into the excavation. A drop distance of three meters is assumed. As a result of soil/material acceleration by gravity and impact with an unyielding surface (*i.e.,* container bottom, ground, etc.), radiological material is postulated to become airborne and result in dose consequences to CW and MOI. Two cases are evaluated: Case A involves the spill/dumping of a single excavator bucket contaminated soils and Case B involves continuous loading of contaminated soils into intermodal containers.

Case A:

Based on the radionuclide inventory summary in Table 3, the largest quantity of $^{239/240}Pu$ is approximately 270 grams around sampling location number 91598. Using the excavation area around this sampling point as the bounding radionuclide concentration the following MAR determination can be made:

MAR = 270 g Pu/2,498 ft³ x 81ft³/bucket
= 8.75 grams Pu/bucket

Where,
Sample location volume = 2,498 ft³ (see §2.1)
Excavator bucket size = 3 yd³ or 81 ft³

Based on the above-calculated MAR/bucket value, a spill of a single bucket results in a radiological dose to the CW and MOI as shown in Table 11. The assumed DR of 1.0 is conservative since the material type is asphalt, fill, and soil and not 100% powder, which is much more dispersible. The ARF and RF are the bounding values for a "free-fall spill of powder" per DOE-HDBK-3010-94 (DOE, 1994a). A LPF of 1.0 was assumed since the weather structure is not credited to provide any containment. A ten-minute release duration is assumed.

Table 11 Spill-1 Dose Consequence Results (Single Bucket)

MAR (g)	DR	ARF	RF	LPF	χ/Q (CW)	χ/Q (MOI)	BR	DCF	CW Dose (rem)	MOI Dose (rem)	CW	MOI
8.75	1.0	2E-03	0.3	1.0	9.94E-03	8.15E-05	3.6E-04 (heavy)	9.70E+06	1.8E-01	1.5E-03	Low	Low

Case B:

Because a spill from a single bucket is considered a routine activity, the spill of multiple buckets is evaluated to determine the radiological dose consequences from a longer duration release. It is assumed that 2,500 ft³ (~93 yd³ or ~31 excavator buckets) of contaminated soils containing 270 grams Pu are excavated and placed into intermodal containers over a 4 hours period. It requires four intermodal containers to package 93 yd³ of contaminated soils. The Intermodals will be moved, one at a time, into the weather structure, staged, filed with contaminated soils, covered, and removed from the tent. Based on this evolution, a 4-hour duration is reasonable. Therefore, a 240-minute release duration is assumed. Table 12 shows the dose consequences associated with the continuous loading of intermodal containers. Conservatism includes (1) modeling the radiological material as 100% powder, which is much more dispersible than the radiologically contaminated soil matrix, and (2) loading contaminated soils into an intermodal drops the material from less than three meters, which results in less dispersion than from dropping it from the assumed three meters.

Table 12 Spill-1 Dose Consequence Results (Multiple Buckets)

MAR (g)	DR	ARF	RF	LPF	χ/Q (CW)	χ/Q (MOI)	BR	DCF	CW Dose (rem)	MOI Dose (rem)	CW	MOI
270	1.0	2E-03	0.3	1.0	4.49E-03	3.68E-05	3.6E-04 (heavy)	9.70E+06	2.5E+00	2.1E-02	Low	Low

It is judged that these spill scenarios bound all other *anticipated* spill scenarios that could occur during in process characterization, sampling, decontamination of equipment, movement of equipment between weather structures, excavation backfilling, or site reclamation. This spill scenario would also bound a spill caused by a compressed gas cylinder missile impacting filled intermodal containers.

Representative Bounding Spill Scenario (Spill-2)

A larger less frequent spill is postulated to occur during (1) waste handling and staging/storage, or (2) on-site transportation of contaminated soils/materials. Two cases are postulated.

Case A:

It is postulated that a single intermodal container filled with contaminated soils/materials is intentionally dumped or accidentally spilled. The exact radiological content of the intermodal container may not be known because the project may be awaiting final sampling results. Although the 903 Pad Project radiological concentration threshold to ship filled intermodal containers offsite is 10 nCi/g, a higher concentration could be present. If sampling results indicate that a single intermodal container has a radiological concentration greater than 10 nCi/g, the container contents will be "blended down" in order to achieve the required concentration. Blending down can occur by either adding additional soil to the intermodal and mixing it with the existing soil/material to achieve the required concentration or by emptying the intermodal back into the excavation and blending the contents with additional soil. The blending of soils will be performed in a weather structure. Prior to blending down the intermodal contents, the intermodal could be involved in a vehicle incident/accident resulting in a spill of the entire contents. Case A is postulated to occur at the 903 Pad inside or outside the weather structure, at the 904 Pad, at the 891 Temporary Waste Storage Area, or on areas/roads inter-connecting these areas. A drop distance of three meters is assumed. As a result of soil/material acceleration by gravity and impact with an unyielding surface (*i.e.*, container, ground, etc.), radiological material is postulated to become airborne and result in dose consequences to the CW and MOI (See Table 13).

Based on the bounding MAR/bucket value postulated in Spill-1, if an entire intermodal with a capacity of ~25 yd^3 were filled with 9 excavator buckets (25 yd^3 ÷ 3yd^3/bucket) of this material the total MAR would be 79 grams Pu (9 buckets x 8.75 grams Pu/bucket). The assumed DR of 1.0 is conservative since the material type is asphalt, fill, and soil and not 100% powder, which is much more dispersible. The ARF and RF are the bounding values for a "free-fall spill of powder" per DOE-HDBK-3010-94. A LPF of 1.0 was assumed since the weather structure is not credited to provide any containment. A ten-minute release duration is assumed.

Table 13 Spill-2, Case A, Dose Consequence Results

MAR (g)	DR	ARF	RF	LPF	χ/Q (CW)	χ/Q (MOI)	BR	DCF	CW Dose (rem)	MOI Dose (rem)	CW	MOI
79	1.0	2E-03	0.3	1.0	9.94E-03	8.15E-05	3.6E-04 (heavy)	9.70E+06	1.6E+00	1.3E-02	Low	Low

Case A bounds all other less than anticipated spill scenarios that could occur during waste handling and staging/storage or on-site transportation activities.

Case B:

Case B is assumed to occur on RFETS roads outside the 903 Pad Project boundaries that will be used to transport the soils/materials offsite. An intermodal container could be involved in a vehicle incident/accident resulting in a spill of the entire contents. This Case B scenario is the same as the Case A scenario except that the MAR would be based on a 10 nCi/gram concentration level (the offsite shipment threshold). This concentration equates to approximately 3.66 grams Pu/intermodal (as shown below) and is considered LLW. Based on the MAR, Case B is bounded by Case A.

MAR = 10 nCi x 1E-9 Ci/nCi x 112.4 lb./ft^3 x 675 ft^3/intermodal x 454 g/lb. x 1 gram Pu/0.094 Ci

= 3.66 Pu/intermodal

Where,

Shippable concentration level = 10 nCi/gram of material
Soil density = 1.8 g/cm^3 or 112.4 lb/ft^3
Volume of intermodal = 25 yd^3 of 675 ft^3

Controls Summary

Based on the *low* unmitigated radiological dose consequences and corresponding *low* risk (Risk Class III/IV) associated with the analyzed spill scenarios, no CW or public protection controls were identified that warrant elevation to the TSR level. The Site SMPs, as described in Section 3, are recognized to provide protection to all receptors. IW controls are discussed in Section 4.4, *Worker Safety Evaluation*.

4.2.7 Explosions

No hydrogen gas explosion scenarios are postulated for the 903 Pad Project. Any hydrogen gas that is generated in or at the excavation due to radiolysis would have dissipated through the contaminated soils/materials matrix into the air and overpressure conditions will not be present. The intermodal containers are not considered airtight and would allow hydrogen gas to dissipate after the containers are filled with contaminated soils/materials.

It is not expected that the use of flammable gases (*i.e.*, acetylene, propane, etc.) will be required during 903 Pad Project activities. The OS&IH and FIRE SMPs governs their safe use.

The P904 propane tank farm is currently located within the defined 891 Temporary Waste Storage Area southwest of the 903 Pad and approximately 100 feet directly south of the 904 Pad. A requirement to remove the tanks from service and empty them prior to the commencement of remediation activities is documented in the 903 Drum Storage Area FHA, Section 11, *Tabulation of Findings, Deficiencies, and Recommendations*. Because the tanks will be relocated or removed from service and emptied, a boiling liquid expanding vapor explosion (BLEVE) resulting in a radiological release from the 903 Pad Project is not further evaluated in this DSA.

A vapor cloud explosion (VCE) could occur at the 903 Pad Project due to high-energy impact that causes the contents of a propane tank to be spilled and migrate towards the 903 Pad Project area. The arrangement of staged/stored waste containers on the 903 Pad, the 904 Pad, or the 891 Temporary Storage Area could create a flame obstruction configuration that could lead to a deflagration event if ignition of the gas cloud occurs. A resulting fire would not occur based on negligible combustible material loading and the flame front associated with a deflagration event moving with such velocity that any combustibles present would not be ignited.

It has been determined that a VCE occurring within an array of stored waste containers would not breach metal waste containers (KH, 2001d).

Controls Summary

Based on the *low* risk associated with the analyzed explosion scenarios, no CW or public protection controls were identified that warrant elevation to the TSR level. However, removal of the P904 propane tank farm from service and the emptying of the tanks is a prerequisite to the commencement of 903 Pad Project remediation activities. The Site SMPs, as described in Section 3, are recognized to provide protection to all receptors. IW controls are discussed in Section 4.4, *Worker Safety Evaluation*.

4.2.8 Nuclear Criticality

An ER criticality incredibility evaluation (KH, 2002c) demonstrates nuclear criticality incredibility for RFETS ER projects and specifically the 903 Pad Project activities. All combinations of bounding failures were considered and the probability of occurrence of a criticality is less than 10^{-6}/yr. Therefore, nuclear criticality events are not evaluated in this DSA.

The primary basis for criticality incredibility is the low concentration of fissile materials in the contaminated soils/materials being excavated, handled, and stored. Because there are no credible criticality scenarios associated with the 903 Pad Project, there are no controls required to support the incredibility analysis and a project-specific criticality safety program is not warranted. The Site level criticality safety program and conduct of operations infrastructure will ensure that (1) no new operation is introduced to the 903 Pad Project that would result in the addition of fissile material, and (2) an extraction process to remove fissile constituents will not be performed.

Controls Summary

Based on nuclear criticality events being incredible for the 903 Pad Project, no CW or public protection controls were identified that warrant elevation to the TSR level. The Site SMPs, as described in Section 3, are recognized to provide protection to all receptors.

4.2.9 Natural Phenomena and External Events

The following natural phenomena and external events are discussed as applicable to the 903 Pad Project.

Seismic Events

Seismic events are not postulated to result in a radiological release during the 903 Pad Project. Any seismic activity that results in excavation ground movement is judged to result in a radiological release that would be bounded by Spill-2, Case A. If a seismic event were to fail staged/stored intermodal container(s) with contaminated soils/materials, the release is judged to be less than that for Spill-2, Case A because the material would not be a free fall spill event. The soils/materials would simply slump into a pile with very little spreading/dispersion beyond the container.

Lightning; High Winds and Tornadoes; Heavy Rain, Flooding, and Freezing; and Heavy Snow Events

Lightning is considered a potential ignition source for fires. The frequency of lightning striking the 903 Pad Project and initiating a fire involving waste containers is considered to be an *extremely unlikely* event because of the low inherent combustible loading associated with project activities and the fact that radioactive material is entrained in a non-combustible soil matrix. The 903 Pad asphalt cap, fill material, and native soil is considered non-combustible material and would not be ignited by a lightning strike. If a lightning strike ignited some transient combustibles at the project site, it is judged that such a fire would be bounded by Fire-2.

High winds and tornadoes could result in the dispersion of contaminated soils/materials at the 903 Pad Project excavation, especially if the weather structure is blown down. The weather structures are designed for 105-MPH wind loads. Under such conditions, project activities would be paused and actions would be taken to mitigate wind blown dispersion of contaminated soils/materials. Any radiological release as a result of high winds and tornadoes would be bound by Spill-2, which postulated a greater MAR and less atmospheric dispersion (*i.e.,* 95^{th} percentile weather).

Heavy rain, flooding, and freezing as well as heavy snow events are not expected to result in an airborne release of radiological material that would affect the CW and/or MOI and are not further evaluated.

Aircraft Crash

An aircraft crash into the 903 Pad Project active excavation area potentially resulting in a radiological release due to impact of the aircraft is considered to be *beyond extremely unlikely* based on the footprint of the excavation. An area of approximately 80 ft. × 90 ft will be excavated and packaged into intermodal containers prior to beginning the next excavation. If the aircraft were to impact the asphalt surface of the 903 Pad, qualitatively estimated to be an *extremely unlikely* event, it would most likely skid across the pad area without disturbing a large quantity of the contaminated soils located one foot below the top of the asphalt. Assuming that a subsequent fuel fire occurs, very little contaminated soil would be subject to the effects of the fire. It is judged that the radiological dose consequences associated with Spill-2 would bound those associated with an aircraft crash onto the asphalt pad.

A similar crash into intermodal staging/storage areas (*i.e.,* 904 Pad, 891 Temporary Waste Storage Area) potentially resulting in a radiological release due to impact of the aircraft with staged/stored intermodal containers is considered to be an *extremely unlikely* event. It is judged that an aircraft crash would impact no more than two intermodal containers based on their size and mass. An aircraft crash could disperse contaminated soils/materials packaged in the intermodal containers. An ensuing fuel fire could add an additional release component to the scenario. It should be noted that the postulated releases are conservatively modeled in that the contaminate is actually distributed within a soil matrix rather than the materials that the ARF and RF are based on (*i.e.,* powder for the spill portion and air-dried salts under a gasoline fire on a porous or otherwise absorbing surface for the fire portion)

The radiological dose consequences from an aircraft crash into the container staging/storage area would be *low* based on (1) Spill-2 scenario radiological dose consequences (1.6 rem to the CW, 0.013 rem to the MOI) bounding the spill component of this aircraft crash, and (2) Fire-2 scenario radiological dose consequences (0.15 rem to the CW, 0.01 rem to the MOI) bounding the fire component of this aircraft crash. If the radiological dose consequences of Spill–2 and Fire-2 were added the consequences remain *low* (1.75 rem to the CW, 0.023 rem to the MOI).

Vehicle Impact and Range Fire Events

Vehicle impacts at the 903 Pad Project could result in a spill or fire involving unexcavated, excavated, or packaged contaminated soils/materials. However, it is judged that the accident scenarios discussed in Section 4.4.3, *Fires* and Section 4.4.4, *Spills*, would bound vehicle impact events.

Range fires are *anticipated* to occur, as there have been several recent range fires at the site since 1990. These fires are expected to be of low to moderate intensity and fast moving due to the arid conditions and easily ignitable fuel around the 903 Pad Project boundaries. The damage potential to the 903 Pad Project from a range fire is dependent on factors including fire fuel sources, spatial separation distances, and fire department response. It is considered *unlikely* that a range fire would cause a radiological material release from unexcavated, excavated, or packaged contaminated soils/materials because inherently low combustible material loading during project activities and the 903 and 904 asphalt pads will preclude fire spread to excavation areas (903 Pad) or the 904 waste staging/storing area. Additionally, the control of Site vegetation and fire prevention inspections (aspects of the FIRE SMP) will minimize the impact of range fires to the 903 Pad, 904 Pad, and the 891 Temporary Waste Storage Area. It is judged that Site fire department response would mitigate a Site range fire prior to it impinging on the 903 Pad Project and resulting in a fire scenario beyond those discussed in Section 4.2.4, *Fires.*

Controls Summary

Based on the *low* risk (Risk Class III/IV) associated with the analyzed natural phenomena and external event scenarios, no CW or public protection controls were identified that warrant elevation to the TSR level. The Site SMPs, as described in Section 3, are recognized to provide protection to all receptors. IW controls are discussed in Section 4.4, *Worker Safety Evaluation.*

4.2.10 Chemical Hazards

Table 14 shows the regulatory thresholds (Reportable Quantities [RQs], TQs or TPQs) for the VOCs that were identified during characterization of the 903 Pad. RQs are based on the potential release of materials into the environment and are not based on the toxicological effects to humans. Releasing a quantity to the environment that is greater than the RQ, for a listed chemical, requires compliance with applicable reporting requirements. Consequence analysis of such a release is not required unless one of the other thresholds is also exceeded.

Table 14 Regulatory Thresholds for Chemicals Found in Soils at the 903 Pad

Chemical	29 CFR 1910.119 TQ (kg)	40 CFR 68 TQ (kg)	40 CFR 302.4 RQ, (kg)	40 CFR 355 TPQ (kg)
Carbon Tetrachloride (CCl_4)	Not listed	Not listed	4.54	Not listed
Methylene Chloride	Not listed	Not listed	454.0	Not listed
Tetrachloroethene (PCE)	Not listed	Not listed	45.4	Not listed
Trichloroethylene (TCE)	Not listed	Not listed	45.4	Not listed
1,2-cis-dichloroethylene (1,2-DCE)	Not listed	Not listed	454.0	Not listed

Because none of the chemicals found in soils at the 903 Pad have listed TQs or TPQs, activities associated with the 903 Pad Project are not expected to result in an airborne release of hazardous chemicals that could affect the CW, MOI or the environment.

Controls Summary

Based on the *low* risk associated with the identified chemical hazards, no CW or public protection controls were identified that warrant elevation to the TSR level. The Site SMPs, as described in Section 3, are recognized to provide protection to all receptors. IW controls are discussed in Section 4.4, *Worker Safety Evaluation.*

4.3 Accident Scenario Results

All of the 903 Pad Project unmitigated accident scenario discussed in Section 4.2 result in *low* radiological dose consequences to the CW and MOI without crediting mitigative controls. Additionally, based on the *low* radiological dose consequences, all the scenarios result in Risk Class III or less events without crediting preventive controls.

SIHs are considered to be sufficiently controlled by the Site SMPs. For non-SIHs, Appendix B of the Site PHA, *Controls Summary,* was reviewed to assure that all potentially available preventive and mitigative controls were considered during the evaluation of postulated accident scenarios. None were identified that warrant elevation to the TSR level.

4.4 Worker Safety Evaluation

For IW safety, three levels of protection are appropriate: (1) physical barriers around or dealing with the hazard that can protect the worker (*e.g.,* primary containers, shielding); (2) general classes of personal protective equipment (PPE) for the worker (*e.g.,* protective clothing, breathing devices); and (3) administrative imposed requirements to protect the worker (*e.g.,* postings, lockout/tagout).

The 903 Pad Project-specific addendum to the ER HASP adequately addresses IW hazards associated with project activities. The addendum includes a hazard evaluation that addresses (1) radiological and chemical hazards, (2) the degree of potential exposure to workers, (3) description of other hazards beside radiological or chemical, (4) hazard controls, (5) unanticipated hazards or conditions, and (6) applicable Job Hazards Analyses (JHAs). Based on the hazard evaluation, PPE is prescribed based on the activity(ies) being performed. Finally, minimum training requirements are specified for project workers as well as emergency procedures in the event of a fire, explosion, or personnel illness/injury.

All of the 903 Pad Project unmitigated accident scenarios discussed in Section 4.2 result in *low* to *moderate* radiological and chemical dose consequences to the IW as defined by the comparison criteria shown in Table 8, *Qualitative Guidelines for IW Consequences.* However, it is judged that the mitigated IW consequences are reduced to *low* by crediting the Site SMPs as described in Section 3. Personnel awareness that an accident has occurred, prompt notification of nearby workers, timely evacuation, and the use of appropriate PPE are some of the important aspects of IW protection prescribed by the SMPs. Based on the *low* radiological and chemical dose consequences, all scenarios result in Risk Class III or less events to the IW without crediting preventive controls. Based on the accident analysis in Section 4 and a review of the Site PHA, no exclusively IW controls were identified that warrant elevation to the TSR level (*i.e.,* specific AC control or restriction).

4.5 Final Hazard Categorization

The 903 Pad Project Final Facility Hazard Categorization is Hazard Category 3 (HC-3) in accordance with DOE-STD-1027-92 (DOE, 1994) based on the amount of radioactive material being excavated and accident analysis results.

4.6 Derivation of Technical Safety Requirements

Based on the hazards and *low* risk associated with 903 Pad Project, no Safety SSCs are relied upon to protect the MOI and/or the CW. Therefore, no LCOs have been written for 903 Pad Project activities. The TSRs consist only of Administrative Controls (ACs).

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5. TECHNICAL SAFETY REQUIREMENTS

The following ADMINISTRATIVE CONTROLS (ACs) maintain the validity of this safety analysis and assure the continued safe operation of the 903 Pad Project.

5.1 DEFINITIONS

NOTE

The defined terms of this section appear in capitalized type throughout the TSRs.

TERM	DEFINITION
ADMINISTRATIVE CONTROLS (ACs)	Provisions relating to SMPs necessary to ensure safe operations. Specific attributes may be AOLs or ACs.
AC NONCOMPLIANCE	A failure to meet an AC resulting in an unplanned entry into AC CONDITION(s) and associated REQUIRED ACTIONS.
ADMINISTRATIVE OPERATING LIMITS (AOLs)	Specific ACs/limits that have been credited in the Safety Analysis. AOLs are credited as providing a reduction in postulated accident scenario initiation frequency and/or a reduction in postulated accident scenario consequences. Such controls are more precise and discrete than those defined by a SMP. The AOLs are an administrative equivalent to hardware requirements specified in LCOs and, as such, have requirements for verification of the AOL and requirements for actions following DISCOVERY of a noncompliance with the AOL.
AFFECTED AREA	That area associated with a specified activity or portion of a specific facility in which the credited safety function provided by an AC is compromised by an AC NONCOMPLIANCE or other CONDITION for which REQUIRED ACTIONS are specified.
BASIS/BASES	Summary statement(s) of the rationale for the ACs. The BASES explain how the numeric value, the specified function, or the SURVEILLANCE fulfills the credited safety function assumed in the Safety Analysis.
903 PAD PROJECT	The 903 PAD PROJECT boundaries include (1) the entire 903 Pad (asphalt area), which is approximately 375 feet by 395 feet (148,125 ft^3 or 3.4 acres), (2) the 903 Lip Area to the east, (3) a backfill stockpile area to the south, (4) the 904 Pad to the west, (5) the 891 Temporary Waste Storage Area to the southwest, and (6) areas/roads inter-connecting the 903 Pad, 904 Pad, 891 Temporary Waste Storage Area, and the backfill stockpile area. (See Figure 1).
COMPLETION TIME	The amount of time allowed to complete a REQUIRED ACTION. The COMPLETION TIME starts whenever a situation (e.g., variable not within limits) is DISCOVERED that requires entering a REQUIRED ACTION for a given CONDITION. REQUIRED ACTIONS shall be performed before the specified COMPLETION TIME expires.

TERM	DEFINITION
CONDITION	Configuration and status of the facility or activity related to compliance with the TSRs for which REQUIRED ACTIONS must be performed within a specified COMPLETION TIME.
DISCOVERY/ DISCOVERED	For TSR compliance, the point in time when 903 PAD PROJECT management makes the determination that an AC is not being met or that an unplanned CONDITION has been entered and REQUIRED ACTIONS must be implemented.
ON-DUTY	A person who is on Site and performing job tasks or functions.
REQUIRED ACTIONS	The mandatory response when an AC CONDITION is entered.
SUSPEND OPERATIONS	A formal suspension of those activities capable of initiating an analyzed operational accident (*e.g.,* movement or handling of containerized waste, hot work, flammable gas use) except for those directly involved in: 1. Placing and maintaining the operation, activity, or facility in a safe configuration; 2. Restoring the safety function associated with the suspension; or 3. Remediating AC NONCOMPLIANCES; This means that activities such as tours, inspections, and maintenance not requiring containerized waste or material handling equipment movement, hot work, or flammable gas use may be authorized.
TECHNICAL SAFETY REQUIREMENTS (TSRs)	Those requirements that define the conditions, safe boundaries, and the management or administrative controls necessary to ensure the safe conduct of 903 PAD PROJECT activities and to reduce the potential risk to the public and site workers from uncontrolled releases of radioactive materials. TSRs consist of ACs and the BASES thereof.
VIOLATION	A TSR VIOLATION occurs when 903 Pad Project Management: 1. fails to take REQUIRED ACTIONS within the specified COMPLETION TIME after failing to meet an AC; 2. fails to SUSPEND OPERATIONS when REQUIRED ACTIONS cannot be met or are not provided; or 3. determines that continued recurrence of an AC NONCOMPLIANCE represents a safety-significant trend. A VIOLATION is considered historical if the CONDITION was corrected prior to DISCOVERY.

5.2 ORGANIZATION AND MANAGEMENT

5.2.1 Requirements for Organization and Management

A minimum staff shall be in place to ensure operation within the defined TSRs. Lines of authority, responsibility, and communication shall be established and defined down through the 903 Pad Project ER Field Managers, including safety and operating organizations important to ensure safe operation.

5.2.2 Specific Controls or Restrictions

The 903 Pad Project shall have a process to assure adequate staffing during the performance of project activities. Adequate staffing includes having:

a. The 903 Pad Project ER Field Manager or designee shall be ON-DUTY whenever project activities occur.

b. The Site Fire Department is capable of responding to a fire event at the 903 Pad.

APPLICABILITY:

Adequate staffing for the 903 Pad Project is applicable at all times as stated above.

ACTIONS:

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. The minimum staffing requirements are not met.	A.1	Restore staffing to minimum requirements.	4 hours.
	OR		
	A.2.1	Make appropriate notifications within the facility and to the Site Shift Superintendent.	4 hours.
		AND	
	A.2.2	SUSPEND OPERATIONS in the AFFECTED AREA(s).	4 hours.
B. Notification that Fire Department does not have minimum staffing required to respond to a fire at the 903 PAD PROJECT.	B.1	SUSPEND OPERATIONS in AFFECTED AREA(s).	4 hours.

SURVEILLANCE REQUIREMENTS:

None Required

5.3 SAFETY MANAGEMENT PROGRAMS

In addition to worker safety, the cumulative effect of the programmatic details in SMPs is important to the safe performance of the 903 Pad Project.

5.3.1 Requirements for Safety Management Programs

a. The SMPs, as described in Section 3, *Safety Management Programs*, shall be established, implemented, and maintained as applicable.

b. The ER Program Manager shall correct a SMP noncompliance in accordance with the requirements of the specific Safety Management Program.

c. The ER Program Manager shall provide tracking and trending data to the Site program owner in accordance with the requirements of the specific SMP.

APPLICABILITY:

These requirements are applicable at all times.

ACTIONS:

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. The overall safety function of an SMP (identified in the SMP description) is lost due to a programmatic failure.	A.1 Notify DOE RFFO of the programmatic failure.	7 days.
	AND	
	A.2 Determine the safety significance of the programmatic failure.	10 days.
	AND	
	A.3 Identify and implement corrective actions.	10 days.

SURVEILLANCE REQUIREMENTS:

None Required

5B TECHNICAL SAFETY REQUIREMENTS BASES

5B.2 ORGANIZATION AND MANAGEMENT BASES

5B2.1 Requirements for Organization and Management

The establishment and maintenance of a minimum staff provides assurance that the 903 PAD PROJECT is capable of operating within the TSRs at all times. Clearly defined lines of authority, responsibility, and communication establish command and control within the 903 PAD PROJECT, accountability for safe operation, and definition of the relationship between support functions important to safety and line management.

5B2.2 Specific Controls or Restrictions

a. The 903 Pad Project ER Field Manager or designee's presence provides command and control of work activities, guidance and interpretation of AB requirements, and response to operational conditions or accidents.

b. The availability of the Site Fire Department to respond to a fire event assures that risk from fires is minimized.

Applicability: The specific control on minimum staffing requirements applies at all times.

ACTION BASES

Condition A:

This AC stipulates actions ensuring consistent direction and timely response upon recognition of inadequate staffing resources. The minimum staffing requirements ensure that sufficient resources are available to fulfill credited safety operations. Four hours is considered sufficient time for the 903 PAD PROJECT to restore minimum staffing requirements or make appropriate notifications within the facility and to the Site Shift Superintendent. Four hours is also considered sufficient time to suspend affected operations and place the 903 PAD PROJECT in a safe configuration.

If the minimum staffing requirements are not met, then either REQUIRED ACTION A.1 or A.2.1 and A.2.2 is required to be performed, but not both. REQUIRED ACTION A.1 requires the minimum staffing requirements be restored within the 4-hour COMPLETION TIME. The action restores compliance with the AC so no further actions are required.

If the minimum staff cannot be restored, REQUIRED ACTION A.2.1 makes appropriate notification within the facility and to the Site Superintendent, and REQUIRED ACTION A.2.2, SUSPENDS OPERATIONS in AFFECTED AREA(s) must both be completed within the same 4 hours.

Condition B:

The Site Fire and Emergency Services Department is essential for nuclear and life safety at the Site. The 903 PAD PROJECT relies on the Fire and Emergency Services Department to minimize material at risk involvement in the event of an accident involving a fire. The safety analysis implicitly credits the Site Fire Department for fires occurring at the 903 PAD

PROJECT. A prompt Fire and Emergency Services Department response could mitigate the effects of a fire at the 903 PAD PROJECT.

The 903 PAD PROJECT can assume that the Fire and Emergency Services Department has adequate fire response capability unless otherwise notified. Upon notification by the Shift Superintendent (as required by the Rocky Flats Environmental Technology Site Safety Analysis Report operational controls) of inadequate fire response capability due to Fire and Emergency Services Department staffing, REQUIRED ACTION B.1 is to SUSPEND OPERATIONS in the AFFECTED AREA(S) within 4 hours. Failure by the Shift Superintendent to notify the 903 PAD PROJECT of inadequate fire response capability does not constitute a non-compliance with these TSRs. This action restricts those activities (*e.g.,* hot work) that could result in a fire that may require Fire Department response.

5B.3 SAFETY MANAGEMENT PROGRAMS BASES

5B.3.1 Requirements for Safety Management Programs

AC 5.3.1a makes a commitment to Safety Management Programs. The commitment to each program encompasses a large number of details that are more appropriately covered in program documents. The cumulative affect of these details is recognized as being important to 903 PAD PROJECT safety, which is the rationale for a top-level programmatic commitment becoming part of the safety basis. The discipline imposed by SMPs goes beyond supporting assumptions in the hazard analysis and is an integral part of defense-in-depth.

AC 5.3.1b requires that ER Program Management correct SMP non-compliances in accordance with the requirements of the specific Safety Management Program. Non-compliances in a program do not constitute a programmatic deficiency (as described above) or violate the DSA safety basis.

AC 5.3.1c simply requires that ER Program Management provide tracking and trending data to the site program owner in accordance with the specific Safety Management Program.

Applicability: The requirements for Safety Management Programs apply at all times.

<u>ACTION BASES</u>

To enter CONDITION A, a programmatic failure must involve multiple deficiencies that are classified as significant non-compliances under the Price-Anderson Amendments Act (PAAA) in multiple areas of the program such that the overall safety function of an SMP identified in Chapter 3 is lost or called into question.

If CONDITION A is entered, the 903 PAD PROJECT shall notify DOE of the programmatic failure within a COMPLETION TIME of 7 days per REQUIRED ACTION A.1. REQUIRED ACTIONS A.2 and A.3 require a determination be made of the safety significance of the programmatic failure, and to identify and implement corrective actions. The 7-day COMPLETION TIME is a reasonable time to complete the reporting processes. The 10-day COMPLETION TIME was based on the short duration of the 903 PAD PROJECT and is a reasonable time for the 903 Pad Project to evaluate the significance of the deficiencies, perform any causal analysis if necessary, identify any corrective actions and implement corrective actions.

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Revision Number: 2
Date: November 2000

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

SAFETY ANALYSIS REPORT

APPENDIX I

SAFETY ANALYSIS
for
RCRA Storage Units

REVIEWED FOR
CLASSIFICATION/UCNI
By Art Ayers (UNU)
Date 1/29/01

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APPROVALS

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CHANGE SUMMARY

Revision Number	Description
1	Added discussion and evaluation of the Canberra Q^2 Mobile Assay System. Added discussion and evaluation of the storage of wooden waste crates at RCRA units.
2	Updated unit descriptions, deleted Unit 21 (Building 788), revised accident analysis source terms, added evaluations of natural phenomena and external event accident scenarios, and re-categorized the RCRA Storage Units as Hazard Category 3 Nuclear Facilities. Additionally, incorporated DOE RFFO technical direction contained in DOE RFFO Ltr. AME:NRD:MER:00-01-01790, *Disapproval of the Site Safety Analysis Report Revision 2,* dated March 22, 2000. Stated technical direction was to submit an AB document for the RCRA Storage Units that is compliant with the DOE Orders contained in the current contract. Revised Accident Analyses to reflect collocated worker at 100 meters and dose conversion factor based on ICRP-68. These changes are per DOE Memorandum AME:NRD:MP:00-02784 dated June 12, 2000.

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EXECUTIVE SUMMARY

This safety analysis provides final hazard classification and authorization basis documentation for Resource Conservation and Recovery Act (RCRA) Waste Storage Units 1, 10, 13 (Building 884), 15A, 18.03, 18.04, and 24 (Building 964), at the Rocky Flats Environmental Technology Site (RFETS), based on the radiological material inventories and the hazards and potential accident scenarios associated with the units. It also addresses the use of the Canberra Qualitative and Quantitative (Q^2) Mobile Waste Assay System. This safety analysis meets the requirements for a graded Safety Analysis Report (SAR) referenced in Department of Energy (DOE) Order 5480.23, *Nuclear Safety Analysis Report* and Standard DOE-STD-3009-94, *Preparation Guide for U. S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Report.*.

RFETS operates multiple waste storage units under a site permit addressing RCRA requirements. The units in this safety analysis address both indoor and outdoor storage areas which contain wastes as allowed by the RCRA permit, with the exception of Transuranic mixed (TRM) wastes. The waste is stored in drums, crates, or non-standard containers. The outdoor storage units store all waste containers inside large cargo containers, with the exception of Units 15A and 18.03 which can store crates outside of cargo containers. The Canberra Q^2 Mobile Waste Assay System will be used to perform non-destructive assay (NDA) services for packaged Low-Level Wastes (LLW) and Low-Level Mixed Wastes (LLMW) to facilitate off-site treatment and disposal.

Some of the hazards of concern for the RCRA Units are material handling accidents or spills, both large and small; fires; material incompatibility issues; container integrity; and hazardous material characteristics such as ignitability, corrosiveness, toxicity, and radioactivity. The principal receptors at risk due to accidental releases from these areas are collocated workers evaluated at 100 meters and immediate workers. Based on the radiological material inventory and comparison of accident analysis consequence results to the Nuclear Facility Hazard Category 3 threshold of "The Hazard Analysis shows the potential for only significant localized consequences" the final hazard classification for RCRA Storage Units 1, 10, 13, 15A, 18.03, 18.04, and 24 is nuclear facility Hazard Category 3. The RCRA Storage Units also pose risk from the non-radiological hazardous constituents in the waste, which fall into the *low* hazard category.

Operational controls are placed on the RCRA Storage Units hazardous material inventory to maintain the hazard classification of nuclear facility Hazard Category 3 and prevent the introduction of materials into the units that would invalidate the safety analysis basis documented herein. The RFETS RCRA permit contains requirements that prevent and/or mitigate the identified hazards. Compliance with the RCRA Permit and implementation of the controls contained in Section 5 of this safety analysis assures that the risk associated with the operations of the RCRA Units is acceptable. Complying with these operational controls assures that this authorization basis remains valid and that all activities are conducted within the documented safety envelope.

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CONTENTS

FIGURES

TABLES

1 INTRODUCTION

This safety analysis is part of the Rocky Flats Environmental Technology Site Safety Analysis Report (Site SAR), Volume I, *Site Description and Characterization.* It addresses the final hazard classification and authorization basis including the controls to safely operate the Resource Conservation and Recovery Act (RCRA) regulated waste storage units: Units 1, 10, 13 (Building 884), 15A, 18.03, 18.04 , and 24 (Building 964). It also addresses the use of the Canberra Q^2 Mobile Waste Assay System at the RCRA Units. The Canberra Q^2 Mobile Waste Assay System will be used to perform non-destructive assay (NDA) services for packaged low-level waste (LLW) and low-level mixed waste (LLMW) to facilitate off-site treatment and disposal. The system will be located and setup near the RCRA Unit 1 waste storage area along the east side of Seventh Street south of Sage Avenue. Upon approval of the Site SAR Volume I, this safety analysis will become the authorization basis for the above RCRA Units.

Department of Energy (DOE) documents (DOE, 1994a, DOE, 1994b) mandate that safety evaluations be performed for nuclear facilities within the DOE nuclear complex that have the potential to adversely affect the health and safety of the workers, the public, or the environment. The Site SAR meets these requirements and provides safety documentation for facilities classified as nuclear facility Hazard Category 3 and below. The Site SAR is separated into two volumes. Volume I contains information germane to the site as a whole as well as the safety analyses for Site nuclear facility Hazard Category 3 facilities. Volume II of the Site SAR contains the safety analyses for Site facilities categorized as *radiological* and below. This safety analysis is Appendix I to Volume I of the Site SAR. Site-wide information contained in Volume I includes:

- descriptions of the site and site-wide utilities;
- authorization basis safety analysis methodology;
- information concerning site-wide hazards, such as natural phenomena events and external man-made threats;
- summaries of the Rocky Flats Environmental Technology Site (RFETS) Safety Management Programs;
- site-wide operational controls; and
- facility summaries and interactions.

This safety analysis provides specific information on the activities performed in the RCRA Storage Units, including use of the Canberra Q^2 Mobile Waste Assay System, a general description of the units, development of the source term based on inventory information, and accident analysis. The hazard assessment uses a hazard identification checklist and description table to provide the framework for the hazard assessment. Standard industrial hazards noted on the table are not analyzed in detail unless they initiate a release of hazardous materials or worsen the consequences of a hazardous material release. Operational controls are identified to address the preventive and mitigative features credited to control the identified hazards.

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2 FACILITY/ACTIVITY CHARACTERIZATION

Hazardous wastes regulated by RCRA are generated at RFETS and stored on-site in permitted storage areas pending transfer to off-site facilities for treatment, storage, or disposal. The operation of these permitted storage areas is primarily defined and controlled by the *Rocky Flats Plant RCRA Part B Permit and Compliance Related Documents* (RFETS, 1995a) which detail the implementation at RFETS of State and Federal requirements for management of radioactive and nonradioactive hazardous wastes. Seven RCRA units are addressed in this document; the remaining areas are addressed in stand-alone authorization basis documentation separate from this safety analysis. Because of the low risk associated with these units (all postulated accident scenarios are Risk Class III or IV events), they have no safety systems, structures, or components (SSCs) that are depended upon to prevent and/or mitigate the consequences of an accident. The structural, operational, and system descriptions provided in this safety analysis are for information purposes only.

2.1 FACILITY MISSION

The RCRA storage units provide for the safe, compliant, and temporary storage of containerized radioactive and nonradioactive hazardous wastes. In accordance with the state-issued permit for the RCRA storage units, only waste generated on site may be stored at these facilities. The storage units addressed in this safety analysis consist of cargo containers, buildings, and fenced outdoor areas. For each storage unit, the permit defines the maximum total capacity, the maximum liquid capacity and allowable waste types.

The RCRA units covered by this safety analysis are permitted for low-level mixed, Transuranic mixed (TRM), and hazardous wastes, both solid and liquid forms. The combination of types and capacities are identified by the RCRA permit. ***Although the permit identifies TRM as an accepted waste type in some RCRA units, operational controls limit the maximum Pu gram loading for various container types/sizes received and stored at any of the RCRA units evaluated in this safety analysis*** (see Section 5.2, *Inventory Control and Material Management*).

RCRA Units 1 and 10 have heated storage areas and are used for liquid wastes that are susceptible to freezing. Liquids stored in unheated units are primarily liquids that do not freeze, such as organics. Units 13 and 24 are not permitted to store liquids. RCRA Unit 15A is permitted for the storage of chip roaster oxide, vacuum filter sludge, soil and debris from corrective action drilling activities, cemented composite chips, and other solid and liquid low-level mixed wastes in cargo containers and crates. RCRA Unit 18.03 is permitted for storage of liquid and solid nonradioactive hazardous and low-level mixed waste generated in environmental restoration and corrective action activities. RCRA Unit 24 is permitted for storage of solidified bypass sludge, a low-level mixed waste. The locations of the RCRA units evaluated in this safety analysis are shown in Figure 1.

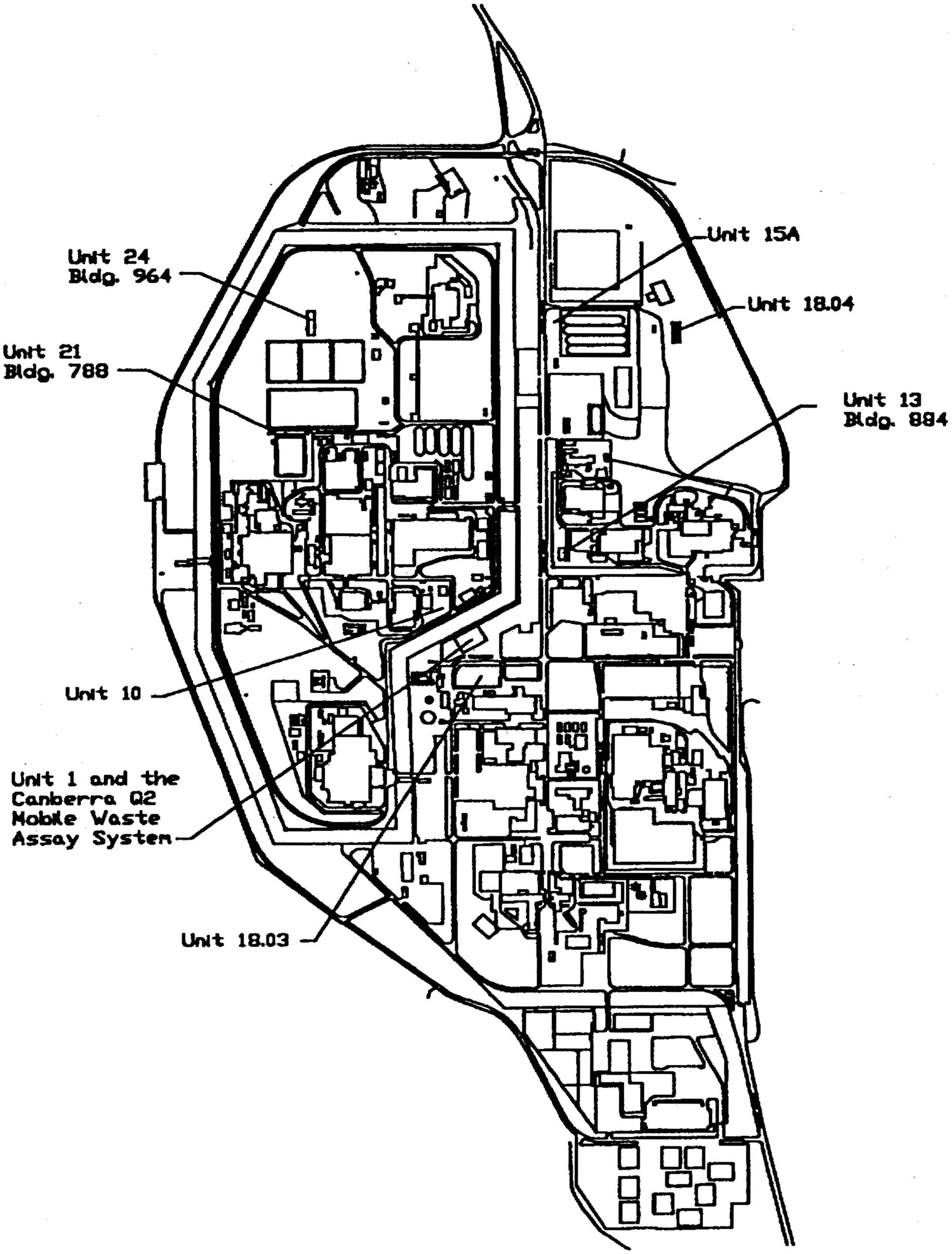


Figure 1 Location of RCRA Units

The RCRA units in this evaluation consist of an array of cargo containers, buildings, and pad areas (used for crates). No drums are stored outside cargo containers or buildings. Figure 2 provides the typical layout for the various size cargo containers used. For all RCRA storage units, required practices for posting; labeling; inspection; storage of ignitable, reactive and incompatible wastes; allowable container types; required container integrity and compatibility; container stacking; maintenance of aisle space; secondary containment; and recordkeeping are specified as standard activities required for compliance with the RCRA permit. Other routine activities performed in the areas to maintain safety and regulatory compliance include both breachment and non-breachment operations.

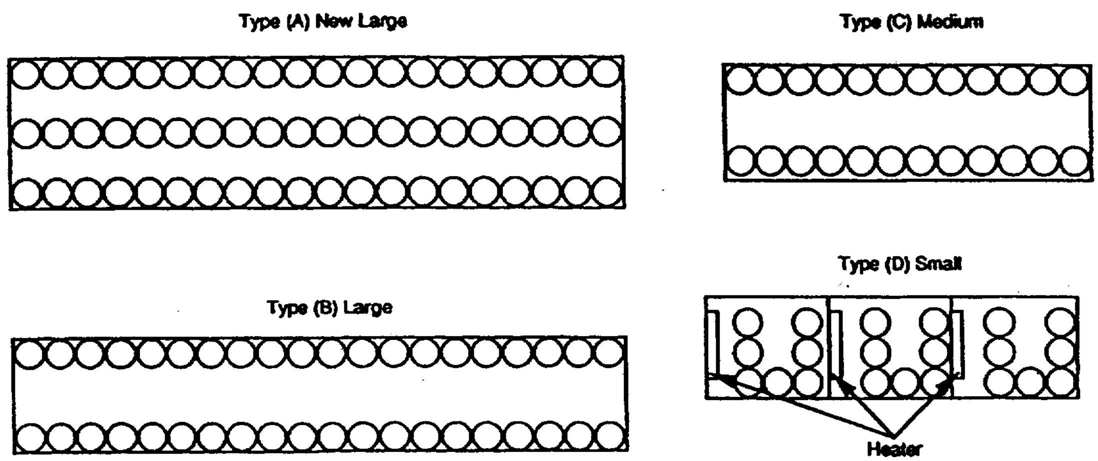


Figure 2 Typical Layouts, by Type, for Cargo Containers in RCRA Units

Routine non-breachment operations performed include, but are not limited to, drum overpack (no leaks), drum and crate movements, Canberra NDA services, hoisting and rigging, housekeeping, staging, on-site transfer, and off-site shipping. Routine breachment operations include drum pumping, overpacking (with leaks), sampling, re-packaging and consolidation, returning samples, lab packing, characterization and verification, drum venting and de-heading, and spill clean-up.

2.2 FACILITY DESCRIPTION

The following paragraphs and figures provide a brief description of the RCRA units evaluated in this safety analysis as well as the siting and operation of the Canberra Q^2 Mobile Waste Assay System. Satellite and 90-day accumulation areas are not covered by this safety analysis because of the transitory nature of the material collected and the frequency of adding and deleting these storage areas.

RCRA Unit 1 is an outdoor waste storage area located along the east side of Seventh Street south of Sage Avenue and consists of a fenced area and cargo containers. Unit 1 has heated cargo containers and is the primary storage area for Priority 3 waste chemicals identified by the Waste Chemical Program (WCP). Priority 3 chemicals are those that do not require treatment prior to storage. Storage of reactive wastes must meet the management requirements provided in the RCRA permit for this unit. The maximum total permitted capacity of the facility is 123,330 gallons, all of which may be liquid wastes. A maximum of forty-one 40-foot cargo containers (or equivalent capacity based on number of waste containers stored within a cargo) may be used to store waste at any one time in Unit 1. Secondary containment for all storage in Unit 1 is provided by use of catch basins that must have sufficient height to contain at least 10% of the liquid volume in storage or the volume of the largest liquid container in storage, whichever is greater. The layout of RCRA Unit 1 is shown in Figure 3. Unit 1 has an asphalt base. Both 20-foot long cargo containers and 40-foot long cargo containers are allowed. Drum storage racks have been removed. Wastes stored in the cargo containers are segregated by compatibility code. All wastes in Unit 1 are packaged in 55-gallon drums, 5- and 10-gallon containers, or 85-gallon overpacks.

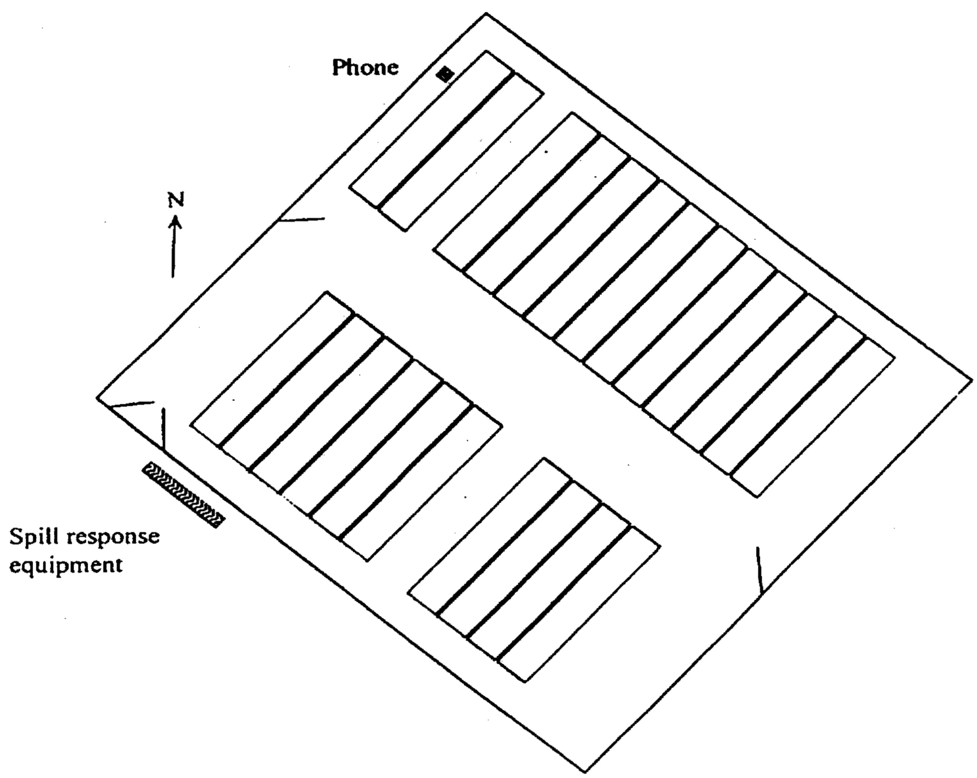


Figure 3 RCRA Storage Unit 1

Also located near RCRA Unit 1 will be the Canberra Q^2 Mobile Waste Assay System that will be used to perform NDA services for packaged LLW and LLMW to facilitate off-site treatment and disposal.

RCRA Unit 10 (Figure 4) is an outdoor waste storage area located southwest of Building 561, consisting of 20-foot and 40-foot long cargo containers on an asphalt pad. The maximum permitted capacity of the facility is 20,800 gallons; this is also the maximum permitted liquid capacity. This unit is used for liquid waste storage and has heated cargo containers for storage of liquids susceptible to freezing. A maximum of nine 40-foot cargo containers (or equivalent capacity) may be used to store waste at any one time in Unit 10. The cargo containers are storage for low-level mixed liquid wastes. Secondary containment is provided in the cargo containers by use of catch basins that must have sufficient height to contain at least 10% of the liquid volume in storage or the volume of the largest liquid container in storage, whichever is greater. Liquids are packaged in 55-gallon drums, 5- and 10-gallon containers or 85-gallon overpacks.

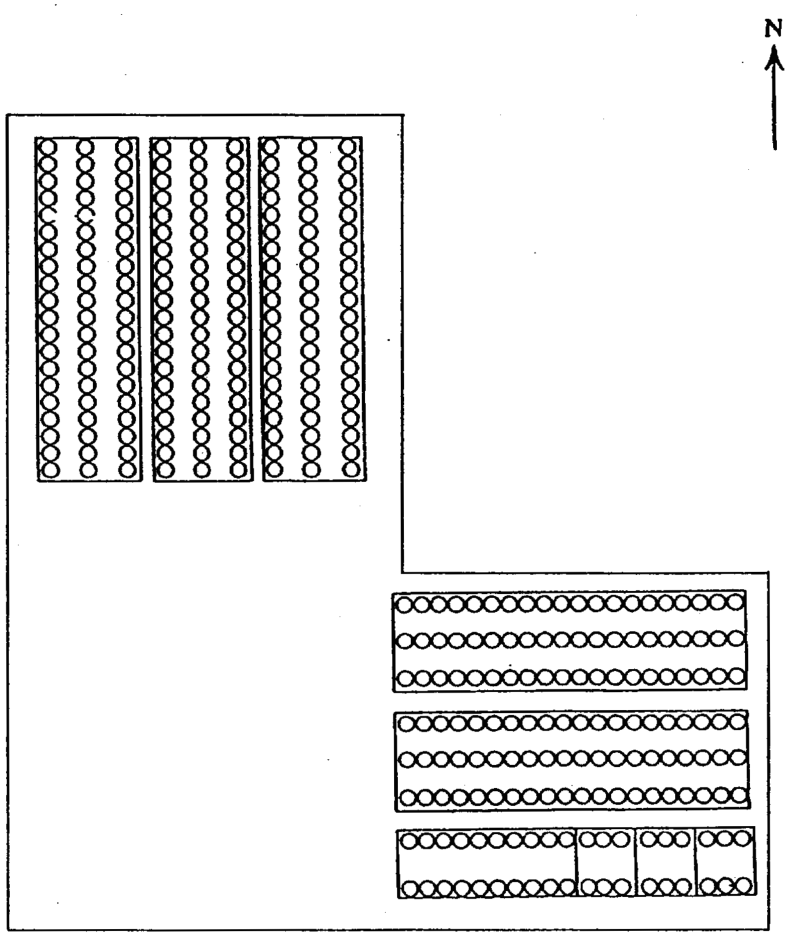
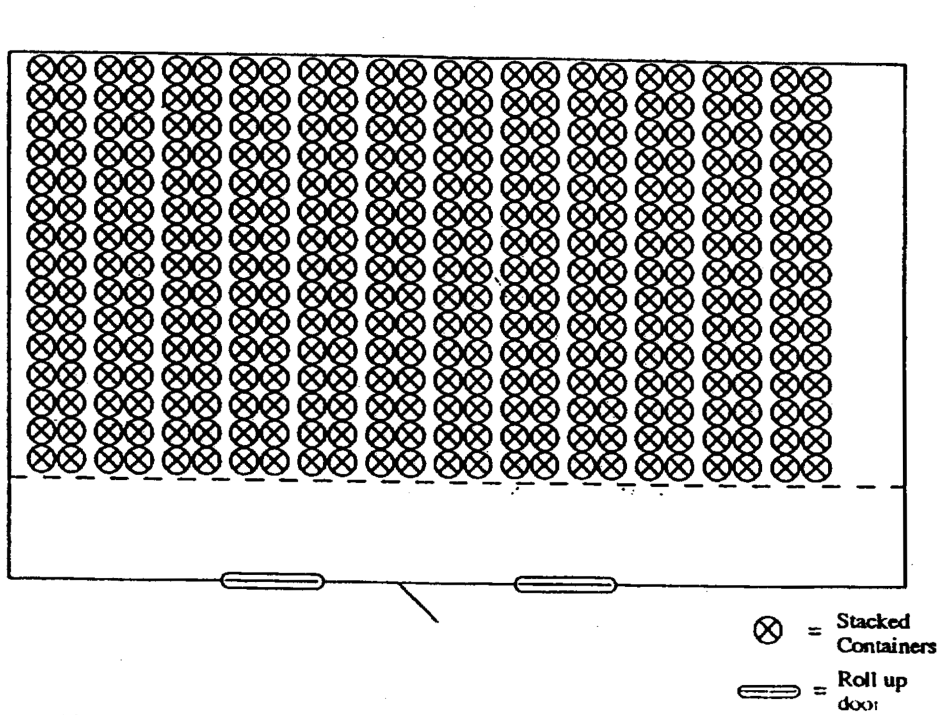


Figure 4 RCRA Storage Unit 10

RCRA Unit 13 (shown in Figure 5), also known as Building 884, is a corrugated steel building on a coated concrete pad. The maximum permitted capacity of the facility is 55,440 gallons; no liquids are allowed in this unit. Containers in storage may be stacked up to three high for solid waste drums; crates may be stacked three high for two-foot crates and two high for four-foot crates. Wastes are stored in 55-gallon drums, 5- and 10-gallon containers or 85-gallon overpacks, as well as crates.



Note: Typical container layout; actual arrangement may vary.

Figure 5 RCRA Storage Unit 13 (Building 884)

RCRA Unit 15A (shown in Figure 6), located on the north side of the 904 Pad, is an outdoor fenced area. The maximum permitted capacity of the facility is 71,565 gallons in drums in cargo containers and 151,470 gallons in crates; the maximum permitted liquid capacity of the facility is 71,565 gallons. A maximum of thirty-four 40-foot cargo containers (or equivalent capacity) may be used to store waste at any time in Unit 15A. Drums stored in cargo containers are configured in single layers with a maximum of 40 drums per cargo container. Containers stacked on 55-gallon and 85-gallon drums can not exceed 10 gallons. Secondary containment is provided by catch basins that must have sufficient height to contain at least 10% of the liquid volume in storage or the volume of the largest liquid container in storage, whichever is greater. Liquid storage is allowed only in cargo containers. Crate storage is located adjacent to the north side of the berm surrounding 904 Pad (RCRA Unit 15B). Solid low-level mixed waste may be stored in plywood crates, metal crates, or non-standard containers. Crates may be stacked three high. The inventory of crates at RCRA Unit 15A, as of May 2000, includes 15 low-level mixed crates and three non-standard containers. Of these, only four crates contain plutonium contaminated waste. Six crates contain uranium contaminated waste. The remaining crates are only radiologically contaminated but the quantities are not measurable.

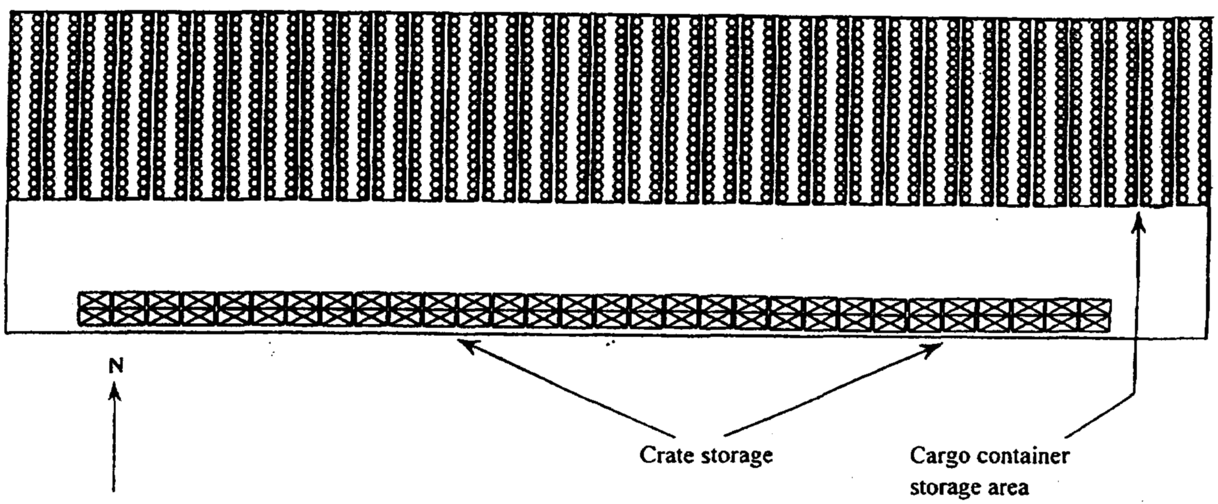


Figure 6 RCRA Storage Unit 15A

<u>RCRA Unit 18.03</u> (shown in Figure 7) is a fenced outdoor area located in the parking lot east of Building 551. The maximum permitted capacity of the facility is 472,245 gallons; the maximum permitted liquid capacity of the facility is 92,400 gallons. Containers in storage may be stacked five high for half crates and three high for full crates. Drums must be configured in single layers for storage in cargo containers. Secondary containment is provided by use of catch basins, which must have sufficient height to contain at least 10% of the liquid volume in storage or the volume of the largest liquid container in storage, whichever is greater. Racks previously used for drum storage are no longer used.

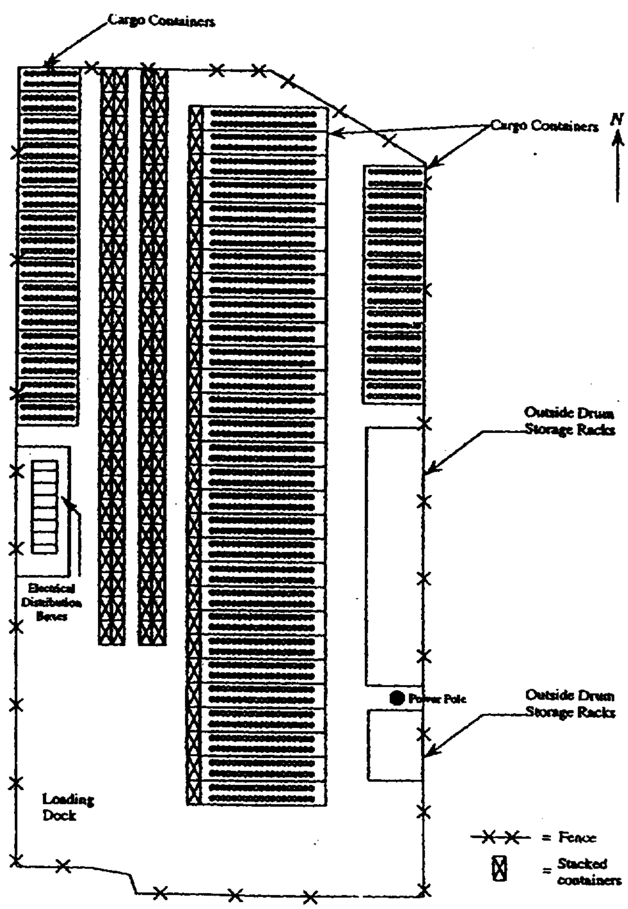


Figure 7 RCRA Storage Unit 18.03

RCRA Unit 18.04 (shown in Figure 8), consists of seventeen cargo containers located south of the Centralized Waste Storage Facility (Building 906). The maximum permitted capacity of the facility is 903 cubic yards (182,406 gallons); the maximum permitted liquid capacity for the unit is 87,340 gallons. Secondary containment is provided by catch basins that must have sufficient height to contain at least 10% of the liquid volume in storage or the volume of the largest liquid container in storage, whichever is greater.

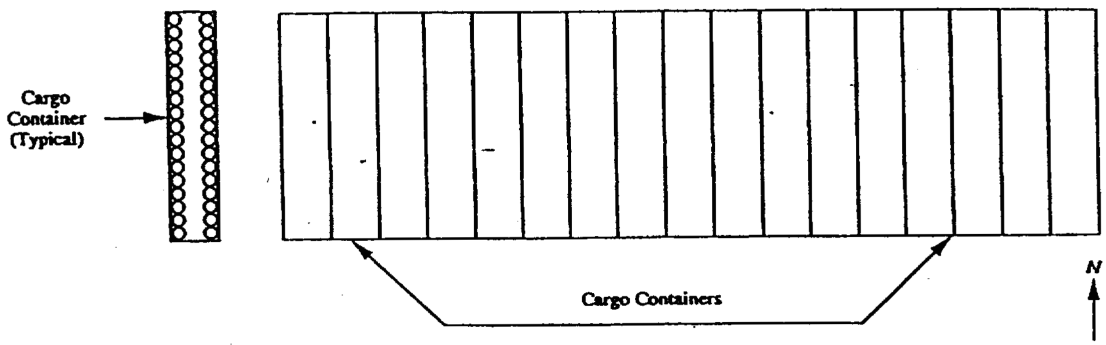
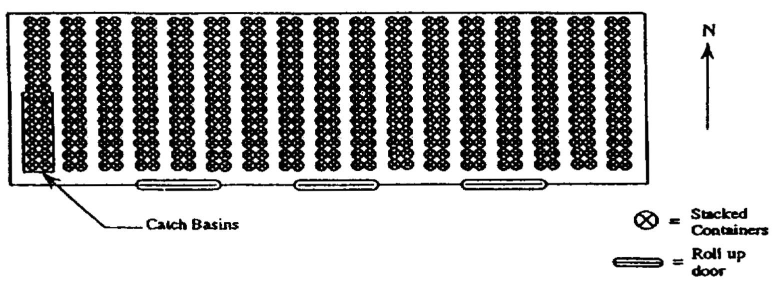


Figure 8 RCRA Unit 18.04

RCRA Unit 21 previously known as Building 788, was placed in an inactive status on April 14, 1999. No waste is currently stored at this unit. The unit will be permanently closed following preparation of an approved closure description document.

RCRA Unit 24 (shown in Figure 9), also known as Building 964, is a wooden frame building with corrugated metal siding and roof on a concrete pad, located east of the Solar Ponds. The maximum permitted capacity of the facility is 123,200 gallons; no liquids. This unit primarily contains solidified bypass sludge, Item Description Code (IDC) 807. Drums in storage may be stacked up to four high and crates may be stacked two high. Free liquids, which are very small quantities and not considered liquid waste, are verified through real-time radiography. Any containers found to hold free liquids are stored in properly sized catch basins for secondary containment.



Note: Typical container layout; actual arrangement may vary.

Figure 9 RCRA Unit 24 (Building 964)

Canberra Q^2 Mobile Waste Assay System is a drum counter that is used to perform NDA services for packaged LLW and LLMW to facilitate off-site treatment and disposal. The system is located and setup near the RCRA Unit 1 waste storage area along the east side of Seventh Street south of Sage Avenue. The system is used primarily to assay waste chemical drums as part of the site Waste Chemical Program (WCP). Drums containing solid and liquid wastes are assayed. The NDA results are used to assure that measured quantities of radiation meet Department of Transportation (DOT) requirements and the requirements of designated waste disposal facilities.

The Canberra Q^2 Mobile Waste Assay System consists of a WM-2100 Series drum counter with multiple germanium (Ge) or NaI detectors for qualitative and quantitative analysis. Steel shielding is provided to shield the detectors and sample from background radiation. The instrument is fully contained and operational within a standard semi-truck trailer that is 48' long by 8.5' wide by 13.5' high. Power requirements are 208 volts AC, 3 phase, 100 amperes. Electrical service will be provided from a power pole located at RCRA Unit 1. An office area located in the nose of the trailer provides space for the operator, analysis electronics, and the analysis computer. The power cable will be terminated in an electrical panel in the office. The power panel contains a main 100-amp circuit breaker and other circuit breakers for power distribution to equipment, lights, heater/air conditioning, and wall outlets. Two smoke detectors are mounted in the trailer as well as two fire extinguishers. The Canberra Q^2 Mobile Waste Assay System was completely assembled, tested, and calibrated at Canberra Industries. It was delivered to RFETS ready to operate with a factory calibration. A check source containing a nominal activity of Cs-137 and Co-60 is provided, along with a convenient geometry for daily check source counts.

The Site Material Stewardship Organization handles the operational aspects of the Canberra Q^2 Mobile Waste Assay System. Two waste technicians, one RCRA Custodian, and one Radiological Control Technician (RCT) are the main labor groups assigned to assay activities. Two Canberra operators, previously certified and trained for operations at RFETS, operate and control the Canberra NDA system. Canberra currently operates a similar instrument that supports drum NDA operations at Building 664. Operations require the movement of waste drums from cargo containers in RCRA Unit 1, via a specialized drum handling forklift, to the Canberra Q^2 Mobile Waste Assay System. The drums are lifted, via the forklift, to the rear of the trailer, which is 56 inches off the ground. Drums are handled within the Canberra trailer manually and via a drum handling jib crane incorporated within the trailer.

The primary isotopes of interest to the WCP are depleted uranium and plutonium-239 and -241. The system is capable of assaying 55, 30, 10, and 5 gallon steel or polyethylene drums, however, the majority of the drums to be counted from RCRA Unit 1 are 55-gallon size. All chemicals inside the drums that will be assayed will have been radiologically surveyed prior to packaging to assure that the drums do not exceed low-level waste limits.

Recognized controls associated with the operation of the Canberra Q^2 Mobile Waste Assay System include (1) approved Canberra operating procedures, (2) drum movements per approved procedures, (3) waste containers not opened, (4) assay of only LLW and LLMW identified by the WCP, (5) emergency response procedures, and (6) check sources controlled by approved Health and Safety Practices.

2.2.1 Facility Systems

Facility systems at the RCRA Storage Units are provided for compliance with occupational safety requirements. These systems serve no safety class or safety significant function in mitigation or prevention of releases of hazardous materials.

Electrical lighting is provided at levels sufficient to allow the safe performance of facility operations. Electrical service is provided from the site distribution system. Electric heaters are used in the units that are heated. Gasoline powered portable generators can be provided at some facilities for backup electrical power. All cargo containers are vented.

2.2.2 Facility Interfaces

The RCRA Units do not have system or utility interfaces with other facilities. The RCRA Units can receive waste from any of the facilities on-site. All waste received in an area must comply with the permit requirements for the area regarding waste form and Environmental Protection Agency (EPA) waste codes and the controls specified in Section 5, *Operational Controls*, of this safety analysis.

The Canberra Q^2 Mobile Waste Assay System 208 volts AC, 3 phase, 100 ampere electrical service is provided from a power pole located near RCRA Unit 1.

2.2.3 Facility Inventory and Source Term Development

By nature of facility operations, the inventory at any RCRA storage facility changes as wastes are transferred to the facility from other storage units and generating facilities, and as wastes are transferred from the facility to off-site treatment, storage, or disposal facilities. The storage units are permitted for a maximum solid and liquid capacity, and for certain hazardous constituents, which are identified by EPA waste codes.

The maximum radiological inventory which constitutes the material at risk (MAR) for the individual storage units may be conservatively assessed based on the permitted capacity of the unit and a plutonium (Pu) loading per container. All the RCRA Units evaluated in this safety analysis are permitted for storage of low-level radioactive mixed waste. Assay of LLW and LLMW will be performed using the Canberra Q^2 Mobile Waste Assay System. The assumed plutonium loading per container used for MAR determination is 0.181 grams per drum (except for Unit 24 where 0.5 grams Pu/waste drum is conservatively assumed based on process knowledge) and 0.63 per crate, based on a 95^{th}-percentile upper confidence limit (UCL) based on gram loadings for low level waste across RFETS. The estimated gram loading for LLMW waste is documented in Table H-2 of the *Safety Assessment and Risk Assessment Handbook* (SARAH) (RFETS, 1997a). The permitted maximum waste, inventories, and corresponding maximum radiological inventory for each RCRA Unit is shown in Table 1.

Table 1 Maximum RCRA Unit Capacity and Inventory

RCRA Unit	Permitted Capacity		Number of Containers		Radiological Inventory
	Maximum	Liquid	55-gal drum equivalents	Crates	Total Estimated g Pu[h]
1	123,300 gal	123,300 gal	2,242	0	406
10	20,800 gal	20,800 gal	380	0	69
13 (Bldg. 884)	55,440 gal	None	Varies (1,008 Max.)	Varies (58 Maximu m)	182[a]
15A	223,035 gal[b]	71,565 gal	1,300	158[c]	235 + 100 = 335
18.03	472,245 gal	92,400 gal	1,680	400[d]	304 + 252 = 556
18.04	182,406 gal[e]	87,340 gal	816[f]	0	148
24 (Bldg. 964)	123,200 gal	None	2,240	(g)	1,120 (2,240 × 0.50 g/drum)

a) Unit can contain both drums and crates, maximum radiological inventory is based on 1,008 drums.
b) 71,565 gal in drums in cargos, 151,470 gal (750 cu yds) in crates.
c) Based on 4.7 cu yards per crate and a permitted volume of 750 cu yards.
d) Number of crates is based on the volume not permitted for liquids (472,245 gal minus 92,400 gal) and 4.7 cu yards per crate.
e) Maximum capacity includes Building 892, which has not been constructed.
f) Based on 17 cargo containers with 48 55-gallon drum equivalents per container.
g) The number of crates is small compared to the number of drums that are stored in these units.
h) Based on 0.181 grams Pu per drum and 0.63 grams Pu per crate (95th % UCL values) unless otherwise noted.

The non-radiological constituent of the facility source term is estimated to fall below adverse health effect thresholds for the public and collocated worker; resulting in only localized potential consequences. This conclusion is based on the waste forms, containment, and other regulatory controls such as waste code compatibility requirements. Therefore, the non-radiological source term is considered negligible. This is discussed in more detail in Section 4.2.3, *Chemical Hazards*.

Crates located outside the areas designated by the RCRA Permit as the limits of the RCRA Unit are not considered to be part of the materials stored in the RCRA Unit and are not considered as part of the inventory of the RCRA unit.

3 SAFETY MANAGEMENT PROGRAMS

The safety analysis for RCRA Storage Units relies on facility implementation of Site Safety Management Programs (SMPs) as defined in the Rocky Flats Environmental Technology Site Safety Analysis Report (Site SAR), Chapter 6. These SMPs provide specific safety functions assumed in the safety analysis that are either specifically credited or recognized to be important for providing defense-in-depth. All of the identified SMPs and their Key Functional Elements are implemented at a Site level.

The RCRA Storage Units implement the Site-level SMPs using a graded approach based upon the specific hazards identified in Section 4, *Hazard and Accident Analyses*. The facility focuses its graded approach implementation on those specific attributes of the SMPs associated with identified hazards, hazard assumptions, and initial conditions presented in the safety analysis.

3.1 SMP RELATIONSHIP TO HAZARDS AND ACCIDENT ANALYSIS

The following sections delineate the relationship between the various Site-level SMPs and RCRA Storage Unit's current mission operation and the operation's related hazards.

3.1.1 Facility Participation in Site SMPs

Based on the current facility mission and those hazards identified for the facility mission, the facility participates in the following SMPs at a Site level:

- Integrated Safety Management
- Organization and Management
- Configuration Management
- Corrective Action
- Emergency Preparedness
- Engineering
- Environmental Management
- Independent Safety Review and Assessments
- Fire Protection
- Safety and Industrial Hygiene
- Maintenance
- Nuclear Safety[a]
- Occurrence Reporting
- Operations
- Quality Assurance
- Procedures
- Radiation Protection
- Records Management and Document Control
- Training and Qualifications

a. Because the RCRA Storage Units store only LLW, a nuclear criticality accident scenario is deemed incredible due to waste container storage container loading and the form and composition of materials stored (ANSI, 1986).

3.1.2 SMPs Important To Hazard and Accident Analysis

This section describes the SMPs that are applicable to the safe operation of the RCRA Storage Units at Rocky Flats. The following SMP is specifically important to the Section 4, Hazards and Accident Analysis (*e.g.*, identified hazards, hazard assumptions, and initial conditions):

Waste Management:

Attributes of the RCRA Units Waste Management Program focus on protecting human health (*e.g.*, the public and workers), and the environment during facility operations. The facility performs waste management and environmental protection activities, such as routine surveillance and inspections, in accordance with the permit conditions of the Site Resource Recovery and Conservation Act (RCRA) permit (RFETS, 1995a).

4 HAZARDS AND ACCIDENT ANALYSES

This hazard assessment was performed to support the activities described in Section 2 for RCRA Units 1, 10, 13 (Building 884), 15A, 18.03, 18.04, and 24 (Building 964). Standard industrial hazards are controlled by implementation of Site SMPs as applicable, including DOE-prescribed occupational safety and health standards, and are not evaluated further in this safety analysis unless they initiate a release of hazardous materials or worsen the consequences of a hazardous material release. This section determines the final hazard classification from which the operational controls are derived. The methodology described in SARAH (RFETS, 1997a) was followed for this hazard assessment.

4.1 HAZARD IDENTIFICATION

Hazards associated with the RCRA units are identified in Tables 2 and 3. All the hazards in the Table 2 checklist were evaluated to identify those associated with the RCRA units. The identified hazards are indicated with a "yes" and are described in more detail in Table 3, which provides information on quantity, form, packaging, and location of the hazards. As indicated in the remarks column of Table 3, most of the hazards are considered standard industrial hazards. The amounts and types of materials considered for each unit are those permitted by the RCRA Permit (RFETS, 1995a).

Table 2 RCRA Storage Units Hazard Identification Checklist

HAZARD	Yes/No	HAZARD	Yes/No
1. High Voltage	Yes	14. High Intensity Magnetic Fields	No
2. Explosive Substances	No	15. Effects of Chemical Exposures	Yes
3. Cryogenic Systems	Yes	16. Toxic, Hazardous, or Noxious Material	Yes
4. Inert & Low-Oxygen Atmospheres	No	17. Inadequate Ventilation	No
5. Direct Radiation Sources	Yes	18. Material Handling	Yes
6. Radioactive Materials	Yes	19. Ambient Temperature Extremes	Yes
7. High Noise Levels	No	20. Working at Heights	No
8. Flammable Gases, Liquids, Dusts	Yes	21. Pesticide Use	No
9. Compressed Gases	No	22. Lasers	No
10. High Temperature & Pressure Sys	No	23. Inadequate Illumination	No
11. Kinetic Energy	Yes	24. Biohazard	No
12. Potential Energy	Yes	25. Unknown or Unmarked Materials	No
13. Non-Ionizing Radiation Sources	No	26. Any Other Hazards	No

Table 3 RCRA Storage Units Hazard Description

Hazard/ Energy Source	Description	Preventive & Mitigative Features	Remarks
1. HIGH VOLTAGE			
13.8-kV service	Electric supply to heated waste enclosures for freeze protection of liquid wastes at RCRA Units 1 and 10.	- Site Health and Safety Practices (HSPs)	Standard industrial hazard, no further evaluation performed.
3. CRYOGENIC SYSTEMS			
Liquid Nitrogen (LN_2) dewer	LN_2 is used by the Canberra Q^2 Mobile Waste Assay System to cool the Ge detectors.	- Located outside of Canberra trailer and away from conveyor system. - Cryogenic burn hazards during LN_2 filling operations precluded via the use of approved procedures and the proper use of PPE.	Standard industrial hazard, no further evaluation performed. Does not contribute to accident scenarios resulting in a radiological release.
5. DIRECT RADIATION SOURCES			
Sealed check sources: Cs-137, Co-60	Check sources used for Canberra drum counter calibration.	- Standard sealed source packaging.	Sealed sources are exempt from DOE-STD-1027 material-at-risk inventory. Standard industrial hazard, no further evaluation performed.
6. RADIOACTIVE MATERIALS			
Low-level mixed radioactive waste	Solid and/or liquid containerized wastes in all Units. See Section 2.2.3	- On-site shipping containers and/or DOT specification containers.	Radiological Work Permits (RWP) are required for work in areas with radioactive materials. Dosimetry and other controls delineated in RWP, as necessary.
8. FLAMMABLE GASES, LIQUIDS, DUSTS			
A. Some RCRA Wastes	Potential for containerized flammable liquid wastes at all units except 13 and 24. Unlikely at Unit 18.03.	- Spacing and waste compatibility requirements for cargo containers per Part B of RCRA Permit. - Control of ignition sources. - On-site shipping containers and/or DOT specification containers.	Both the RCRA Part B Operating Requirements and the site Fire Protection Program provide controls for this hazard.
B. Diesel Fuel	Fuel used in Canberra tractor during initial staging of the Canberra Q^2 Mobile Waste Assay System.	Short residence time. Tractor is disconnected and removed from RCRA unit subsequent to locating the Canberra Q^2 Mobile Waste Assay System.	Standard industrial hazard, no further evaluation performed. A tractor/fuel fire resulting in a radiological release is not considered credible.

Table 3 RCRA Storage Units Hazard Description

Hazard/ Energy Source	Description	Preventive & Mitigative Features	Remarks
11. KINETIC ENERGY			
A. Vehicular traffic	Traffic both inside and outside units (includes staging of the Canberra Q^2 Mobile Waste Assay System.	- Limited use of kinetic energy barriers. - Training and licensing of drivers, enforcement, and posting.	Standard industrial hazard no further evaluation performed. Low vehicle traffic around most units.
B. Jib crane	Integral to Canberra Q^2 Mobile Waste Assay System, used to move drum into drum counter, 108" hook height.	- Design/factors of safety - Proof testing	Standard industrial hazard; no further evaluation performed.
12. POTENTIAL ENERGY			
Jib crane	Intergral to Canberra Q^2 Mobile Waste Assay System, used to lift drum into trailer, 108" hook height	- Design/factors of safety - Proof testing	Standard industrial hazard; no further evaluation performed.
15. CHEMICAL EXPOSURES			
A. RCRA Wastes	Solid and liquid containerized waste classified as hazardous per RCRA regulations in all Units	- RCRA Operating Permit requirements - Inspections, spill response equipment and procedures. - On-site shipping containers and/or DOT specification containers (drums and boxes).	Exposures from any spills or leaks would not be expected to be significant except potentially during cleanup (recovery). Units are not generally staffed.
B. LN_2	LN_2 is used by the Canberra Q^2 Mobile Waste Assay System to cool the Ge detectors.	- Asphyxiation hazards precluded by independent ventilation system in control rooms.	See also Hazard/Energy Source 3, *Cryogenic System Hazards*.
16. TOXIC OR HAZARDOUS MATERIALS			
RCRA and low-level mixed waste	Solid and liquid containerized wastes in all units.	- Standard RCRA and Radiation Protection Program fully implemented. - On-site shipping containers and/or DOT specification containers.	See also Hazard/Energy Source 15, *Chemical Exposures*.

Table 3 RCRA Storage Units Hazard Description

Hazard/ Energy Source	Description	Preventive & Mitigative Features	Remarks
18. MATERIAL HANDLING			
Drum handling and transportation equipment.	Drums and crates at all units; drum loading/ unloading into Canberra Q^2 Mobile Waste Assay System.	- Physical and administrative controls required by Part B of the RCRA permit. - Proper unloading and loading, transportation handling practices On-site Transportation Manual.	Standard industrial hazard. Part B of the RCRA permit requires planning, training, and equipment for both large and small spills.
19. AMBIENT TEMPERATURE EXTREMES			
Cargo containers and buildings	Both high and low temperature extremes possible at all units	- Heating is provided by electric heaters in areas containing liquid wastes if freezing is a concern. - Regular inspections of areas and containers.	Standard industrial hazard. Unlikely material release initiator. Likely concern when performing breachment or spill cleanup operations due to personal protective equipment requirements.

4.2 ACCIDENT ANALYSIS

Based on the hazards assessment, the release mechanisms for material contained in the RCRA Units are (1) material handling, (2) kinetic energy, (3) fire, (4) the combination of kinetic energy and fire, (5) natural phenomena including earthquake, tornado/high winds, heavy rain/snow, and lightning, and (6) an aircraft crash. Each release mechanism is discussed below.

4.2.1 Scenario Development

Material Handling Scenario

Material handling accidents could occur during both breachment and non-breachment routine operations. This type of spill would be expected to involve no more than four containers (equal to the number of drums which fit on a pallet) and most likely will breech only one. Since these areas are permitted for RCRA and mixed waste, there are concerns regarding exposure to both chemical and radioactive materials. However, consequences from this type of release would be limited to the immediate worker. This is based on the fact that only LLW (assumed to be packaged with less than 0.5 grams Pu/55-gallon drum and less than 3 grams Pu/waste crate) is allowed to be stored in the RCRA Units analyzed in this safety analysis (see Section 5.2, *Inventory Control and Material Management*). Additionally, hazardous chemicals will not be easily released in quantities which could result in airborne concentrations exceeding adverse health effect thresholds due to material form, dilution, stabilization, and packaging (see Section 4.2.3, *Chemical Hazards*). Potential material handling accident scenarios associated with the Canberra Q^2 Mobile Waste Assay System operations are bounded, from a radiological dose consequence perspective, by the scenario discussed above because (1) drums will be loaded into the Canberra Q^2 Mobile Waste Assay System one-at-a-time preventing accidents involving more than one drum, and (2) the system will be used to assay only LLW and LLMW drums.

Material handling accidents involving crates would be limited to one crate because only one crate is moved at a time. The consequences of a crate spill would be limited to the immediate worker based on the small amount of radioactive material present in wastes stored in crates.

Kinetic Energy (Vehicle Impact) Scenario

Kinetic energy poses a potential release mechanism for both small and large spills. The small spill would be comparable to the spill discussed above resulting from material handling. A large spill could result from a high-speed vehicle impact into one cargo container in an outdoor storage area or a storage building. Based on the proximity of roads, Units 1, 10, or 18.03 would be the most vulnerable to a vehicle collision. The vehicle involved would need to be moving at high speed in order to penetrate the perimeter fence and hit a cargo container far enough from a corner to cause a breach (corners of containers are so structurally sound that penetration by a truck impact is considered incredible). It is *extremely unlikely* that more than one cargo container could be impacted and that enough force would be available to breach all the drums within the cargo container. This is considered conservative due to the protection afforded by the container structure and distance from the site roads. Potential vehicle impact accident scenarios associated with the transport/staging of the Canberra Q^2 Mobile Waste Assay System are bounded, from a radiological dose consequence perspective, by the high speed vehicle impact discussed above because (1) slow vehicle speeds associated with the activity preclude a vehicle impact resulting in a radiological release, and (2) training and qualification of the driver.

Clean-up from a large spill would pose the most hazard and potential consequences compared to the initial release due to the intimate handling which would be required. This analysis addresses accidental releases, therefore, evaluating consequences associated with clean-up (recovery) are outside the scope but would be controlled by the RCRA Part B Operating Requirements (RFETS, 1995a).

Vehicle impact to crates stored in RCRA Units 15A and 18.03 are not credible based on the location of the crates. The crates in Unit 15A are separated from the roadway by a drainage ditch and the cargo containers in the unit. Unit 18.03 is surrounded by a chainlink fence with the cargo container storage on the perimeters of the area, and as of April 2000 no wooden crates are stored in this unit.

Fire Scenario

A fire has the potential to result in radiological and toxicological consequences to immediate and collocated workers. Toxicological consequences result from the decomposition products associated with any fire and are particularly significant when hazardous materials are involved. A fire originating in a cargo container would not be expected to cause any significant impact to adjacent cargo containers or contents. The exception would be cargo containers storing flammable or ignitable material. The RCRA Permit Part B Operating Requirements specifically address this issue and requires minimum spacing between cargo containers storing ignitable or flammable wastes (RFETS, 1995a).

Potential fire scenarios associated with the transport/staging or operation of the Canberra Q^2 Mobile Waste Assay System are bounded, from a radiological dose consequence perspective, by the cargo container fire discussed above. Controls that preclude fires include (1) loading drums into the Canberra Q^2 Mobile Waste Assay System one-at-a-time with no waste container staging at/near the Canberra trailer, (2) smoke detectors and fire extinguishers mounted in the Canberra trailer, and (3) approved Material Stewardship and Canberra operating procedures.

Potential fire scenarios involving the wooden crates stored in the RCRA units are assumed to involve all crates stored in a single waste storage group. A minimum 30-foot separation between groups of wooden waste crates provides reasonable assurance that two or more groups will not interact during a fire (RFETS, 1998a). Limiting the total quantity of fissile material in a single group of crates to less than 8.4 grams plutonium mitigates the consequences of a fire involving all containers in the group (see Section 5.2, *Inventory Control and Material Management*).

Kinetic Energy and Fire Combination

A scenario combining the kinetic energy and fire hazards could occur with a vehicle accident. This scenario involves a high-speed vehicle impact into one cargo container in an outdoor storage area resulting in a fire. The conditions for vehicle impact would be the same as an impact without fire. The duration of the fire is qualitatively evaluated to be of short duration due to the limited supply of fuel in vehicles on the site. Impact by a fuel tanker with a subsequent fire is not considered credible. Fires involving the contents of a fuel tanker are usually related to tank refueling activities and therefore are not considered here. For Buildings 884 and 964, the damage from a vehicle crash would be to building structure and to the drums immediately adjacent to the point of impact. Buildings 884 and 964 are not in close proximity of main roads and/or have natural or physical barriers between them and the roads, such as a drainage ditch and fences. Potential accident scenarios involving a high-speed vehicle impact into the Canberra Q^2 Mobile Waste Assay System trailer resulting in a fire and subsequent radiological release is bounded, from a radiological dose consequence perspective, by the high-speed vehicle impact into one cargo container discussed above because (1) physical separation between the Canberra trailer and RCRA Unit 1 prevents the involvement of multiple drums, and (2) drums will be loaded into the Canberra Q^2 Mobile Waste Assay System one-at-a-time with no waste container staging at/near the Canberra trailer minimizes material involvement.

Kinetic energy scenarios resulting in fire involving wooden crates is not considered to be credible because of the locations of the crates with respect to the cargo containers in the same unit. The cargo containers would be most likely impacted, protecting the crates.

Earthquake

An earthquake is credible at the Site and considered to result in a spill scenario. The waste stored in Buildings 884 (Unit 13) and 964 (Unit 24) can be impacted during an earthquake two ways: (1) full collapse of the facility creates debris that can fall onto exposed waste drums, and (2) third and fourth tier drums may topple. RCRA Units 13 and 24 are the only two units considered to be impacted by an earthquake. Waste drums may be stacked three high in Unit 13 and four high in Unit 24. The other RCRA Units store 55-gallon waste drums in a single planar array inside cargo containers (a second layer of 10-gallon drums may be stacked on top of the 55-gallon drums). Any toppling and breaching of drums stored inside cargo containers, which is not considered likely, would be bounded by the earthquake scenario postulated to affect RCRA Units 13 and 24. Wooden waste crates are permitted to be stacked at several of the RCRA Units including Units 13, 15A, 18.03, and 24. However, due to the footprint and weight of wooden waste crates they are much less susceptible to toppling during an earthquake than drums and are assumed to remain intact and not breach. Therefore, they are not considered in the earthquake scenario.

Tornado/High Winds

Tornado and high wind scenarios are judged to be bounded by the earthquake caused spill scenario based on the following qualitative assumptions (1) the low mass of the facility structure will not exert enough impact forces to create a drum breach, and (2) tornado and high winds forces will not result in toppling more drums than assumed in the postulated earthquake scenario. The number of drums assumed to topple during the postulated earthquake scenario is 140 (see Section 4.2.2).

Heavy Rain

A load can be applied to the roof of Building 884 (Unit 13) or Building 964 (Unit 24) due to the amount of rainfall and/or ponding. Ponding of water on the roofs of Buildings 884 and 964 is not a concern since the roofs are adequately sloped. Heavy rain events are not further analyzed.

Heavy Snow

A scenario involving structural damage to the roofs of Building 884 (Unit 13) or Building 964 (Unit 24) due to snow loads exceeding the design capability could result in a spill scenario. The accident consequences are considered bounded by the earthquake initiated spill scenario discussed earlier. Heavy snow scenarios are not further analyzed.

Lightning

Lightning is considered a potential ignition source for fire scenarios. Each cargo container in the RCRA units is required to be fitted with an electrical ground per the Site RCRA Permit. A lightning strike to a cargo container stored at RCRA units 1, 10, 15A, 18.03, and 18.04 is not expected to ignite a fire because (1) a lightning strike would be dissipated to ground through the exterior of the cargo container to the electrical ground conductor, and (2) flammable/combustible materials are packaged in 55-gallon drums within the cargo containers. If a lightning strike to wooden waste crates were to occur, limiting the available MAR to less than 8.4 grams Pu per waste storage group and separating the groups by 30 feet mitigates the radiological dose consequences. A lightning strike to the exterior of Building 884 or Building 964 is expected to dissipate to ground through the corrugated metal roof and siding of these buildings. If a fire were initiated, it is assumed that it would be bounded by the aircraft crash scenario discussed below.

Aircraft Crash

The frequency of occurrence for a small aircraft crash as a function of target area has been analyzed in Emergency Preparedness Technical Report, 97-EPTR-004, *Analysis of Aircraft Crash Accidents at the Rocky Flats Environmental Technology Site* (RFETS, 1997b). In terms of frequency, the greatest numbers of aircraft are represented by the small plane category associated with the Jefferson County (Jeffco) Airport due to its operational volume and the closeness to the Site (RFETS, 1996b). The crash of a large aircraft at the Site is screened out as a possibility (RFETS, 1997b). Denver International Airport and the J-60 Jet Route are also screened out from the analysis using the methodology of DOE Standard 3014-96, *Accident Analysis for Aircraft Crash into Hazardous Facilities* (DOE, 1996), because the airport is more than 12 miles from the Site and the center of the jet route is more than six miles from the Site. The technical report concludes that the accident frequency involving Site facilities has been determined to be 7.67×10^{-4} accidents/square mile-year for a small single engine aircraft weighing 6,000 lbs. or less. Using the methodology specified in DOE-STD-3014-96, the frequency of occurrence of an aircraft crash into any one of the RCRA Units analyzed in this safety analysis has been determined to be *extremely unlikely* (10^{-4} - 10^{-6} events/yr). The aircraft crash frequencies per year for each RCRA Storage Unit are shown in Table 4. The frequency calculation methodology is presented in Attachment A.

Table 4 RCRA Storage Units Aircraft Crash Frequencies

RCRA Unit	Length, ft	Width, ft	Height, ft	Effective Area, mi^2	Crash Frequency per Year
1	169	100	8	2.10E-03	1.61E-06
10	106	106	8	1.63E-03	1.25E-06
13 (Bldg. 884)	80	38	20	1.39E-03	1.06E-06
15A	296	66	8	2.62E-03	2.10E-06
18.03	275	120	8	3.26E-03	2.50E-06
18.04	120	60	8	1.33E-03	1.02E-06
24 (Bldg. 964)	163	40	20	2.19E-03	1.68E-06

4.2.2 Accident Scenario Source Terms

Based on the maximum permitted capacities and the estimated maximum number of 55-gallon drum equivalents and crates that can be stored at each RCRA unit, shown in Table 1, a total estimated inventory of plutonium can be determined. All the estimated total inventories shown in Table 1 exceed the DOE-STD-1027-94 (DOE, 1992) nuclear Hazard Category 3 lower threshold; however, due to the configuration of storage (*i.e.,* in cargo containers and/or spacing) and the location of the units, only a fraction of the total inventory would be considered releasable in the event of an accident. The major initiators or energy sources for accidents at RCRA storage units are (1) vehicle impacts, (2) an earthquake, and (3) an aircraft crash. The source terms for each accident type are developed in the following paragraphs.

Vehicle Impacts

Based on the configuration of the RCRA units, a "waste storage group" is identified that is considered to be the maximum number of containers that would be involved in a vehicle accident. For drums, it is conservatively estimated that 50% or less of the containers in the waste storage group would be involved, based on the stout construction of cargo containers and the cushioning effect of arrays of drums in buildings. A damage ratio of 0.1 is applied. This damage ratio is for an impact by a vehicle moving between 30 and 55 miles per hour (mph) (RFETS, 1998b). For crates, a waste storage group would include all crates not separated by 30-feet or more from other stored RCRA wastes. For crate spills due to vehicle impact, ten containers are conservatively assumed to be involved and a 1.0 damage ratio is applicable based on the susceptibility of wooden waste crates to impact damage. Fire scenarios involving crates would impact all the containers in the waste storage group with a damage ratio of 1.0. Applying these factors to the waste storage group inventory provides the available MAR for accidental releases from each RCRA unit. The available MAR during vehicle impacts is given in Table 5. Because the available MAR is less than the Hazard Category 3 limit of 8.4 grams Pu and assuming no interaction between waste storage groups, the radiological dose consequences associated with a vehicle impact accident are expected to be *low.* A vehicle impact into two wooden waste crates (conservatively assuming each are packaged with 3 grams plutonium) and an ensuing fire of unconfined combustible material also results in *low* consequences (0.30 rem) to the collocated worker and *low* consequences (0.009rem) to the maximum exposed off-site individual (MOI). The 3 grams plutonium per crate is the maximum allowable amount for a full-size wooden waste crate (RFETS, 1997a) and is more appropriate for modeling a two crate accident than using the 95th % UCL value. The risk class to the collocated worker and the MOI is Risk Class IV (*extremely unlikely* frequency, *low* consequence). The accident consequence calculations using Radiological Dose Template (Radidose) Version 1.3 (RFETS, 2000) are presented in Attachment A.

Table 5 Maximum RCRA Storage Units Available MAR

RCRA Unit	Number of drums and crates per waste storage group	Estimated inventory per waste storage group, g Pu	Available MAR per waste storage group, g Pu
VEHICLE IMPACTS (waste storage group defined by RCRA storage configuration)			
1	60 55-gallon drums 60 10-gallon drums	22	1.1[b]
10	60 55-gallon drums 60 10-gallon drums	22	1.1[b]
13	90 55-gallon drums	17	0.85[b]
15A	40 55-gallon drums 40 10-gallon drums 13 crates	15 7	0.7[b] 7[c]
18.03	40 55-gallon drums 40 10-gallon drums 13 crates	15 7	0.7[b] 7[c]
18.04	40 55-gallon drums 40 10-gallon drums	15	0.7[b]

Table 5 Maximum RCRA Storage Units Available MAR Continued

RCRA Unit	Number of drums and crates per waste storage group	Estimated inventory per waste storage group, g Pu	Available MAR per waste storage group, g Pu
24 (Bldg. 964)	112 55-gallon drums 7 crates	56 (112 drums × 0.50 g/drum[d]) 5	2.5[b] 5
EARTHQUAKE (waste storage group includes entire RCRA Unit inventory)			
1	2,242 55-gallon drums	406	not analyzed, no drum stacking
10	380 55-gallon drums	69	not analyzed, no drum stacking
13	1,008 55-gallon drums	182	6[c]
15A	1,300 55-gallon drums 158 crates	235 100	not analyzed, no drum stacking
18.03	1,680 55-gallon drums 400	304 252	not analyzed, no drum stacking
18.04	680 55-gallon drums	123	not analyzed, no drum stacking
24 (Bldg. 964)	2,240 55-gallon drums 7 crates	1,120 (2,240 drums × 0.50 g/drum[d]) 5	34[e] do not contribute to available MAR
AIRCRAFT CRASH (waste storage group defined by RCRA storage configuration)			
1	60 55-gallon drums 60 10-gallon drums	22	44 (2 cargo/group involvement)
10	60 55-gallon drums 60 10-gallon drums	22	44 (2 cargo/group involvement)
13	--	--	87 (480 drums × 0.181 g/drum)
15A	40 55-gallon drums 40 10-gallon drums 13 crates	15 7	44 (3 cargo/group involvement)
18.03	40 55-gallon drums 40 10-gallon drums 13 crates	15 7	44 (3 cargo/group involvement)
18.04	40 55-gallon drums 40 10-gallon drums	15	44 (3 cargo/group involvement)
24 (Bldg. 964)	112 55-gallon drums 7 crates	56 (112 drums × 0.50 g/drum[d]) 5	240 (480 drums × 0.50 g/drum[d])

a) Based on 0.181 grams Pu per waste drum (based on the 95[th] % UCL value for 55-gallon waste drums) and 0.63 grams Pu per crate (95[th] % UCL values) unless otherwise noted.
b) Assuming 50% involvement and a 0.1 damage ratio.
c) Based on ten crates containing 0.63 grams Pu per crate assuming 100% involvement and a 1.0 damage ratio.
d) The 0.50 g/drum value is the assumed quantity of Pu per 55-gallon drum.
e) Based on a 0.03 damage ratio.

Earthquake

The bounding earthquake scenario is postulated to involve a beyond design basis earthquake resulting in a material spill and radiological release in Building 964. Building 964 is the bounding case because the maximum permitted capacity is greatest in Building 964 and an earthquake is not expected to significantly impact waste stored in cargo containers at other RCRA units. The likelihood of this postulated accident scenario is judged to be *unlikely* based on the following considerations: (1) the occurrence frequency of a design basis earthquake is 1.2×10^{-3} per year and is considered to be an *unlikely* event, and (2) the occurrence frequency of a beyond design basis earthquake would be less than 1.2×10^{-3} per year but is still in the *unlikely* frequency bin. Building 964 is a wooden frame building with corrugated metal siding and roof panels. Its low mass is not expected to result in significant damage to impacted waste drums.

The waste stored in Building 964 is impacted by a beyond design basis earthquake in two ways: (1) full collapse of the facility creates debris which can fall onto exposed waste drums and lead to a breach of a small fraction of the drums, and (2) upper tiers drums (third or fourth tiers) may topple and drop more than four feet resulting in a breach of a fraction of the drums.

It is assumed that the exposed drums (drum lids exposed to the ceiling) in the facility will be impacted by debris from the collapse of the building. Of the drums subjected to falling debris, it is judged that none will be breached to the point of losing confinement because the low mass of the building structure (two by four framing and sheet metal panels) combined with the debris fall height (approximately 8 feet) will not significantly damage waste drums nor cause them to topple.

It is assumed that upper tier drums (3rd or 4th tiers) may topple during the beyond design basis earthquake. It is conservatively assumed that 25% of the drums on the upper tiers of stacks are subject to falling from the top of the stack. The 25% value is based on engineering judgment and is believed to be conservative since: (1) stacked drums are not susceptible to falling except for very large earthquakes (it is not expected that stacks of boxes or drums will fall under ground accelerations below 0.3g,) (S&W, 1991) and (2) the upper tier drums (above two high) are banded reducing the likelihood of drums falling during an earthquake. Of the drums subjected to falling from the upper tiers, it is assumed that 25% of the drums are breached to the point of losing confinement of radioactive material contents (failure of drum and internal packaging). The 25% value is also based on engineering judgment and takes into account the strength of the drums, the assumption that a single drum in the four banded set is subject to damage from the crushing weight of the other three drums in the banded set, and the limited amount of room available for upper tier drums to fall onto the floor (other drums in the way or limited aisle space). A rigid liner and polyurethane bag provide additional resistance to internal package breaching resulting in a material release. However, it is conservatively assumed that 100% of the material from the breached drums will be released as the internal packaging may have degraded due to the presence of hazardous chemicals. Drum breaches due to toppling are analyzed as confined material releases. A ground-level (non-lofted) release of the radioactive material is assumed. The spill is a short duration event and a minimum release duration (10 minutes) is analyzed. A concurrent fire, caused by the earthquake, is not considered due to lack of ignition sources during an earthquake.

The total number of 55-gallon waste drums that can be stored in Building 964 is 2,240 when stacked four high. This number is based on the maximum waste capacity as specified in the RCRA permit (see Table 1). The total number of upper tier drums (3rd or 4th tiers) is estimated to be 1,120 drums based on the typical storage configuration shown in Figure 9. Taking 25% of the upper tier drums as falling and 25% of the falling drums having the drum fail yields approximately 70 drums that fail due to falling. All 70 drums are conservatively assumed to release their entire contents. The resulting overall equivalent damage ratio is approximately 3% (70 drums out of 2,240).

The maximum Pu gram loading for LLMW drums (rounded up) is 0.50 grams/drum (RFETS, 1997a). This value is used rather than the 95th % UCL value because, based on process knowledge of the primary waste type stored in Building 964 (solidified bypass sludge, IDC 807), the radiolonuclide quantity is closer to the upper limit of 0.50 grams than it is to the 0.181 95th % UCL value. Therefore, the available MAR during an earthquake caused spill scenario is assumed to be 34 grams WG Pu (2,240 drums × 0.03 × 0.50 grams Pu/drum).

The accident consequence calculations are presented in Attachment A. The scenario modeling assumptions are summarized as follows: earthquake caused spill; confined material release; 10 minute release duration; nearest public receptor, defined as the MOI, located at 2,168 meters; *extremely unlikely frequency*; 2,240 LLMW drums; aged WG Pu; 1,120 grams total MAR; Solubility Class W Dose Conversion Factor; DR = 0.03. The radiological dose consequences are *low* (0.12 rem) to the collocated worker and *low* (0.00098 rem) to the MOI. The risk class to the collocated worker and MOI is Risk Class III (*unlikely* frequency, *low* consequence). In the event of an earthquake, the normally unoccupied Building 964 would be evacuated if it were occupied. The major hazard to facility personnel, if they were present and unable to exit the building, would be falling building structure and toppling drums rather than the radiological release. A *high* consequence is assigned to the immediate worker due to the physical consequences of the earthquake and a *low* consequence is assigned based on the postulated radiological release.

The earthquake scenario for Building 964 assumed a maximum quantity of MAR (1,120 grams Pu) based on the maximum permitted capacity specified in the RCRA permit. Because the radiological dose consequences are *low* to both the collocated worker and MOI, based on the waste type stored in the building, a material inventory limit of 900 grams Pu (the lower threshold for a Hazard Category 2 Nuclear Facility) has not been imposed.

Aircraft Crash

A small single engine aircraft weighing 6,000 pounds or less with 200 gallons of fuel on board is postulated to crash into a single RCRA Storage Unit. Based on this size aircraft, a kinetic energy trade-off calculation (RFETS, 1996d) estimated that the energy required to stop the aircraft was equal to the energy required to severely damage 70 drums. The calculation took no credit for absorbing any energy when crashing through building walls (or cargo containers), friction loss, or pushing any drum stacks back. Therefore, the 70 drum number is considered a very conservative estimate. Upon impact into a RCRA Unit, an ensuing fire would have an average burn area of 250 ft^2 per 50 gallons of spilled fuel. Therefore, the burn area for the entire 200 gallons is estimated to be 1,000 ft^2 (Hughes, 92).

A radiological release due to an aircraft crash consists of three elements each contributing to the calculated radiological dose (1) a spill of the 70 severely damaged drums due to the aircraft impact, (2) a 1,000 ft^2 fuel pool fire burning the unconfined contents of the 70 spilled drums, and

(3) the pool fire involving 410 additional drums as a confined material release (the drums are involved in the fire but were not significantly damaged by impact). Three cases were evaluated:

Case 1: Unit 13 (Building 884) – For Building 884 it is postulated that an aircraft crashes into a side of the building resulting in damage to 70 drums spilling their contents. An airborne release fraction (ARF) of 1.0E-03 and a respirable fraction (RF) of 0.1, are appropriate when modeling the spill portion of the scenario (DOE, 1996). Assuming that a subsequent fuel pool fire occurs, the 70 damaged drums are involved as unconfined combustible material. Because of the size of the pool fire, assuming an aircraft fuel load of 200 gallons, 410 additional drums are assumed to be involved as confined material. ARFs of 5.0E-02 for unconfined combustible materials and 5.0E-04 for confined material and an RF of 1.0 are appropriate when modeling the fire portion of the scenario (DOE, 1996). The total effective MAR for this scenario is 87 grams WG Pu (480 drums × 0.181 grams/drum). The distance to the MOI is 1,812 meters. The fuel pool fire is assumed to burn hot and fast and is therefore modeled as a lofted plume with a release duration of 10 minutes. The accident consequence calculations are presented in Attachment A. The accident consequences are summarized in Table 6 along with the scenario risk class.

Case 2: RCRA Units 1, 10, 15A, 18.03, and 18.04 – At RCRA Units that store waste in outdoor cargo containers, it is assumed that the aircraft directly impacts three 40 foot × 8 foot cargo containers or two 40 foot × 12 foot cargo containers with a total drum inventory of 240 drums (assumed to be 120 55-gallon drums and 120 10-gallon drums). One hundred and twenty of the drums (70 55-gallon drum equivalents by volume) are assumed to be breached spilling their contents. An ARF of 1.0E-03 and an RF of 0.1, are appropriate when modeling the spill portion of the scenario (DOE, 1996). Assuming that a subsequent fuel pool fire occurs, the 120 damaged drums are involved as unconfined material. The remaining drums (120 drums) are assumed to be involved in the fire as confined material. ARFs of 5.0E-02 for unconfined combustible materials and 5.0E-04 for confined material and an RF of 1.0 are appropriate when modeling the fire portion of the scenario (DOE, 1996). The total effective MAR for this scenario is 44 grams WG Pu (240 drums × 0.181 grams/drum). The distance to the MOI is 1,636 meters. The fuel fire is assumed to burn hot and fast and is therefore modeled as a lofted plume with a release duration of 10 minutes. The accident consequence calculations are presented in Attachment A. The accident consequences are summarized in Table 6 along with the scenario risk class.

Case 3: Unit 24 (Building 964) - For Building 964 it is postulated that an aircraft crashes into a side of the building resulting in damage to 70 drums spilling their contents. Since the majority of the waste type stored in Building 964 is solidified bypass sludge (a cement/concrete like aggregate), an ARF of 1.0E-03 and an RF of 0.001 are appropriate when modeling the spill portion of the scenario (DOE, 1996). Assuming that a subsequent fuel pool fire occurs, the 70 damaged drums are involved as unconfined combustible material. Because of the size of the pool fire, assuming an aircraft fuel load of 200 gallons, 410 additional drums are assumed to be involved as confined material. Since the majority of the waste type stored in Building 964 is solidified bypass sludge, an ARF of 6E-03 and an RF of 0.01 are appropriate when modeling the fire portion of the scenario (DOE, 1996). The total effective MAR for this scenario is 211 grams WG Pu (480 drums × 0.44 grams/drum). The distance to the MOI is 1,812 meters. The fuel fire is assumed to burn hot and fast and is therefore modeled as a lofted plume with a release duration of 10 minutes. The accident consequence calculations are presented in Attachment A. The accident consequences are summarized in Table 6 along with the scenario risk class.

Table 6 RCRA Storage Units Aircraft Crash Accident Consequences

RCRA Unit	Radiological Dose Consequence (rem)		Risk Class	
	CW	MOI	CW	MOI
13 (B884)	0.86	0.02	IV	III/IV[a]
1, 10, 15A, 18.03, & 18.04	1.49	0.04	IV	III
24 (B964)	0.014	0.0002	IV	IV

a. The radiological dose to the MOI is at the *moderate* threshold and therefore the Risk Class is borderline Risk Class III/IV.

4.2.3 Chemical Hazards

The accident consequence levels for accidents involving identified chemicals and hazardous materials are summarized in Table 7. Concerns associated with the non-radiological hazardous constituents of waste include exceeding adverse health affect thresholds, unplanned chemical reactions, challenging waste container integrity, and environmental impact.

A qualitative determination was made of the consequence levels for accidents involving storage unit waste inventories. This was necessary because complete and accurate characterization data are not available for all of the waste types potentially present in the storage units and the fact that the waste inventory will continuously change. Existing engineered and administrative controls mandated by RCRA regulations are credited as preventive and mitigative measures for controlling chemical hazards associated with RCRA wastes. Specific regulatory controls placed on RCRA container storage areas are documented in the *Rocky Flats Plant RCRA Permit and Compliance Document* (RFETS, 1995a).

Containerized wastes include those packaged in standard containers such as 10-gallon drums, 55-gallon drums, TRUPACT II SWBs, ATMX boxes, and wooden crates. Containerized wastes that can be characterized as "RCRA non-hazardous" have been eliminated from further evaluation based on their non-hazardous designation. The presence of Toxic Substances Control Act (TSCA) wastes that may or may not be designated as RCRA hazardous waste are discussed separately below. Accident consequence levels for accidents involving RCRA non-hazardous wastes (excluding TSCA wastes) have been judged to be *insignificant*. The presence of these non-hazardous wastes do not present any potential safety or health hazards such as fire, explosion, or chemical exposure above the normal conditions in the storage units.

For containerized wastes categorized as RCRA hazardous, it is not always possible to determine exact chemical quantities since the actual chemical constituents are not always known and the waste inventories will continuously change. A *low* accident consequence has been qualitatively assigned to *anticipated* accident scenarios involving RCRA containerized waste that result in the release of the contents of a single container. This determination is based on the fact that for those waste storage containers analyzed to date (approximately 20% of the various types of waste containers present on site), no ERPG fraction for an individual container has exceeded 1.0. Typical ERPG fractions (at a distance of 1,900 meters), for fire and spill scenarios, involving specific IDCs range from 10^{-13} to 10^{-4} per Nuclear Safety Calculation 96-SAE-006 (RFETS, 1996a). A *low* accident consequence has also been assigned to *unlikely* and *extremely unlikely* accident scenarios involving RCRA containerized waste which result in the release of the contents of multiple containers. This *low* accident consequence has been qualitatively assigned based on multiple containers of multiple IDCs being breached and the low possibility of exceeding unity when summing the individual fractions for ERPG-2 at 1,900 meters or ERPG-3 at 100 meters. This low possibility is assumed based on the relatively small number of waste containers that will be present in individual cargo containers (or in groupings in buildings, separated by aisles), the number of waste containers involved in the bounding accident scenarios, and the very small ERPG fractions determined in Nuclear Safety Calculation 96-SAE-006 (RFETS, 1996a) for analyzed waste IDCs typically stored at RFETS.

Containerized wastes with Toxic Substances Control Act (TSCA) regulated Polychlorinated Biphenyls (PCBs) could also be present in the storage units. Site PCB wastes include liquid PCB waste forms (oil with PCBs and fluorescent light ballasts) and solid PCB waste forms (drained PCB equipment, rags, debris, or soils). Liquid PCB waste forms include IDC 533 (PCB liquids with hazardous constituents), IDC 970 (PCB liquids without hazardous constituents), IDC 971 (PCB fluorescent light ballasts), and IDC 973 (PCB transformers/ capacitors). Solid PCB waste forms include IDC 972 (miscellaneous PCB debris). A *low* accident consequence has been assigned to accident scenarios involving containerized wastes with PCB liquids based on the small number of containers of these IDCs present at the Site. The ERPG-2 and ERPG-3 fractions for IDC 970 range from 10^{-8} to 10^{-5} for various accidents (e.g., fire or spill) and container types per Nuclear Safety Calculation 96-SAE-006. With ERPG fractions in this range, it would require a release from many containers to exceed the *low* accident consequence level. The storage of TSCA regulated waste meets all applicable requirements of the *TSCA Management Plan* (RFETS, 1993).

Table 7 Chemical Evaluation Summary

CHEMICAL OR CHEMICAL SOURCE	ACCIDENT CONSEQUENCE LEVEL[a]		
	MOI	Collocated Worker	Immediate Worker
RCRA Hazardous Containerized Waste (release of a single container)	Moderate - Low	Moderate - Low	High - Low
RCRA Hazardous Containerized Waste (release of multiple containers)	Moderate - Low	Moderate - Low	High - Low
TSCA Polychlorinated Biphenyl (PCB) Containerized Waste (potentially present)	Low	Low	Low

a. Accident consequence levels vary based on the quantity of liquid chemicals present in RCRA waste.

As previously mentioned, in most cases, the actual hazardous chemical constituent levels of individual waste containers are not accurately known. There is a continuing effort at RFETS to document waste characterization information for backlog waste. Backlog waste is all the waste currently in the RFETS inventory. This program is intended to provide information regarding the hazardous nature of all backlog waste at RFETS which is documented in the Backlog Waste Reassessment Baseline Book (BWRBB) (RFETS, 1995d). Past Nuclear Safety efforts to determine the quantities of hazardous chemicals present in RCRA regulated wastes are based on process knowledge documented in the BWRBB. These past evaluations have resulted in safety analyses involving wastes using conservative estimates of the worst possible chemical constituent. From a safety analysis perspective, this provides both conservative source terms and consequences.

For facilities that have both radiological and chemical hazards in solid, non-liquid, waste forms (i.e., IDCs that contain free liquids in quantities less than approximately 4 liters), the radiological consequences dominate any significant hazardous chemical release. This has been shown in the analysis for other waste storage facilities at RFETS (RFETS, 1995b, 1995c), which have documented that even with conservative analysis, adverse health affect thresholds for the public and collocated worker are not exceeded for facilities containing waste representative of the current backlog.

For facilities, such as RCRA Unit 1, that store liquid waste forms (containers with chemical quantities greater than 4 liters), it is judged that a chemical release could result in adverse consequences to the MOI, collocated worker, or immediate worker due to inhalation, or absorption in the case of the immediate worker, depending on the quantity and toxicity of the chemical(s) released. Release mechanisms include those accident scenarios addressed earlier for radiological releases as well as a release due to a drum handling accident at the Canberra Q^2 Mobile Waste Assay System trailer. A liquid chemical release at a RCRA unit is estimated to involve multiple drums based on (1) the amount of liquid chemical waste stored within a single RCRA unit, and (2) the likelihood of such an inventory being involved in a postulated accident scenario previously discussed. A maximum of five 55-gallon drums are judged to be involved/breached based on the assumptions discussed for the kinetic energy (vehicle impact) scenario. A liquid chemical release at the Canberra Q^2 Mobile Waste Assay System trailer, due to a drum drop or puncture, would involve only a single drum since drums will be handled and assayed one-at-a-time. A single drum accident at the Canberra trailer would be bounded by a chemical release scenario at a RCRA unit.

A *moderate* to *low* accident consequence level has been qualitatively assigned to the MOI based on the quantities of chemicals, that if spilled, could result in an airborne release that migrates to the MOI. Secondary containment and/or spill response procedures are credited to effectively mitigate releases. Secondary containment, such as a berm or a catch pan, reduces the surface area of the chemical spill/puddle, which in turn reduces the evaporation rate, and subsequently reduces the amount of chemical that becomes airborne. Similarly, the use of absorbent packaging materials is credited to reduce the quantity of material that becomes airborne. Timely spill response is credited to reduce the release duration, which also reduces the amount of chemical that becomes airborne. By crediting these controls, a *moderate* to *low* accident consequence can be assigned.

A *moderate* to *low* accident consequence level has also been assigned to the collocated worker as a result of a chemical release at a RCRA unit or at the Canberra trailer. Secondary containment and/or spill response procedures are credited to effectively mitigate releases that could affect the collocated worker. In addition, emergency response actions, including use of the LS/DW system and sheltering in place practices, will further mitigate the accident consequences to the collocated worker.

A *high* to *low* accident consequence level has been qualitatively assigned to the immediate worker in close proximity to a chemical release at a RCRA unit or at the Canberra trailer. An immediate worker exposed to a spill of a highly toxic chemical could easily be exposed to airborne concentrations, at or near the point of release, that exceed short-term exposure guidelines such as Permissible Exposure Limit-Ceiling (PEL-C), Immediately Dangerous to Life or Health (IDLH), or Threshold Limit Value-Ceiling (TLV-C). Exceedance of any of these thresholds can result in adverse health effects to the immediate worker. For this reason a *high* consequence level is assigned to the immediate worker. For a smaller spill or a spill of a less toxic chemical, the accident consequences would be less severe.

Credited controls discussed in the previous paragraphs are specified in the RCRA Permit Part B Operating Requirements.

Chemical hazards associated with wastes stored in crates would be bounded by the liquid chemical wastes in drums.

4.3 WORKER SAFETY EVALUATION

The consequences of spills associated with wastes stored in the RCRA units evaluated in this safety analysis range from *low* to *high* for immediate and collocated workers depending on response actions taken. Material handling poses the most hazard for immediate workers as routine operations include both breachment and non-breachment activities. The Operating Requirements contained in the RFETS RCRA Part B Permit have many provisions for addressing response to, mitigation of, and prevention for these types of releases. Some of these requirements include emergency equipment, training, personal protective equipment, and facility conditions. Other controls include Radiation Work Permits and Integrated Work Control Process to delineate monitoring and controls for specific work.

Controls related to preventing the occurrence of scenarios caused by vehicle collisions are access and physical barriers (*e.g.,* concrete, chain link fence, and natural). These controls are discussed in the RCRA Permit, Part B Operations Instructions. The RCRA Units are generally unoccupied so affected workers may be limited to only vehicle drivers and material handlers.

Fire hazards are controlled by separating materials, controlling combustibles, and limiting ignition sources. All of these conditions are required by the RCRA Permit, Part B Operating requirements and the site Fire Protection Program. Fire hazards related to wooden waste crates stored at RCRA units are controlled by limiting transient combustibles in the area and the site Fire Protection Program. Consequences resulting from a crate fire are mitigated by limiting the quantity of fissile material to below of 8.4 grams plutonium per waste storage group. By limiting the quantity of fissile material to less than 8.4 grams plutonium, the consequences to the collocated worker in the event of a fire, assuming a confined material release, would be *low*.

Worker safety issues associated with the operation of the Canberra Q^2 Mobile Waste Assay System are addressed in the Canberra system safety analyses and the Health and Safety Plan.

4.4 FINAL HAZARD CLASSIFICATION

Based on the maximum possible radioactive material inventory and results of the accident analysis in Section 4.2, the RCRA Units within the scope of this safety analysis are categorized as Hazard Category 3 Nuclear Facilities per DOE-STD-1027-92. The Canberra Q^2 Mobile Waste Assay System/Trailer is classified as a non-nuclear facility/activity.

4.5 DERIVATION OF OPERATIONAL CONTROLS

Based on the hazards and relatively low risks associated with the RCRA Storage Units, no safety structures, systems, and components (SSCs) are relied upon to protect the collocated worker and/or the public. Therefore, no Limiting Conditions for Operation (LCOs) have been written for the RCRA Storage Units.

The operational controls derived for the RCRA Storage Units consist only of Administrative Controls (ACs) addressing (1) organization and management, (2) inventory control and material management, and (3) safety management programs (SMPs). This set of administrative controls provides (a) worker safety based on standard industrial hazards and (b) defense-in-depth.

5 OPERATIONAL CONTROLS

The following Administrative Controls (ACs) maintain the validity of this safety analysis and assure the continued safe operations of the RCRA Storage Units including use of Canberra Mobile Waste Assay Systems/Trailers.

DEFINITIONS

NOTE
The defined terms of this section appear in capitalized type throughout the ACs.

TERM	DEFINITION
ADMINISTRATIVE CONTROLS (ACs)	Provisions relating to organization and management, inventory control and material management, and safety management programs necessary to ensure the safe operations of the RCRA STORAGE UNITS.
BASIS/BASES	Summary statement(s) of the rationale for the OPERATIONAL CONTROLS. The BASES explain how the numeric value, the specified function, or the surveillance fulfills the credited safety function assumed in the safety analysis.
CREDITED PROGRAMMATIC ELEMENT	A functional (performance language) statement depicting analytical assumptions embodied in safety analysis specific to a given program. These functional statements relate to assumptions that determine the progression of accident scenarios.
NUCLEAR MATERIAL	Includes Special Nuclear Material (enriched uranium, uranium-233, uranium-235, or plutonium), americium, or neptunium in quantities of one gram or more. It does not include natural uranium, depleted uranium, contamination, or sealed sources.
RCRA STORAGE UNITS	RCRA Storage Units 1, 10, 13 (Building 884), 15A, 18.03, 18.04, and 24 (Building 964).
REQUIRED ACTIONS	The mandatory response when an AC specific control or restriction cannot be met.
OPERATIONAL CONTROLS	OPERATIONAL CONTROLS define the ACs and BASES thereof necessary to reduce the potential risk to the workers from the uncontrolled release of radioactive or other hazardous materials.
VIOLATION	A VIOLATION of an OPERATIONAL CONTROL can occur as a result of an AC VIOLATION, as defined by AC 5.0.4.

5.0 USE AND APPLICATION

AC 5.0 General Application

AC 5.0 only applies to individual failures against CREDITED PROGRAMMATIC ELEMENTS in AC 5.1 and AC 5.2 and does not apply to other aspects of SMPs in AC 5.3.

AC 5.0.1 ACs Shall Be Met At All Times, Unless Otherwise Specified

AC deviations may occur at three levels: individual failures, programmatic deficiencies, and AC VIOLATIONS.

AC 5.0.2 AC Individual Failure

Individual failures to comply with a CREDITED PROGRAMMATIC ELEMENT of an AC, which are isolated and not systemic in nature, do not constitute non-compliance with the AC. Individual failures, deemed to be systemic in nature, are addressed under AC 5.0.3, AC Programmatic Deficiency.

An individual failure of an AC limit (*i.e.*, Specific Control or Restriction) and its action statement is an AC VIOLATION.

AC 5.0.3 AC Programmatic Deficiency

The CREDITED PROGRAMMATIC ELEMENTS in each AC are the standards by which the adequacy of the AC is assessed. The programmatic ACs may be implemented by specific Site Integrated SMP elements or through a facility-specific program.

An AC programmatic deficiency occurs when:

a. The same non-compliance or a closely similar non-compliance continues to occur, indicating the corrective action, including root cause determination, has not been effective;
b. Several non-compliances have occurred that are related but not identical, indicating a common breakdown in a program or program area; or
c. Intentional violation or misrepresentation (typically a failure to perform a substantive activity required by nuclear safety requirements coupled with the alteration, concealment, or destruction of documents pertaining to those activities) as determined by the PAAA Program.

Additional information on determining programmatic deficiency is included in the BASES for Section 5.0.

An AC programmatic deficiency shall require the following actions:

a. Notify DOE-RFFO of the programmatic deficiency in accordance with Occurrence Reporting and PAAA requirements;
b. Conduct a root cause analysis to identify the corrective actions to ensure future compliance with the AC requirement and prevent recurrence;
c. Inform DOE-RFFO of root cause analysis and corrective actions in accordance with Occurrence Reporting requirements; and
d. Implement identified corrective actions as necessary.

AC 5.0.4 AC VIOLATION

An AC VIOLATION occurs when:

a. There is a programmatic deficiency involving a CREDITED PROGRAMMATIC ELEMENT; or
b. An AC limit (*i.e.*. Specific Control or Restriction) and its REQUIRED ACTION are not met.

Upon identification that an AC VIOLATION exists, the following actions are required:

a. Ensure a safe facility configuration for violations associated with Specific Controls or Restrictions; and
b. Notify DOE-RFFO of the VIOLATION in accordance with occurrence reporting requirements.

5.1 ORGANIZATION AND MANAGEMENT

5.1.1 Requirements for Organization and Management

A minimum staff shall be in place to ensure operation within the controls defined in the OPERATIONAL CONTROLS. Lines of authority, responsibility, and communication shall be established and defined down through the Facility Manager, including safety and operating organizations important to ensure safe operation.

5.1.2 Credited Programmatic Elements

The program shall include the following CREDITED PROGRAMMATIC ELEMENTS:

a. The lines of authority, responsibility, and communication are documented and updated, as appropriate, in the form of organizational charts, functional descriptions of departmental responsibilities and relationships, and job descriptions of key personnel positions, or in equivalent forms of documentation; and

b. The minimum staff (*e.g.*, the number of qualified personnel, managers, supervisors, and operators) is maintained to ensure the facility is operated within the analyzed safety envelope (*i.e.* the facility is placed and maintained in a safe condition).

5.2 INVENTORY CONTROL AND MATERIAL MANAGEMENT

5.2.1 Requirements for Inventory Control and Material Management

A program shall be established, implemented and maintained to protect NUCLEAR MATERIAL and other hazardous material, and to control storage configurations, locations and quantities in accordance with the limits analyzed in the hazard and accident analysis. This element protects the initial source term assumptions of the accident analysis that limit the amount of MAR available for release.

5.2.2 Credited Programmatic Elements

The program shall include the following CREDITED PROGRAMMATIC ELEMENTS:

a. Configuration, location, and quantities of NUCLEAR MATERIAL radioactive and other hazardous material are controlled (*e.g.*, quantity per container, storage location, stack height);

b. NUCLEAR MATERIAL is packaged and stored in Site approved containers; and

c. Inspections are performed to detect degradation of NUCLEAR MATERIAL containers.

5.2.3 Specific Controls or Restrictions

Controlling the quantities of NUCLEAR MATERIALS limits their potential release in the event of an accident. The following inventory controls assure that the RCRA STORAGE UNITS and Canberra Mobile Waste Assay Systems/Trailers operate within the bounds of this safety analyses.

APPLICABILITY: All RCRA STORAGE UNTS evaluated in this safety analysis.

CONTROLS/RESTRICTIONS:

1. The quantity of NUCLEAR MATERIAL in waste drums and waste crates/boxes received or stored at the RCRA STORAGE UNIT shall not exceed the following:

≥ 55-gallon Waste Drums	0.5 grams weapons grade (WG) Pu per container
< 55-gallon <u>and</u> > 10-gallon Waste Drums	0.4 grams WG Pu per container
≤ 10-gallon Waste Drums	0.2 grams WG Pu per container
Waste Crates/Boxes	3 grams WG Pu per container

2. The total quantity of NUCLEAR MATERIAL present in a single group of wooden waste crates in outside storage at a RCRA STORAGE UNIT shall not exceed 8.4 grams WG Pu.

3. Groups of wooden waste crates in outside storage at a RCRA STORAGE UNIT shall be at least 30 feet from other groups of crates or materials in the unit.

4. While located at any RCRA STORAGE UNIT, the Canberra Mobile Waste Assay System shall not accept waste drums packaged with greater than 0.5 grams WG Pu.

5. Drums stacked above the second tier shall be banded together.

ACTIONS:

CONDITION		REQUIRED ACTION	COMPLETION TIME
A. RCRA STORAGE UNIT or Canberra Mobile Waste Assay system inventory control exceeded [enter this condition upon failure of control 1 or 4]	A.1 **OR** A.2	If during receipt, do not accept. If discovered during assay or storage, develop an action plan defining short-term compensatory measures and final disposition of non-compliant waste container(s).	8 hours. 72 hours.
B. Groups of wooden waste crates in outside storage exceed 8.4 grams WG Pu. [enter this condition upon failure of control 2]	B.1	Bring the single group of wooden waste crates into compliance.	8 hours.
C. Groups of wooden waste crates not separated by at least 30 feet. [enter this condition upon failure of control 3]	B.1	Re-establish required separation.	8 Hours.
D. Discovery that drums stacked above second tier are not banded. [enter this condition upon failure of control 5]	C.1 <u>OR</u> C.2	Move the non-banded drums that are above the second tier to the first or second tier. Band drums to be stored above the second tier.	72 hours. 72 hours.

SURVEILLANCE REQUIREMENTS:

SURVEILLANCE REQUIREMENT		FREQUENCY
5.2.3.1	Verify prior to receipt that inventory controls will not be exceeded.	Before shipment **OR** At receipt.

5.3 SAFETY MANAGEMENT PROGRAMS

5.3.1 Requirements for Safety Management Programs

The Safety Management Programs (SMPs), as described and graded in Chapter 3, *Safety Management Programs*, of this safety analysis shall be maintained to provide worker protection and defense-in-depth safety functions. The enforcement of SMPs is covered under the PAAA program.

5B OPERATIONAL CONTROLS BASES

5B.0 General Application Bases

ACs 5.0.1 through 5.0.5 establish the rules for AC use and application and are applicable to all ACs at all times, unless otherwise stated.

AC 5.0.1 establishes the requirement that ACs are to be met at all times. Each AC is divided into two distinct requirement sections. All ACs will have CREDITED PROGRAMMATIC ELEMENTS. Certain ACs will contain specific controls or restrictions consisting of limits and controls that have associated action statements. The manner in which the ACs is met is defined by either specific controls or restrictions with an associated action statement or by adherence to CREDITED PROGRAMMATIC ELEMENTS.

ACs 5.0.2 through 5.0.4 establishes the rules under which failures in AC programs progress from the level of individual failures of CREDITED PROGRAMMATIC ELEMENTS or failure of specific controls or restrictions through to VIOLATION of the AC.

CREDITED PROGRAMMATIC ELEMENTS is a defined term relating to programmatic elements that are credited for controlling the progression of an accident scenario. These elements minimize the potential frequency or consequence of an accident scenario. They are reflected in assumed operational aspects that impact base frequency or available hazardous material assumptions. Controls or restrictions relate to aspects of operation that limits the frequency or consequence of an accident scenario. These latter conform to the limits of the analysis (e.g., total material-at-risk in a facility available for involvement in a seismic event or maximum amounts of material-at-risk allowed in certain containers or locations).

The rules regarding CREDITED PROGRAMMATIC ELEMENTS contain a three tiered control structure consisting of individual failures, programmatic deficiencies, and AC VIOLATION. Adequate implementation of programmatic elements is the responsibility of facility management who must be able to demonstrate that programmatic compliance is achieved at all times. Individual failures are used as a measurement of adequate program implementation and should be tracked at some level by facility management. Upon occurrence of an individual failure, it is the responsibility of facility management to ensure a safe facility configuration. The safety significance of individual failures will be assessed through the site infrastructure program for Occurrence Reporting coupled with the requirements of the Unreviewed Safety Question (USQ) process in assessing Occurrence Reports for DISCOVERY conditions. REQUIRED ACTIONS for DISCOVERY conditions will be governed by the USQ process. When individual failures are determined to be systemic in nature, the adequacy of the program implementation comes into question and corrective measures must be taken. Failure to take appropriate corrective measures will lead to a programmatic deficiency and continued failure to correct the problem will lead to AC VIOLATION.

Programmatic deficiencies are defined through the Contractor's Price-Anderson Act Amendment program. They can occur through repetitive or recurring non-compliances, programmatic breakdown, or intentional violation or misrepresentation. DOE guidance on defining these types of deficiencies is as follows:

Repetitive or Recurring: The same non-compliance or a closely similar noncompliance continues to occur, indicating that the corrective action, including root cause determination, has not been effective. The expectation is that non-compliances will be tracked in a contractor's tracking system, and will be routinely reviewed by the contractor for potential trends and repeat occurrences.

> Example: Two workers are cutting a pipe in a contamination area and wearing respirators as required by the radiation work permit. Two other workers in the same room are working a job that does not require the use of respirators and are not alerted by the job foreman for the pipe cutting operation of the need for respirators. The two workers without respirators receive small but confirmed uptakes. Since a similar instance had previously occurred at this facility by workers co-located to a job requiring respirators, this is determined to represent a *repetitive* issue.

Programmatic breakdown: Several non-compliances have occurred that are related but not identical, indicating a common breakdown in a program or program area. These non-compliances might have a common cause indicating a programmatic weakness. A programmatic breakdown generally involves some weakness in administrative or management controls, or their implementation, to such a degree that systematic problems occur. This weakness might be identified as part of the root cause determination for a single event.

> Example 1: A contractor assessment of criticality safety finds that a large number of criticality infraction cases remain open, their corresponding corrective actions being incomplete. The contractor further notes a similarity in several of the infractions. The contractor concludes that a *programmatic* issue of weak criticality control compliance led to the large number of events, and a second *programmatic* issue existed due to inadequate and untimely corrective action.

> Example 2: While disposing of radiologically contaminated equipment, workers did not follow work package instructions to notify radiological control technicians for a survey of the equipment before beginning work. The workers, then, did not know the exact contamination or radiation levels they were exposed to. In addition, the work was done under a general radiation work permit that did not specifically address the scope of work to be performed. The bag holding the contaminated equipment was inadvertently cut during disposal work and was repaired by taping over the cut, rather than by over-bagging as required by procedure. The repair method was inadequate to prevent contamination of the bag's exterior and the floor beneath the bag. These multiple instances of failure to follow

approved procedures led to the determination that there had been a *programmatic* breakdown of the controls for this activity.

Intentional violation or misrepresentation: Most intentional violations involve the failure to perform substantive activities required by nuclear safety requirements coupled with the alteration, concealment, or destruction of documents pertaining to those activities.

Failure to meet the action statements for the specific controls or restrictions will lead directly to VIOLATION of the AC.

Upon the occurrence of an AC VIOLATION, safe facility configuration must be assured but may not require the suspension of operations. As these are programmatic requirements, the severity of response will depend on the individual VIOLATION and its impact on operations. This assessment is the responsibility of facility management. The following guidance applies to scoping the suspension of operations:

- The scope of suspension of operations may be focused when the underlying program deficiency involves a specific repetitive element (5.0.3.a).

- A programmatic breakdown (5.0.3.b) warrants suspension of those operations with safety reliance on the affected program.

- An intentional violation as determined under the PAAA requirements would necessitate SUSPEND OPERATIONS without scope limitation.

5B.1 Organization and Management Bases

5B.1.1 Requirements for Organization and Management Bases

The establishment and maintenance of a minimum staff provides assurance that the RCRA Units are capable of operating within the OPERATIONAL CONTROLS at all times. Clearly defined lines of authority, responsibility, and communication establish command and control within the facility, accountability for safe operation, and definition of the relationship between support functions important to safety and line management.

5B.1.2 Credited Programmatic Elements Bases

a. Documenting lines of authority, responsibility, and communication within the facility establishes a formal command and control structure necessary for safe operation. Management and operating personnel accountabilities are defined, decision-making authority is established, and support organization roles and reporting relationships to line management are formalized. Multiple forms of documentation may be utilized, including organizational charts, functional descriptions of departmental responsibilities and relationships, or job descriptions of key personnel positions. Documentation is updated whenever organizational changes are of sufficient significance to modify the command and control structure.

b. The minimum staff defines those management and operating personnel that are necessary for facility safety. Minimum staffing assures that qualified personnel are available to provide the expertise and decision-making capability required to operate the facility within the analyzed safety envelope (*i.e.*, the facility can be placed and maintained in a safe condition).

5B.2 Inventory Control and Material Management Bases

5B.2.1 Requirement for Inventory Control and Material Management Bases

Inventory Control and Material Management provides control for the location, storage configuration, and handling of NUCLEAR MATERIAL within the facility based on the quantity, type, and form. This element protects the initial source term assumptions of the accident analysis that limit the amount of MAR available for potential release in the event of an accident.

5B.2.2 Credited Programmatic Elements Bases

Since there is no specific SMP for Inventory and Material Control, these elements comprise an adequate program as derived from the results of the accident analysis.

a. This element protects the initial source term assumptions of the accident analysis that limit the amount of MAR available for potential release in the event of an accident.

b. By adhering to Site accepted container standards for NUCLEAR MATERIAL packaging, the amount of MAR is minimized through the containment provided by the drum or storage container. This element controls the consequences of a fire both to the worker and the non-worker and assures that if a container is dropped, its integrity will be maintained.

c. Damaged or degraded containers may not confine NUCLEAR MATERIAL adequately to minimize the consequences in the event of a drum failure. Therefore, visual inspections of the exterior surfaces of the container (*e.g.*, no noticeable signs of bulging or damage such as indentations, punctures, or leakage) are performed to identify any significant degradation of container integrity that could lead to a release of radiological material. This early detection limits the potential of a catastrophic failure and controls the hazard to which the worker may be exposed. Visual detection may take place upon receipt, prior to movement, or periodically during area tours and surveillances to confirm the integrity of primary confinement and to provide for early detection of confinement degradation.

5B.2.3 Specific Controls or Restrictions Bases

Specific controls and restrictions are placed on hazardous material inventory to prevent the introduction of materials into any of the RCRA STORAGE UNITS or Canberra Mobile Waste Assay Systems that would invalidate the safety analysis basis. The hazard classification of Nuclear Facility Hazard Category 3 for the RCRA STORAGE UNITS and non-nuclear for the Canberra Mobile

Waste Assay System is based on the maximum inventory of low-level waste allowed, consequences analyses, and maintaining the current staging/storage configurations.

Table H-2 of the SARAH (RFETS, 1997a) specifies the maximum allowable amounts of WG Pu in 55-gallon low level waste drums and low level waste crates as 0.44 grams and 2.78 grams, respectively. The 0.44 and 2.78 gram values were determined based on (1) the waste containers not exceeding 100 nCi/(g of waste) of alpha activity, and (2) the waste containers not exceeding their maximum allowable net weights. The maximum allowable net weight for 55-gallon waste drums is 739 pounds, and the maximum allowable net weight for half-size crates (2 feet × 4 feet × 7 feet) is 4,650 pounds. The maximum allowable net weight for a half-size crate is used because it is greater than the maximum allowable net weight for a full-size crate (4 feet × 4 feet × 7 feet). Calculating the maximum allowable amounts of WG Pu per container based on these maximum allowable net weights and the alpha activity of WG Pu yielded the 0.44 and 2.78 gram values. The operational controls specifying a 0.5 gram WG Pu limit for 55-gallon or larger waste drums and a 3 gram WG Pu limit for waste crates/boxes provides operational flexibility and is consistent with the safety analysis. Similarly, a 0.4 gram WG Pu limit for waste drums between 10-gallons and 55-gallons and a 0.2 gram WG Pu limit for waste drums less or equal to 10-gallons provide the same operational flexibility.

The number of crates in a group is determined by the quantity of plutonium, and is not restricted to a specific number. This control is for groups within a RCRA STORAGE UNIT and does not pertain to wooden crates stored in other locations on the site. Actual WG Pu gram values, if known, shall be used to comply with the 8.4 gram requirement. If WG Pu gram values are not known, then the 95th percentile upper confidence level value of 0.63 grams WG Pu per crate shall be used. A 30-foot separation between groups of wooden waste crates precludes a fire from propagating from one group to a nearby adjacent group thus mitigating the consequences of a fire.

Banding together multiple waste drums on each pallet of the top tier of a stack (above the second tier) is credited in determining the damage ratio used in evaluation of the earthquake caused spill scenario.

The REQUIRED ACTIONS and COMPLETION TIMES assure that the RCRA STORAGE UNITS and the Canberra Q2 Mobile Waste Assay System maintain compliance with the specific controls and restrictions. The COMPLETION TIMES are judged to be reasonable based on facility risk.

Surveillance 5.2.3.1 is intended to assure that the RCRA units and Canberra Mobile Waste Assay are operated within the bounds of the safety analysis.

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ATTACHMENT A

RCRA STORAGE UNITS

SAFETY ANALYSIS SUPPORTING DATA

Aircraft Crash Frequency Determination

Aircraft Wingspan ft.	Building Length ft.	Building Width ft.	Building Height ft.	mean cot ϕ	Skid Distance ft.	Percent of 360° radius valid for impact
50	169	100	8	8.2	68	100%

R ft.
196.37

A_f ft^2	A_s ft^2	A_{eff} ft^2	A_{eff} mi^2
41,668.06	16,753.13	58,421.19	2.10E-03

Crash frequency per year per square mile (From EPTR-004-97)	7.67E-04
Building specific crash frequency per year	1.61E-06
Critical area specific crash frequency per year	1.61E-06

Description: RCRA Unit 1

Legend:

$A_{eff} = A_f + A_s$

$A_f = (WS + R) \times Hcot\phi + (2 \times L \times W \times WS)/R + L \times W$

$A_s = (WS + R) \times S$

[Equations are taken from DOE-STD-3014-96, *Accident Analysis for Aircraft Crash into Hazardous Facilities*, October 1996]

Where,

A_{eff} = Effective Target Area
A_f = Effective Fly-in Area
A_s = Effective Skid Area
L = Length of Facility
W = Width of Facility
H = Height of Facility
S = Aircraft Skid Distance (from Table B-18 in DOE-STD-3014-96)
WS = Aircraft Wingspan (from Table B-16 in DOE-STD-3014-96)
R = Length of the Diagonal of the Facility $(L^2 + W^2)^{1/2}$
Cotϕ = Mean of the Cotangent of the Aircraft Impact Angle (from a Table B-17 in DOE-STD-3014-96)

RCRA Units Area Specific Crash Frequencies

RCRA Unit	Length, ft.	Width, ft.	Height, ft.	Effective Area, mi^2	Crash Frequency, per year
1	169	100	8	2.10E-03	1.61E-06
10	106	106	8	1.63E-03	1.25E-06
13 (Bldg. 884)	80	38	20	1.39E-03	1.06E-06
15A	296	66	8	2.62E-03	2.10E-06
18.03	275	120	8	3.26E-03	2.50E-06
18.04	120	60	8	1.33E-03	1.02E-06
24 (Bldg. 964)	163	40	20	2.19E-03	1.68E-06

Input Selections	Option/Value	Description
Scenario (1-7) =	1	Fire, Lofted Plum
Material (1-8) =	2	Aged WG Pu
X/Q Meteorology (1-3) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	3	Uncon Combust
Basis for DCF (1-9) =	[illegible]	Moderate, 5 um
Damage Ratio =	[illegible]	
Material at Risk (g) =	[illegible]	
Ambient Leakpath Factor (not HEPA) =	[illegible]	
TNT Explosion Equivalent (g) =	[illegible]	
Mass of Matrix, If Applicable (g) =	[illegible]	
Plume/Release Duration (min) =	[illegible]	
Least Distance to CW (m) =	100	
Least Distance to Site Boundary (m) =	[illegible]	
Evaluate Non-Criticality Accident? (Y/N)	[illegible]	

Isotopic Mass Fractions		
Isotope	User Specified	Values Used
Pu-238		1.85E-04
Pu-239		9.24E-01
Pu-240		5.61E-02
Pu-241		1.02E-04
Pu-242		3.06E-04
Am-241		3.05E-03
SUM	0.000	

Describe Scenario:

[illegible]

Version 1.3

Default Parameters	Lofted Values	Non-Lofted X/Q
Airborne Release Fraction =	5.0E-02	
Respirable Fraction =	1.0E+00	
Breathing Rate (m^3/s) =	3.60E-04	
Dose Conversion Factor (rem/g-mix) =	9.70E+06	
Effective MAR, Including DR (g) =	6.00E+00	
Plume Expansion Factor =	1.246	
Collocated Worker X/Q (s/m^3) =	2.80E-04	7.90E-03
Public X/Q (s/m^3) =	8.19E-06	6.80E-05
Ambient Leakpath Factor (Not HEPA) =	1.00E+00	

Change Options		
Accept Default?	New Value	Value Used
Y		5.0E-02
Y		1.0E+00
Y		3.60E-04
		9.70E+06

Respirable Initial Source Term (g) = 3.00E-01

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	3.0E-01	8.8E-03
One	6.4E-03	7.0E-05
Two	1.7E-05	1.4E-07
Three	3.3E-08	2.8E-10
Four	6.7E-11	5.6E-13

Two Crate Fire – RCRA Unit 24 (Building 964)

Input Selections	Option/Value	Description
Scenario (1-7) =	[illegible]	Spill
Material (1-8) =	2	Aged WG Pu
X/Q Meteorology (1-3) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Basis for DCF (1-9) =	7	Moderate, 5 um
Damage Ratio =	[illegible]	
Material at Risk (g) =	[illegible]	
Ambient Leakpath Factor (not HEPA) =	[illegible]	
TNT Explosion Equivalent (g) =	[illegible]	
Mass of Matrix, If Applicable (g) =	[illegible]	
Plume/Release Duration (min) =	10	
Least Distance to CW (m) =	100	
Least Distance to Site Boundary (m) =	[illegible]	
Evaluate Non-Criticality Accident? (Y/N)	Y	

Isotopic Mass Fractions		
Isotope	User Specified	Values Used
Pu-238		1.65E-04
Pu-239		9.24E-01
Pu-240		5.61E-02
Pu-241		1.02E-04
Pu-242		3.06E-04
Am-241		3.05E-03
SUM	0.000	

Describe Scenario:

[illegible]

Version 1.3

Default Parameters	
Airborne Release Fraction =	1.0E-03
Respirable Fraction =	1.0E-01
Breathing Rate (m^3/s) =	3.60E-04
Dose Conversion Factor (rem/g-mix) =	9.70E+06
Effective MAR, Including DR (g) =	3.36E+01
Plume Expansion Factor =	1.000
Collocated Worker X/Q (s/m^3) =	9.94E-03
Public X/Q (s/m^3) =	8.33E-05
Ambient Leakpath Factor (Not HEPA) =	1.00E+00

Change Options		
Accept Default?	New Value	Value Used
Y		1.0E-03
Y		1.0E-01
Y		3.60E-04
Y		9.70E+06

Respirable Initial Source Term (g) = 3.36E-03

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	1.2E-01	9.8E-04
One	1.2E-04	9.8E-07
Two	2.3E-07	2.0E-09
Three	4.7E-10	3.9E-12
Four	9.3E-13	7.8E-15

Earthquake Caused Spill Accident Scenario – RCRA Unit 24 (Building 964)

S

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
X/Q Meteorology (1-3) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Basis for DCF (1-8) =	7	Moderate, 5 um
Damage Ratio =	1.00E+00	
Material at Risk (g) =	1.30E+01	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =	0.00E+00	
Mass of Matrix, if Applicable (g) =	0.00E+00	
Plume/Release Duration (min) =	30	
Least Distance to CW (m) =	400	
Least Distance to Site Boundary (m) =	1,812	
Evaluate Non-Criticality Accident? (Y/N)	Y	

Isotopic Mass Fractions		
Isotope	User Specified	Values Used
Pu-238		1.85E-04
Pu-239		9.24E-01
Pu-240		5.81E-02
Pu-241		1.02E-04
Pu-242		3.06E-04
Am-241		3.05E-03
SUM	0.000	

Describe Scenario:
RCRA Unit 13 (B884) Plane Crash - Spill Component
ICRP 68
CW 400 meters

Version 1.3

Default Parameters	
Airborne Release Fraction =	1.0E-03
Respirable Fraction =	1.0E-01
Breathing Rate (m^3/s) =	3.60E-04
Dose Conversion Factor (rem/g-mix) =	9.70E+06
Effective MAR, Including DR (g) =	1.30E+01
Plume Expansion Factor =	1.000
Collocated Worker X/Q (s/m^3) =	9.94E-03
Public X/Q (s/m^3) =	1.09E-04
Ambient Leakpath Factor (Not HEPA) =	1.00E+00

Change Options		
Accept Default?	New Value	Value Used
y		1.0E-03
y		1.0E-01
y		3.60E-04
y		9.70E+06

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	4.5E-02	5.0E-04
One	4.5E-05	5.0E-07
Two	9.0E-08	9.9E-10
Three	1.8E-10	2.0E-12
Four	3.6E-13	4.0E-15

Respirable Initial Source Term (g) = 1.30E-03

Aircraft Crash Scenario, Spill Component – RCRA Unit 13 (Building 884)

Input Selections	Option/Value	Description
Scenario (1-7) =	1	Fire, Lofted Plum
Material (1-8) =	2	Aged WG Pu
X/Q Meteorology (1-3) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	3	Uncon Combust
Basis for DCF (1-8) =	7	Moderate, 5 um
Damage Ratio =	1.00E+00	
Material at Risk (g) =	1.30E+01	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =	0.00E+00	
Mass of Matrix, if Applicable (g) =	0.00E+00	
Plume/Release Duration (min) =	10	
Least Distance to CW (m) =	100	
Least Distance to Site Boundary (m) =	1,812	
Evaluate Non-Criticality Accident? (Y/N)	Y	

Isotopic Mass Fractions		
Isotope	User Specified	Values Used
Pu-238		1.85E-04
Pu-239		9.24E-01
Pu-240		5.81E-02
Pu-241		1.02E-04
Pu-242		3.06E-04
Am-241		3.05E-03
SUM	0.000	

Describe Scenario:
RCRA Unit 13 (B884) Plane Crash - Fire, Unconfined Material
ICRP 68
CW 100 meters

Version 1.3

Default Parameters	Lofted Values	Non-Lofted X/Q
Airborne Release Fraction =	5.0E-02	
Respirable Fraction =	1.0E+00	
Breathing Rate (m^3/s) =	3.60E-04	
Dose Conversion Factor (rem/g-mix) =	9.70E+06	
Effective MAR, Including DR (g) =	1.30E+01	
Plume Expansion Factor =	1.000	
Collocated Worker X/Q (s/m^3) =	3.59E-04	9.94E-03
Public X/Q (s/m^3) =	1.02E-05	1.09E-04
Ambient Leakpath Factor (Not HEPA) =	1.00E+00	

[illegible]
[illegible]

Change Options		
Accept Default?	New Value	Value Used
y		5.0E-02
y		1.0E+00
y		3.60E-04
y		9.70E+06

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	8.1E-01	2.3E-02
One	2.3E-02	2.5E-04
Two	4.5E-05	5.0E-07
Three	9.0E-08	9.9E-10
Four	1.8E-10	2.0E-12

Respirable Initial Source Term (g) = 6.50E-01

Aircraft Crash Scenario, Fire Component (unconfined material) – RCRA Unit 13 (Building 884)

Input Selections	Option/Value	Description
Scenario (1-7) =	1	Fire, Lofted Plum
Material (1-8) =	2	Aged WG Pu
X/Q Meteorology (1-3) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Basis for DCF (1-8) =	7	Moderate, 5 um
Damage Ratio =	1.00E+00	
Material at Risk (g) =	7.40E+01	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =	0.00E+00	
Mass of Matrix, if Applicable (g) =	0.00E+00	
Plume/Release Duration (min) =	10	
Least Distance to CW (m) =	100	
Least Distance to Site Boundary (m) =	1,812	
Evaluate Non-Criticality Accident? (Y/N)	y	

Isotopic Mass Fractions		
Isotope	User Specified	Values Used
Pu-238		1.85E-04
Pu-239		9.24E-01
Pu-240		5.81E-02
Pu-241		1.02E-04
Pu-242		3.06E-04
Am-241		3.05E-03
SUM	0.000	

Describe Scenario:
RCRA Unit 13 (B884) Plane Crash - Fire, Confined Material Component
ICRP 68
CW 100 meters

Version 1.3

Default Parameters	Lofted Values	Non-Lofted X/Q
Airborne Release Fraction =	5.0E-04	
Respirable Fraction =	1.0E+00	
Breathing Rate (m^3/s) =	3.60E-04	
Dose Conversion Factor (rem/g-mix) =	9.70E+06	
Effective MAR, Including DR (g) =	7.40E+01	
Plume Expansion Factor =	1.000	
Collocated Worker X/Q (s/m^3) =	3.59E-04	9.94E-03
Public X/Q (s/m^3) =	1.02E-05	1.09E-04
Ambient Leakpath Factor (Not HEPA) =	1.00E+00	

[illegible]
[illegible]

Change Options		
Accept Default?	New Value	Value Used
y		5.0E-04
n	1.0E-02	1.0E-02
y		3.60E-04
y		9.70E+06

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	Plume Doses MOI (rem)
Zero	4.6E-04	1.3E-05
One	1.3E-05	1.4E-07
Two	2.6E-08	2.8E-10
Three	5.1E-11	5.7E-13
Four	1.0E-13	1.1E-15

Respirable Initial Source Term (g) = 3.70E-04

Aircraft Crash Scenario, Fire Component (confined material) – RCRA Unit 13 (Building 884)

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-3) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Basis for DCF (1-8) =	7	Moderate, 5 um
Damage Ratio =	1.00E+00	
Material at Risk (g) =	2.20E+01	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =	0.00E+00	
Mass of Matrix, if Applicable (g) =	0.00E+00	
Plume/Release Duration (min) =	10	
Least Distance to CW (m) =	100	
Least Distance to Site Boundary (m) =	1,836	
Evaluate Non-Criticality Accident? (Y/N)	y	

Isotopic Mass Fractions		
Isotope	User Specified	Values Used
Pu-238		1.85E-04
Pu-239		9.24E-01
Pu-240		5.81E-02
Pu-241		1.02E-04
Pu-242		3.06E-04
Am-241		3.05E-03
SUM	0.000	

Describe Scenario:
RCRA Unit 18.03 Plane Crash - Spill Component
ICRP 68
CW 100 meters

Version 1.3

Default Parameters	
Airborne Release Fraction =	1.0E-03
Respirable Fraction =	1.0E-01
Breathing Rate (m^3/s) =	3.30E-04
Dose Conversion Factor (rem/g-mix) =	9.70E+06
Effective MAR, Including DR (g) =	2.20E+01
Plume Expansion Factor =	1.000
Collocated Worker χ/Q (s/m^3) =	9.94E-03
Public χ/Q (s/m^3) =	1.28E-04
Ambient Leakpath Factor (Not HEPA) =	1.00E+00

Change Options		
Accept Default?	New Value	Value Used
y		1.0E-03
y		1.0E-01
y		3.30E-04
y		9.70E+06

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	MOI (rem)
Zero	7.8E-02	8.8E-04
One	7.8E-05	9.8E-07
Two	1.5E-07	2.0E-09
Three	3.1E-10	3.9E-12
Four	6.1E-13	7.8E-15

Respirable Initial Source Term (g) = 2.20E-03

Aircraft Crash Scenario, Spill Component – RCRA Unit 18.03

Input Selections	Option/Value	Description
Scenario (1-7) =	1	Fire, Lofted Plume
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-3) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	3	Uncon Combust
Basis for DCF (1-8) =	7	Moderate, 5 um
Damage Ratio =	1.00E+00	
Material at Risk (g) =	2.20E+01	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =	0.00E+00	
Mass of Matrix, if Applicable (g) =	0.00E+00	
Plume/Release Duration (min) =	10	
Least Distance to CW (m) =	100	
Least Distance to Site Boundary (m) =	1,836	
Evaluate Non-Criticality Accident? (Y/N)	y	

Isotopic Mass Fractions		
Isotope	User Specified	Values Used
Pu-238		1.85E-04
Pu-239		9.24E-01
Pu-240		5.81E-02
Pu-241		1.02E-04
Pu-242		3.06E-04
Am-241		3.05E-03
SUM	0.000	

Describe Scenario:
RCRA Unit 18.03 Plane Crash - Fire, Unconfined
Material Component
ICRP 68
CW 100 meters

Version 1.3

Default Parameters	Lofted Values	Non-Lofted X/Q
Airborne Release Fraction =	5.0E-02	
Respirable Fraction =	1.0E+00	
Breathing Rate (m^3/s) =	3.30E-04	
Dose Conversion Factor (rem/g-mix) =	9.70E+06	
Effective MAR, Including DR (g) =	2.20E+01	
Plume Expansion Factor =	1.000	
Collocated Worker χ/Q (s/m^3) =	3.50E-04	9.94E-03
Public χ/Q (s/m^3) =	1.02E-05	1.28E-04
Ambient Leakpath Factor (Not HEPA) =	1.00E+00	

Change Options		
Accept Default?	New Value	Value Used
y		5.0E-02
y		1.0E+00
y		3.30E-04
y		9.70E+06

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	MOI (rem)
Zero	1.4E+00	3.9E-02
One	3.8E-02	4.9E-04
Two	7.6E-05	9.8E-07
Three	1.5E-07	2.0E-09
Four	3.1E-10	3.9E-12

Respirable Initial Source Term (g) = 1.10E+00

Aircraft Crash Scenario, Fire Component (unconfined material) – RCRA Unit 18.03

Input Selections	Option/Value	Description
Scenario (1-7) =	1	Fire, Lofted Plume
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-3) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Basis for DCF (1-8) =	7	Moderate, 5 um
Damage Ratio =	1.00E+00	
Material at Risk (g) =	2.20E+01	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =	0.00E+00	
Mass of Matrix, if Applicable (g) =	0.00E+00	
Plume/Release Duration (min) =	10	
Least Distance to CW (m) =	100	
Least Distance to Site Boundary (m) =	1,836	
Evaluate Non-Criticality Accident? (Y/N)	y	

Isotopic Mass Fractions		
Isotope	User Specified	Values Used
Pu-238		1.85E-04
Pu-239		9.24E-01
Pu-240		5.81E-02
Pu-241		1.02E-04
Pu-242		3.06E-04
Am-241		3.05E-03
SUM	0.000	

Describe Scenario:
RCRA Unit 18.03 Plane Crash - Fire, Confined
Material Component
ICRP 68
CW 100 meters

Version 1.3

Default Parameters	Lofted Values	Non-Lofted X/Q
Airborne Release Fraction =	5.0E-04	
Respirable Fraction =	1.0E+00	
Breathing Rate (m^3/s) =	3.30E-04	
Dose Conversion Factor (rem/g-mix) =	9.70E+06	
Effective MAR, Including DR (g) =	2.20E+01	
Plume Expansion Factor =	1.000	
Collocated Worker χ/Q (s/m^3) =	3.50E-04	9.94E-03
Public χ/Q (s/m^3) =	1.02E-05	1.28E-04
Ambient Leakpath Factor (Not HEPA) =	1.00E+00	

Change Options		
Accept Default?	New Value	Value Used
y		5.0E-04
y		1.0E+00
y		3.30E-04
y		9.70E+06

RESULTS

Number of HEPA Stages	Plume Doses CW (rem)	MOI (rem)
Zero	1.4E-02	3.9E-04
One	3.8E-04	4.9E-06
Two	7.6E-07	9.8E-09
Three	1.5E-09	2.0E-11
Four	3.1E-12	3.9E-14

Respirable Initial Source Term (g) = 1.10E-02

Aircraft Crash Scenario, Fire Component (confined material) – RCRA Unit 18.03

Input Selections	Option/Value	Description
Scenario (1-7) =	6	Spill
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-3) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Basis for DCF (1-8) =	7	Moderate, 5 um
Damage Ratio =	1.00E+00	
Material at Risk (g) =	3.10E+01	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =	0.00E+00	
Mass of Matrix, if Applicable (g) =	0.00E+00	
Plume/Release Duration (min) =	10	
Least Distance to CW (m) =	100	
Least Distance to Site Boundary (m) =	2,100	
Evaluate Non-Criticality Accident? (Y/N)	Y	

Isotope	User Specified	Values Used
Pu-238		1.85E-04
Pu-239		9.24E-01
Pu-240		5.81E-02
Pu-241		1.02E-04
Pu-242		3.08E-04
Am-241		3.05E-03
SUM	0.000	

Describe Scenario:
RCRA Unit 24 (B964) Plane Crash - Spill Component
ICRP 30
CW 100 meters

Version 1.3

Default Parameters	
Airborne Release Fraction =	1.0E-03
Respirable Fraction =	1.0E-01
Breathing Rate (m^3/s) =	3.60E-04
Dose Conversion Factor (rem/g-mic) =	9.70E+06
Effective MAR, including DR (g) =	3.10E+01
Plume Expansion Factor =	1.000
Collocated Worker χ/Q (s/m^3) =	8.94E-03
Public χ/Q (s/m^3) =	8.33E-05
Ambient Leakpath Factor (Not HEPA) =	1.00E+00

Accept Default?	New Value	Value Used
Y		1.0E-03
N	1.0E-02	1.0E-02
Y		3.60E-04
Y		9.70E+06

RESULTS

Number of HEPA Stages	CW (rem)	MOI (rem)
Zero	1.1E-02	9.0E-05
One	1.1E-05	9.0E-08
Two	2.2E-08	1.8E-10
Three	4.3E-11	3.6E-13
Four	8.6E-14	7.2E-16

Respirable Initial Source Term (g) = 3.10E-04

Aircraft Crash Scenario, Spill Component – RCRA Unit 24 (Building 964)

Input Selections	Option/Value	Description
Scenario (1-7) =	1	Fire, Lofted Plum
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-3) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	2	Uncon Non-com
Basis for DCF (1-8) =	7	Moderate, 5 um
Damage Ratio =	1.00E+00	
Material at Risk (g) =	3.10E+01	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =	0.00E+00	
Mass of Matrix, if Applicable (g) =	0.00E+00	
Plume/Release Duration (min) =	10	
Least Distance to CW (m) =	100	
Least Distance to Site Boundary (m) =	2,100	
Evaluate Non-Criticality Accident? (Y/N)	Y	

Isotope	User Specified	Values Used
Pu-238		1.85E-04
Pu-239		9.24E-01
Pu-240		5.81E-02
Pu-241		1.02E-04
Pu-242		3.08E-04
Am-241		3.05E-03
SUM	0.000	

Describe Scenario:
RCRA Unit 24 (B964) Plane Crash - Fire, Unconfined Material
ICRP 30
CW 100 meters

Version 1.3

Default Parameters	Lofted Values	Non-Lofted X/Q
Airborne Release Fraction =	6.0E-03	
Respirable Fraction =	1.0E-02	
Breathing Rate (m^3/s) =	3.60E-04	
Dose Conversion Factor (rem/g-mic) =	9.70E+06	
Effective MAR, including DR (g) =	3.10E+01	
Plume Expansion Factor =	1.000	
Collocated Worker χ/Q (s/m^3) =	3.50E-04	9.94E-03
Public χ/Q (s/m^3) =	1.02E-05	8.33E-05
Ambient Leakpath Factor (Not HEPA) =	1.00E+00	

Accept Default?	New Value	Value Used
Y		6.0E-03
Y		1.0E-02
Y		3.60E-04
Y		9.70E+06

RESULTS

Number of HEPA Stages	CW (rem)	MOI (rem)
Zero	2.3E-03	6.0E-05
One	8.5E-05	5.4E-07
Two	1.3E-07	1.1E-09
Three	2.8E-10	2.2E-12
Four	5.2E-13	4.3E-15

Respirable Initial Source Term (g) = 1.86E-03

Aircraft Crash Scenario, Fire Component (unconfined material) – RCRA Unit 24 (Building 964)

Input Selections	Option/Value	Description
Scenario (1-7) =	1	Fire, Lofted Plum
Material (1-8) =	2	Aged WG Pu
χ/Q Meteorology (1-3) =	2	95th %
Breathing Rate (1-3) =	3	Heavy Activity
Form of Material (1-11) =	1	Confined Mat
Basis for DCF (1-8) =	7	Moderate, 5 um
Damage Ratio =	1.00E+00	
Material at Risk (g) =	1.80E+02	
Ambient Leakpath Factor (not HEPA) =	1.00E+00	
TNT Explosion Equivalent (g) =	0.00E+00	
Mass of Matrix, if Applicable (g) =	0.00E+00	
Plume/Release Duration (min) =	10	
Least Distance to CW (m) =	100	
Least Distance to Site Boundary (m) =	2,100	
Evaluate Non-Criticality Accident? (Y/N)	Y	

Isotope	User Specified	Values Used
Pu-238		1.85E-04
Pu-239		9.24E-01
Pu-240		5.81E-02
Pu-241		1.02E-04
Pu-242		3.08E-04
Am-241		3.05E-03
SUM	0.000	

Describe Scenario:
RCRA Unit 24 (B964) Plane Crash - Fire, Confined Material Component
ICRP 30
CW 100 meters

Version 1.3

Default Parameters	Lofted Values	Non-Lofted X/Q
Airborne Release Fraction =	5.0E-04	
Respirable Fraction =	1.0E+00	
Breathing Rate (m^3/s) =	3.60E-04	
Dose Conversion Factor (rem/g-mic) =	8.70E+06	
Effective MAR, including DR (g) =	1.80E+02	
Plume Expansion Factor =	1.000	
Collocated Worker χ/Q (s/m^3) =	3.50E-04	9.94E-03
Public χ/Q (s/m^3) =	1.02E-05	8.33E-05
Ambient Leakpath Factor (Not HEPA) =	1.00E+00	

Accept Default?	New Value	Value Used
Y		5.0E-04
N	1.0E-02	1.0E-02
Y		3.60E-04
Y		9.70E+06

RESULTS

Number of HEPA Stages	CW (rem)	MOI (rem)
Zero	1.1E-03	3.2E-05
One	3.1E-05	2.6E-07
Two	6.2E-08	5.2E-10
Three	1.2E-10	1.0E-12
Four	2.5E-13	2.1E-15

Respirable Initial Source Term (g) = 9.00E-04

Aircraft Crash Scenario, Fire Component (confined material) – RCRA Unit 24 (Building 964)

Derivation of Airborne Release Fractions and Respirable Fractions used to model the Aircraft Crash into RCRA Unit 24 (Building 964)

Spill Component

The ARF × RF for the fragmentation of an aggregate solid that can undergo brittle fracture can be estimated by the equation:

$ARF \times RF = (A)(P)(g)(h)$

Where:
- A = empirical correlation, 2E-11 cm^3 per $g\text{-}cm^2/s^2$
- P = specimen density, calculated to be 2 g/cm^3
- g = gravitational acceleration, 980 cm/s^2
- h = fall height, assumed to be 10 feet (305 cm)

$ARF \times RF = (2E\text{-}11\ cm^3 \text{ per } g\text{-}cm^2/s^2)(2\ g/cm^3)(980\ cm/s^2)(305\ cm) = 1.2E\text{-}05$

Reference DOE-STD-3010-94 Section 4.3.3