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Abstract

This document addresses the potential hazards relative to the activities performed at the Radioactive Materials Handling Facility (RMHF), and the subsequent engineering safeguards and procedural guidelines implemented to eliminate, control, or mitigate the hazards to personnel and to the environment.

This document supersedes the Energy Technology Engineering Center (ETEC) Safety Analysis Document GEN-ZR-0019. It was prepared by and/or contributed to by the combined staff of the Boeing-Canoga Park Safety, Health & Environmental Affairs Department (SHEA).

Responsible Person: Ravnesh Amar

The Metaphase online procedure system contains the latest approved revision of this document.

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Supporting Document Summary of Change

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Rev.	Summary of Change	Approvals and Date
A	General revision to update document to reflect shipment of TRU waste and current inventory of facility. Executive Summary added. New Figure 3 added and subsequent figures renumbered. Table 3 updated. Section 4 revised to add introduction and new Section 4.1. Old Sections 4.1 and 4.2 changed to 4.2 and 4.3 respectively. New Table 5 added in Section 4.1 and subsequent tables renumbered. Calculations of Section 4.3 updated to current inventory. Risk assessment summary table updated.	R. Amar R. Marshall P. Rutherford **RELEASE** **07-15-04 CV**

EXECUTIVE SUMMARY

The Radioactive Materials Handling Facility (RMHF) is located at the Boeing Canoga Park Santa Susana Field Laboratory (SSFL), and is operated under the Energy Technology Engineering Center (ETEC) Closure Program for the Oakland Operations Office of the US Department of Energy (DOE-OAK). This Process Hazard Analysis[1] addresses the potential hazards associated with the activities performed at the RMHF, and the subsequent engineering safeguards and procedural guidelines that are implemented to eliminate, control, or mitigate the hazards to personnel, local residents, and the environment. It was prepared in accordance with Boeing Canoga Park guidance documents and meets the requirements of PMP-00001, "Program Management Plan for ETEC Closure."

This document also functions as the Safety Basis Document for the RMHF in accordance with OAK-SD-5481.1-B, "Safety Analysis and Review System," and meets the requirements of Appendix A and Appendix B (Footnote 1). It presents the analyses used to determine and substantiate that the RMHF is properly classified as a DOE "low risk" facility in accordance with the guidance of OAK-SD-5481-1B, Appendices A, B, and D.

Section 1 provides a brief introduction, Section 2 presents an overview and summary of the analyses, and Section 3 provides a detailed description of the RMHF facility, including its operations and safety features. Section 4 presents the details of the Boeing Process Hazards Analysis, which that also functions as the DOE "Preliminary Hazards Analysis."

Within Section 4, Section 4.1 provides the technical basis for determination of the facility classification, in accordance with DOE-STD-1027-92, Change 1, "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports." It is classified as a radiological facility, with a sum of fractions of 0.226. Section 4.2 provides a risk assessment in accordance with Appendix D of OAK-SD-5481.1-B. The RMHF has been determined to be a "low risk" facility.

Section 4.3 presents a bounding accident analysis based on the RMHF radionuclide inventory. Calculations used airborne release fractions (AFRs) recommended in NUREG 1140, release times recommended in 10 CFR 100, and dispersion methods of NRC Regulatory Guide 1.145. The dose at the site boundary (300 m) under worse-case accident conditions was determined to be 17 mrem (risk = 8.5×10^{-6})[2] and the dose to the Maximally Exposed Individual (MEI) is 1.1 mrem (risk = 5.5×10^{-7}). These doses are negligible compared to the NRC post-accident exclusion area limit of 25,000 mrem (risk = 0.0125) and the EPA post-accident protective action guideline (PAG) of 10,000 mrem (risk = 5×10^{-3}). It is also well below the background exposures of 300 mrem per year (risk/year = 1.5×10^{-4}).

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[1] Boeing Canoga Park uses the term "Process Hazards Analysis" (PHA) and DOE uses the term "Preliminary Hazards Analysis" (PHA). The terms are not interchangeable, but the processes are similar and the analyses contained in this document satisfy requirements for both Boeing Process Hazards Analyses in accordance with Boeing document EID-06146, "Guidelines for Performing Process Hazards Analyses for Closure of ETEC" and DOE Preliminary Hazards Analyses in accordance with OAK-SD-5481.1-B.

[2] Risk is defined in this document as the lifetime fatal cancer rate risk.

Protective measures that Boeing-Canoga Park considers to be exceptionally important in ensuring safety are identified as Operational Safety Requirements (OSRs) or Technical Safety Requirements (TSRs). Because of the low probability risk ranking, there are no OSRs or TSRs for the RMHF.

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1.0 INTRODUCTION

As required in the PMP-00001, "Program Management Plan for ETEC Closure," *(Reference 1)*, this Process Hazard Analysis addresses the potential hazards relating to the activities performed at the Radioactive Materials Handling Facility (RMHF), and the subsequent engineering safeguards and procedural guidelines that are implemented to eliminate, control, or mitigate the hazards to personnel, local residents, and the environment. This analysis was conducted in accordance with EID-06146, "Guidelines for Performing Process Hazards Analyses for Closure of ETEC" *(Reference 2)* and supersedes all prior analyses of the RMHF.

The RMHF is operated by Boeing Canoga Park for the U.S. Department of Energy (DOE) under the guidelines established in applicable DOE Orders, State of California regulations, and the requirements set forth in Boeing Canoga Park System of Procedures (SOP). SOP C-101, "Safety, Health and Environmental Affairs Program," *(Reference 3)* is a Boeing Canoga Park SOP policy document that is relevant to the operation of the RMHF. The RMHF provides storage, handling, packaging, and shipping of radioactive waste material in support of the ongoing Energy Technology Engineering Center (ETEC) Site Closure site restoration contract. The RMHF currently has a Part A Resource Conservation and Recovery Act (RCRA) interim permit (No. CA3890090001) for the storage and treatment of mixed waste. Except for minute amounts generated by decontamination and decommissioning (D&D) operations, the RMHF no longer handles or stores any special nuclear materials (SNM). All transuranic (TRU) waste was shipped off-site in December 2002. Boeing notified the DOE-Oakland Operations Office (DOE-OAK) *(Reference 4)* of the subsequent downgrade of the facility to a "radiological facility" with a "low" risk classification.

This document includes a brief description of the site location and a specific description of the RMHF and operations conducted in the facility. It also includes an accident analysis to identify the risks and demonstrate the appropriateness of controls to eliminate the hazards.

2.0 OVERVIEW AND SUMMARY

The RMHF is operated by Boeing Canoga Park and is located in Area IV of the Boeing Santa Susana Field Laboratory (SSFL) in the Simi Hills of Ventura County, California. The RMHF has been operated safely since its initial use in 1960 and is currently operated by the DOE Site Restoration Team (D/117) in support of the ETEC Closure Program site cleanup activities. The RMHF is a fenced compound of eight buildings used to support the accumulation, packaging, storage, and treatment of radioactive and/or mixed hazardous wastes prior to shipment to an off-site disposal facility. No radioactive or mixed wastes are disposed of at the RMHF. Ongoing operations include decontamination, storage, processing, packaging, and/or off-site disposal of radioactive materials. Non-radioactive, hazardous wastes are accumulated at the facility but are not stored beyond the allowable accumulation time and are not treated at the RMHF.

The RMHF was designed and constructed to withstand naturally occurring hazards including winds, brushfire, earthquakes, landslides, and rainwater flooding. Descriptions and provisions to minimize the hazards associated with handling solid and liquid radioactive waste are presented. Adequate systems and controls are in place to minimize direct radiation exposure to personnel and the release of radioactive material into the environment. All potential hazards have been identified and engineering controls have been incorporated into the operation of the facility to ensure that safe operation is maintained at all times. No credible accidents with significant off-site consequences could be identified.

The overall conclusion of the safety analysis is based on review of RMHF operations and credible incidents. Based on current and planned future use, it is concluded that the RMHF operations pose, at most, a “Low” risk as defined in OAK SD 5481.1-B *(Reference 5)*. There is no potential off-site impact and only minor on-site impact.

Protective measures that Boeing-Canoga Park considers to be exceptionally important in ensuring safety are identified as Operational Safety Requirements (OSRs) or Technical Safety Requirements (TSRs). Because of the Low risk ranking, there are no OSRs or TSRs for this facility.

3.0 DESCRIPTION OF SITE, FACILITY, AND OPERATIONS

3.1 LOCATION

The RMHF is located within the Boeing Canoga Park, SSFL in the Simi Hills of southeastern Ventura County, California. The SSFL is adjacent to the Los Angeles County line, approximately 29 miles northwest of downtown Los Angeles. Nearby communities include Simi Valley (2 to 3 miles north of the site), two modular home parks along Woolsey Canyon Road (1 to 2 miles east of the site), Bell Canyon (3 to 4 miles to the south of the site), and the San Fernando Valley (4 to 7 miles east of the site).

The RMHF is located approximately 985 feet (300 meters) south of the northern property line of the SSFL, as shown in the SSFL site map of Figure 1. The RMHF occupies approximately 3 acres of land on which the following facilities have been constructed:

1. Building 4021, radioactive waste processing, packaging, and equipment decontamination
2. Building 4022, radioactive material handling and waste storage (low level and mixed-low level)
3. Building 4034, administrative and engineering offices
4. Building 4044, health physics services
5. Building 4075, inactive storage building
6. Building 4621, radioactive sources and mixed waste storage
7. Building 4665, emergency supplies storage
8. Building 4688, open, covered building for temporary storage of chemicals and equipment
9. Building 4658, inactive security post (guard house) at the main gate
10. RMHF rainwater runoff catch basin

Figure 2 shows the RMHF facility layout and Figure 3 provides an aerial view of the facility.

3.2 BUILDING CODES

All RMHF buildings are of robust construction, featuring steel frames with steel sidings and roofs. The foundations, floors, slabs, piles, and subsurface structures are steel-reinforced concrete. Construction was in conformance with the Uniform Building Code (UBC), Ventura County Building Regulations, State of California General Industrial Safety Orders (including dynamic analysis), National Fire Codes (NFPA requirements), and special trade codes in place at the time of construction where applicable.

Design and construction criteria have been drawn from these codes and regulations to ensure that the RMHF buildings will withstand the naturally occurring hazards of earthquakes, winds, brushfires, landslides, and rainwater flooding. It is noteworthy that the magnitude (M_w) 6.7 Northridge earthquake of January 17, 1994 did not effect the RMHF buildings. SSFL site geology/topography, meteorology, and other physical characteristics are discussed in *Reference 6*.

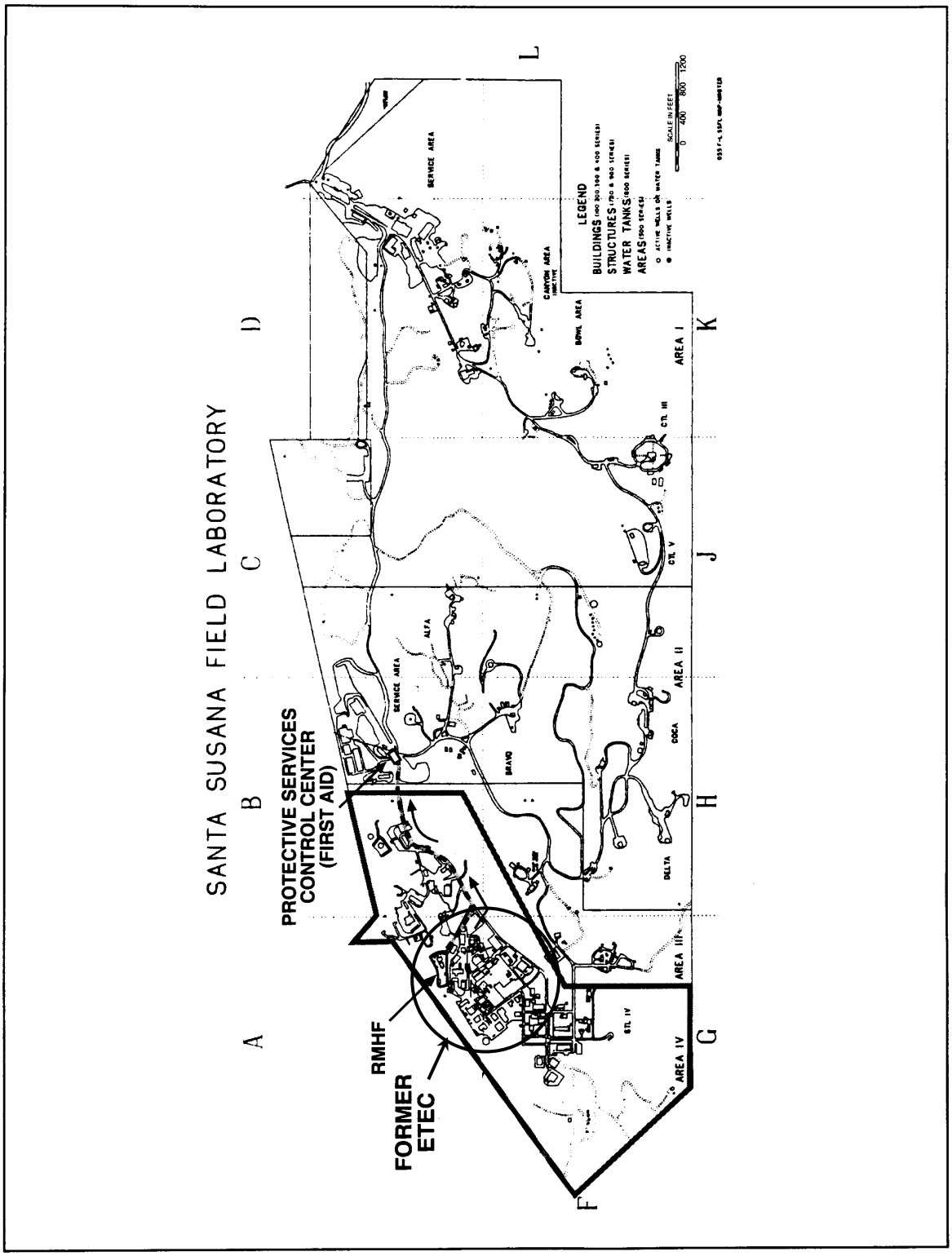


Figure 1. Santa Susana Field Laboratory Map.

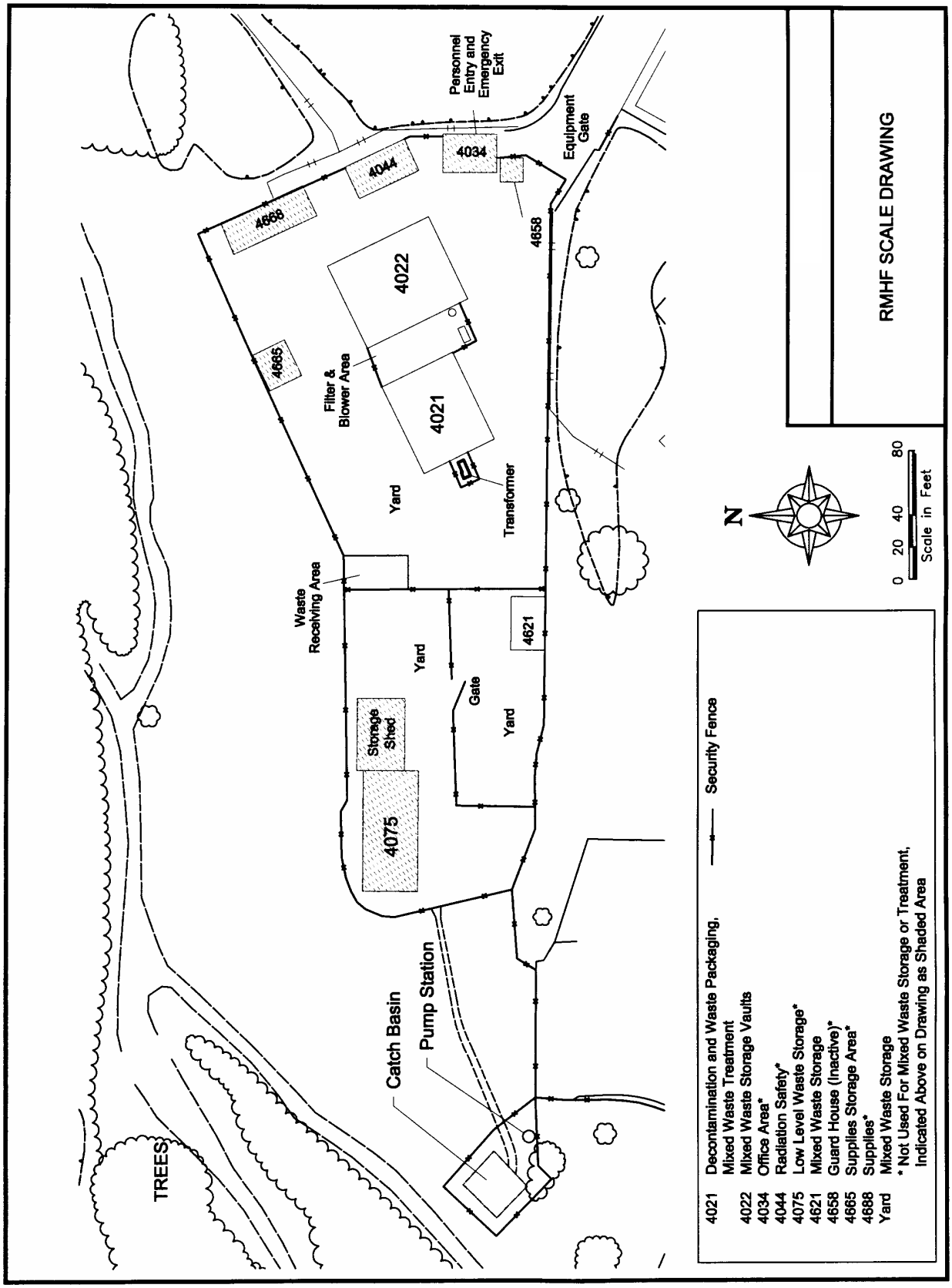


Figure 2. RMHF Facility Layout Drawing.

Figure 3. Aerial View of the RMHF (Looking South).

3.3 PROFILE

The site is completely paved, part with concrete slabs and the rest with bituminous asphalt. The landscape slopes from the east-end vehicle gate and engineering office (Building 4034) to the west-end catch basin. Certain equipment items are located out of doors on concrete pads (i.e., ventilation system blowers, filters, emergency diesel generator (inactive), compressors, stack, and evaporator ventilation unit).

Table 1 contains a description of each building and equipment area. The description indicates current use, dimensions, special provisions, and systems incorporated into each building.

3.4 DESIGN SAFETY FEATURES

3.4.3 Security and Radiation Area Controls

An 8-foot-tall chain link fence with barbed wire at the top encloses the entire compound. Access beyond the Engineering Office (Building 4034) is controlled by locked doors and locked gates. Foot traffic enters though the Engineering Office (Building 4034) and motor vehicles enter through an adjacent equipment gate (see Figure 2).

Table 1. Building Descriptions *(Sheet 1 of 2)*

Bldg. No.	Description	Approximate Dimensions	Access Provisions	Remarks
4021	Radioactive Materials Decontamination and Packaging Facility (3000 ft^2)	60 ft x 50 ft x 25 ft H; 14 ft H at eaves		HEPA ventilation, heating and A/C, sump tanks with level control panel (outside), fire sprinklers
	Packaging Room	29 ft x 29 ft x 12 ft H	Door to decontamination room, exterior roll-up equipment door	Fume hood (dry), cement mixer
	Decontamination Room	49 ft x 29 ft x 12 ft H	Door to hot change room, 2 roll-up equipment doors, 2 emergency exits	Fume hood (dry), sink, overhead 5-ton crane, evaporator for contaminated water
	Hot Change Room	9 ft x 15 ft x 8 ft H	Decontamination/ packaging cold change	Sink and shower (drain to R/A holdup tank)
	Cold Change Room	12 ft x 15 ft x 8 ft H	Entry door to building	Toilet; sink; storage lockers; shower, & radiation monitor
	Laundry	14 ft x 21 ft x 8 ft H	Entry door to building & to cold change room	Evaporator control unit, equipment trouble light panel, PPE storage lockers
None	4021/4022 Filter & Blower Area (yard)	20 ft x 55 ft	Fenced with 6-ft.-wide gates at both ends	HEPA ventilation blowers, filter banks, & stack for 4021 & 4022
4022	Radioactive Waste Handling & Storage (3850 ft^2)			HEPA ventilated facility, smoke detectors
	High Bay	70 ft x 55 ft x 57 ft H	Personnel door, emergency exit & 2 double-sliding equipment doors	50-ton bridge crane, radiation monitor & alarm, solid radioactive waste compactor, waste tank level control panel
	Below-grade storage vaults	7 vaults: 6-10 ft x 20 ft, 12-25 ft. deep	3-ft.-thick concrete covers, requires facility crane for access	Seven shielded & HEPA ventilated storage vaults (8,000-gal. liquid waste hold-up tank in Vault 2)

Table 1. Building Descriptions *(Sheet 2 of 2)*

Bldg. No.	Description	Approximate Dimensions	Access Provisions	Remarks
4034	Administrative & Engineering Office Building (756 ft^2)	36 ft x 21 ft x 12 ft H	2 personnel doors	A/C and heating, fire sprinklers, restrooms
4044	Radiation Safety Services & Technician Shop Area (800 ft^2)	20 ft x 40 ft		Heating and A/C, fire sprinklers, restroom
	Technician Support Area	20 ft x 35 ft and rest-room	2 personnel doors & 1 sliding door	Technician break room and small work area
	Radiation Safety Office	12 ft x 15 ft	Inside personnel door	HP instrumentation
4075	Storage Building (Inactive)	35 ft x 75 ft	2 sliding doors - padlocked	Fire sprinklers
4621	Storage Building: storage area for MLLW and calibration sources	20 ft x 32 ft	Personnel door, 1 roll-up equipment door	Smoke detectors
4658	Guard House (Inactive)	10 ft x 10 ft x 10 ft H	Personnel door-locked	
4665	Storage Building: Emergency backup equipment for SSFL	20 ft x 24 ft	Personnel door and sliding door	Emergency pumps, plastic sheets, hoses, etc.; smoke detectors
Area 4668	Open storage shed for flammable and chemical storage	20 ft x 24 ft	N/A	Non hazardous decontamination chemical solutions, emergency gas for forklifts, fire sprinklers
Catch Basin	Facility runoff catch basin	20 ft x 30 ft x 5 ft deep	Fenced with barbed wire (gate)	Radiation monitor & alarm, pumps with water level controls, high water alarm

Entry to storage buildings containing radioactive waste material is restricted during off-hours by locked or padlocked doors. Ropes, signs, and/or procedural controls restrict access to areas in which radiation hazards exist. Building 4021 is readily accessible, but radiation warning signs are posted in the hot change room specifying that any personnel wanting to enter the packaging or decontamination room shall be fitted with proper protective clothing as described in the procedures. The entry into the decontamination room and packaging room from the hot change room is kept locked when not in use. The radioactive waste storage buildings (4022 and 4621) are locked unless facility personnel are on-site. Inactive buildings (4075 and 4858) are closed and locked.

3.4.2 Evacuation Routes

Evacuation routes have been engineered into the design of the facility layout and evacuation signs are displayed throughout accordingly. The normal mode of evacuation is shown in Figure 4. Evacuation is through Building 4034 or through the crash gate adjacent to the vehicle gate. Procedural controls provide the necessary guidance regarding the evacuation of personnel who may be contaminated. There is a prescribed Emergency Assembly Area (EAA) (see Figure 4) where the evacuees congregate outside of the RMHF. An emergency phone connected directly to the Boeing Communications Center (BCC) at Seal Beach is located at the assembly area. BCC dispatches SSFL Security & Fire Services personnel as needed and makes necessary public address announcements.

3.4.3 Shielding Provisions

In accordance with DOE orders, radiation shielding is an integral design feature of the RMHF to ensure that doses to personnel are kept “As Low As Reasonably Achievable” (ALARA) and that dose rates at the SSFL boundary are kept below the specified limits.

The primary sources of external (direct) radiation at the RMHF are as follows:

1. Radioactive materials/waste in Building 4022
2. Residual solids in the evaporator in Building 4021
3. Waste materials awaiting size reduction and packaging in Building 4021
4. Calibration sources, and mixed-hazardous waste in Building 4621
5. Packaged radioactive waste in the storage yards adjacent to Buildings 4075 and 4621

Shielding in Building 4022 consists of seven below-grade vaults with magnetite concrete walls and ~ 3-foot-thick vault covers with steel-clad concrete vault cover plugs. Due to the low activity of the materials stored in the rest of the RMHF facility, and/or the use of shielded containers (for sources and packaged waste), shielding in the other buildings is not needed.

Consistent with the State of California requirement *(Reference 7)*, the shielding keeps the radiation dose rate at the facility fence below 2 mrem per hour and below 100 mrem per total hours in one week. Dose rates are monitored and controlled so that no member of the general public could receive more than 100 mrem per year, as required by DOE Order 5400.5 *(Reference 8)*. Doses to occupational personnel do not exceed 2000 mrem per year, per Boeing Canoga Park Radiological Controls Manual SM-40-402 *(Reference 9)*. Additional ALARA controls for minimizing occupational dose are implemented on an ongoing basis. Annual exposures to

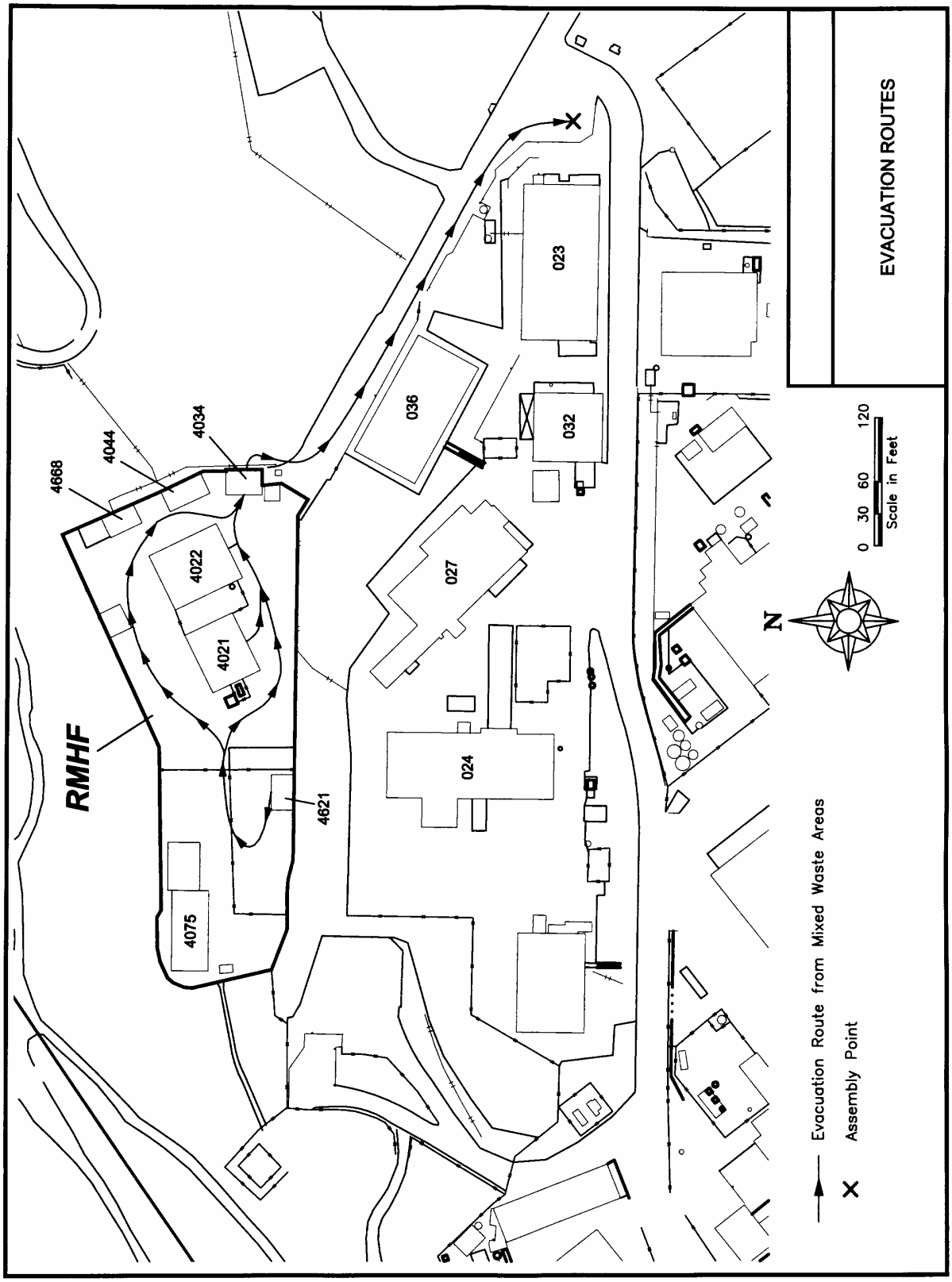


Figure 4. RMHF Evacuation Routes.

personnel are well below limits. The average and maximum personnel dose for radiological workers were 17 and 620 mrem, respectively, in 2002.

3.4.4 Ventilation and Filtration

The ventilation and exhaust filtration systems for Buildings 4021 and 4022 are designed to control airborne contamination. The direction of airflow is designed to flow from areas of lowest to highest contamination to prevent the spread of contamination. The ventilation exhaust from Buildings 4021 and 4022 is directed through pre-filters and then through high-efficiency particulate air (HEPA) filters before being released through the facility stack. Filter replacement is performed periodically in accordance with procedures. The filters are tested for efficiency after each filter change or annually. An air monitor in the stack exhaust is routinely checked for performance and includes an alarm set at 2 times background.

Emergency blowers are not provided for Building 4021 and 4022; therefore, a ventilation blower failure in either of these building requires operations to be shut down, the decontamination and packaging rooms evacuated, and all doors closed until the areas are determined safe for reentry.

3.4.5 Site Water Runoff Control

As noted in Section 3.3, the RMHF is sloped so that all water runoff from the facility is directed towards the west end of the site and is collected in a catch basin west of the facility. Building foundations are further designed so that all runoff is directed around and not into buildings. The catch basin is sealed with coated asphalt to prevent seepage of radioactive contamination into the environment. The catch basin is equipped with a pair of limit switches to control the amount of contained water automatically. When the water reaches the lower level, the limit switch actuates the primary pump to begin pumping the water to the surface drainage SSFL retention pond (R2A); if the water reaches a higher level, an additional pump starts. The high-level switch activates a local alarm (audible alarm and light) at the catch basin control panel. When the water has been pumped to an established minimum, the pump stops. Radiation Safety Health Physicists (HPs) sample the catch basin to monitor for radioactive material in the collected water as frequently as required during periods of rainfall and monthly during periods of no rainfall. The catch basin is also equipped with a local radiation alarm (audible alarm and light) at the catch basin that activates at a radiation level of 2.5 times normal background. A remote alarm panel located in Building 4034 (lamp and buzzer) is activated for either a high-water or radiation alarm.

3.4.6 Alarm Instrumentation

Certain signals have been designated to indicate specific hazards at the RMHF. Table 2 describes each alarm function, location, and the action to be taken upon actuation. Minor hazards activate local (RMHF) alarms. Fire, Building 4022 8,000-gallon tank high-level, and Building 4021 sump high-water alarms are connected directly to the Boeing Communications Center (BCC) in Seal Beach. BCC notifies SSFL Fire Protection personnel who respond to the alarms. During off-normal hours, BCC also contacts RMHF-designated personnel for information and/or assistance to on-site personnel. As required, RMHF personnel or trained Plant Services personnel may be called in to correct alarm situations.

Table 2. Warning Signals*

Alarm and Setting	Alarm Description and Location	Action
Radiation alarm for RMHF catch basin (2.5 times normal background)	Audible alarm at catch basin, R/A indicator light and buzzer on 4034 alarm panel	Take water sample, analyze, and (as required) stop release of radioactive material into catch basin
High water level at RMHF catch basin	Alarm at catch basin, “high water” indicator light and buzzer on 4034 alarm panel	Take water sample and analyze
Airborne radioactive contamination in stack effluent	Bell and blinking red light inside monitoring box at base of stack	Verify condition, notify HP and take appropriate action (shut down blowers and/or evacuate area as required)
Fire	Horn outside 4022 south wall, alarm at BCC	Notify Security & Fire Services and fight fire if safe to do so
4021 sump tank high level (1 ft from top)	Buzzer-light on control panel at 4021 west side, alarm at BCC	Verify and cut off water source
4021 sump tank overflow (wet sump)	Buzzer-light on control panel at 4021 west side	Verify and cut off water source
4022 8,000-gallon tank high level (3,500 gallons)	Bell inside 4022 at west wall, alarm at BCC	Determine cause of alarm and correct
4022 8,000-gallon tank low level (350 gallons)	Bell inside 4022 at west wall	Determine cause of alarm and correct
4022 Vault 2 catch pan (under 8,000-gallon tank)	Red light and small bell in 4022	Determine cause of alarm and correct
Ventilation system problem	Buzzer outside south west corner 4022 and trouble light indicator inside 4021 laundry room	Determine problem and correct
Loss of power	None (back up power not required)	Determine loss of power and correct
Transformer over-temperature	Buzzer outside south west corner 4022 and trouble light indicator inside 4021 laundry room	Shut down equipment loading transformer, determine problem and correct

* Monitoring instruments (devices) actuate automatically

In addition to other protective communication and alarm systems controls, the public address system (covering both indoor and outdoor areas) is continuously available for verbal information and alarm announcements.

3.4.7 Fire Protection

Fire protection includes smoke detectors and corresponding alarms in Buildings 4022, 4621, and 4665. Sprinklers are installed inside Buildings 4034, 4044, 4021, 4075, and Area 4668. Area sprinklers are installed along the SSFL northern fence line behind the RMHF to aid in suppression of brush fires. SSFL Security & Fire Services includes a small staff of Emergency Medical Technicians (EMTs) and fire fighters, and has fire fighting, Hazmat, and ambulance equipment available within one mile of the RMHF. The Ventura County Fire Department provides around-the-clock backup support and acts as the primary fire-fighting organization for off-normal hours, due to the reduced Security & Fire Services staff during that time.

3.4.8 RMHF Contingency Plan

A facility-specific document has been prepared to provide detailed instructions during various emergencies that might occur at the RMHF. This "RMHF Contingency Plan," EPA-00046 *(Reference 10)*, is comprehensive and broadly includes civil emergencies, environmental emergencies, and chemical or radioactive spills/releases. The document identifies the Incident Commander(s) by name, identifies emergency equipment available at the RMHF and nearby SSFL locations, and provides detailed procedures to be followed as appropriate for the various incidents that might be encountered. It also identifies RMHF personnel available to aid the Incident Commander by providing information on relevant facility activities, conditions and/or materials present, and to act as an Facility Emergency Team. The plan includes requirements for review and updating the document.

The "SSFL Master Emergency Plan," maintained by the Boeing Canoga Park Security & Fire Services department, addresses corresponding SSFL site-wide responses to natural disasters and other emergencies.

3.5 OPERATIONS

The RMHF near-term operations support the final-phase D&D of the former Systems for Nuclear Auxiliary Power (SNAP) Ground Prototype Facility below-grade test vault, which is located in Building 4059. RMHF will also support future D&D activities at the former SNAP Development Test Lab (Building 4024). Ultimately, the RMHF will also be decommissioned and decontaminated. Primary RMHF operations activities consist of: (1) receiving, temporarily storing, staging for shipment, and shipping packaged solid radioactive waste; (2) receiving and evaporating radioactive water, plus collecting, drying, stabilizing, and packaging the evaporation process solids for shipment as solid radioactive waste; (3) size-reducing and repackaging radioactive waste for waste minimization; (4) decontaminating materials, tools, and equipment used in D&D activities; and (5) providing interim storage and treatment of mixed waste under the facility RCRA Part A Interim Status Permit. Additional activities include the temporary storage of contaminated equipment from D&D projects and sources used by Radiation Safety for calibration

purposes. All activities are conducted in accordance with the DOE Order 435.1 *(Reference 11)* as implemented through *Reference 12*. The RMHF Part B Operations Plan *(Reference 13)* and the ETEC Closure Program Health & Safety Plan (HASP) *(Reference 14)* further identify hazards, limits, controls, and requirements for safe operation of the RMHF. The ETEC Closure Integrated Safety Management System (ISMS) Description *(Reference 15)* provides a comprehensive review of how the ISMS principles are applied in the ETEC Closure Program (Section 5.5 of *Reference 15* addresses hazard controls). Table 1 of *Reference 12* provides a matrix of ISMS Guiding Principles, Core Functions, and low-level waste (LLW) management implementing documents.

The Radiation Safety requirements for the safe operation of the RMHF are defined in *References 9*, *16*, and *17*. General requirements include posted radiological area designations, periodic radiation and contamination surveys, air monitoring, stack monitoring, personnel monitoring devices, and area monitoring systems. The amount of personal protective equipment (PPE) worn by personnel in radiation areas depends upon the magnitude of the hazard, as determined by the facility/project HP. In the unlikely event that chemical hazards are also present (use of chemicals is restricted in radiological areas), the SHEA Health & Safety representative would identify any additional PPE requirements. When required, the HP monitors radiation and contamination levels during specific operations. Procedures for decontaminating personnel, visitor entry, and emergency evacuation are in place.

There is currently no nuclear fuel, high-level waste, or transuranic waste on site. There are no plans for any future nuclear programs. The RMHF support activities are described below.

3.5.1 Evaporation of Radioactively Contaminated Water

The RMHF Radioactive Water Evaporation System (RWES) is located in Building 4021, Room 104. The RWES provides the capability to remove and concentrate radioactive particulate from contaminated water transferred from other facilities to the RMHF or generated by the decontamination of equipment in Building 4021.

Radioactive water can be transferred from the other facilities by utilizing a portable (~500-gallon) radioactive water transfer tank (RWTT). The RWTT liquid is transferred through the Building 4021 floor drain to the sump tank. The sump tank is equipped with sensors to detect the tank water level. Upon actuation of the sump tank pump, water is pumped from the sump tank through a set of filters, with first and second stage filters of 10-micron filtration capability, to an 8,000-gallon stainless steel tank located in Building 4022.[3] The sump tank and holdup tank are located in pits with holding capacities greater than the tanks. The 8,000-gallon holdup tank is further contained within a stainless steel (catch pan) liner in Vault 2. In the event of a leak in the 8,000-gallon tank or overflow of the sump tank, local alarms will sound at the RMHF and at the BCC.

The RWES consists of an atmospheric evaporator, exhaust, and process control systems. The RWES process is a batch-type operation fed from the 8,000-gallon tank in Building 4022. The water is heated to a nominal 200 ^{o}F by means of electric immersion-type heaters. An exhaust

[3] An upgraded RWES has been designed and is planned for installation during FY04. The current 200-gallon sump tank and pumps, the filtration system, and the evaporator will be replaced in Building 4021. The 8000-gallon holding tank in Building 4022 will be replaced with one or more tanks of smaller capacity in Building 4021. The new system will incorporate secondary containment and safeguards equivalent to or exceeding the existing system.

blower carries the vapor through HEPA filters to the facility stack. The concentrated solids are periodically removed from the evaporator, sampled, analyzed to verify the absence of hazardous chemicals above regulatory limits, and packaged for disposal as radioactive waste.

The RWES is an automatically controlled, minimum maintenance process, in which flow, water level, and heat input parameters are controlled. Interlock functions are provided for water over-temperature, high and low water level, and airflow in the evaporator exhaust.

3.5.2 Decontamination

Decontamination procedures and responsibilities for chemical spills are specified in the RMHF Contingency Plan *(Reference 10)*. These types of incidents are very unusual at the RMHF, because chemicals are excluded to the degree practical in order to preclude the possibility of generating a mixed waste. The handling and decontamination of radioactively contaminated objects and materials is one of the primary missions of the RMHF. Radiological decontamination procedures are developed on a case-by-case basis. Engineering Work Requests (EWRs), Form R-94L, are prepared for specific non-routine tasks as required by the RMHF Engineer (Person) in Charge (PIC). EWRs consider such factors as:

1. Level of contamination
2. Material involved
3. Surface conditions
4. Geometry

Appropriate PPE are specified by the project/facility HP on a Controlled Work Permit (CWP), Form 719L, for general facility operations and/or specific non-routine tasks. Typical radioactivity dose rates for specific work areas are shown in Table 3. Applicable regulatory dose rate limits are shown in Table 4.

The decontamination of packages and equipment is typically accomplished by hand wiping, hand washing, or spraying with a high-pressure washer. Two fume hoods with 3-foot by 6-foot work areas are available to decontaminate small items. Small items to be decontaminated are typically washed with non-hazardous cleaning solutions using the fume hoods to control the airflow. The decontamination room also has a large, sealed stainless steel floor area that may be used to decontaminate larger items. This area is equipped with a monorail crane to facilitate the handling of large, heavy items. Flexible ducting connected into the facility HEPA ventilation system is used to provide localized ventilation when needed.

3.5.3 Packaging and Size Reduction

Size reduction and packaging of radioactive waste materials is carried out in the packaging room of Building 4021. These operations may include the use of a cutting torch, jackhammer, or concrete saw. The level of protective clothing required for personnel performing the work is specified by the HP, and as required the SHEA Health & Safety representative, in the applicable CWP (Form 719-L).

Table 3. Typical Dose Rates at RMHF

Building / Area	Dose Rate (µR/h)
Background (SSFL)	8
Fence line	10 - 1000
Building 4022	15 - 200
Building 4021	
Laundry room	100 - 400
Hot change room	100 - 1000
Decontamination room	400 - 5,000
Evaporator Surface	5,000 - 10,000
Packaging room	1,000 - 3,000
Mixer	1,500
Building 4075 (inactive)	100 - 2,000
Building 4621	100 - 5,000
Building 4034	10 - 15
Building 4044	12 - 60
Building 4665	11 - 30

Table 4. Applicable RMHF Regulatory Dose Rate Limits

Condition	Regulatory Limit and Reference
Posting of "Radiation Area" signs required	5,000 µR/h *(Reference 18)*
Maximum allowed at fence line	2,000 µR/h *(Reference 7)*
Maximum dose to general public	100,000 µR/yr *(Reference 8)*
Maximum dose to occupational worker	$2x10^6$ µR/yr *(Reference 9)*

The cutting torch operation uses compressed oxygen gas (200-ft.^{3} "K" bottles). The bottles are brought to the facility on an "as needed" basis in sufficient quantity to perform the specific task. Empty and excess bottles are removed from the facility at the end of the job. Since compressed gases are classified as a hazardous material (reportable quantity = 200 ft.^{3}), the RMHF PIC reports inventory quantities in excess of one "K" bottle to SHEA for reporting to the appropriate government agencies.

3.5.4 Storage and Transfer

Upon receipt at the RMHF, packaged waste from other facilities (e.g., potentially Building 4024 or 4059) is placed in the designated "Hold" area until it is visually inspected, surveyed, and

logged into the RMHF Tracking System (RTS). Packaged radioactive waste materials are transferred to designated areas within Buildings 4022 or 4621, or one of the storage yards, for temporary storage pending off-site shipment for disposal. The storage vaults in Building 4022 are used as required for temporary storage of packaged higher-activity, low-level material to minimize exposure to personnel. As described in Section 3.5.1, Vault 2 contains the RWES 8,000-gallon tank.

3.6 TYPES AND AMOUNTS OF RADIOACTIVE MATERIALS AND WASTE

The amounts of radioactive material and waste stored at the RMHF vary as amounts are received from the ongoing D&D projects and shipments are made for off-site disposal. Depending on D&D activity levels, up to approximately two hundred radioactive items (waste containers and stored equipment) may be located at the RMHF (currently there are less than 20 containers of LLW at the RMHF). Wastes are managed and stored in accordance with DOE Order 435.1, "Radioactive Waste Management," *(Reference 11)* and the ETEC Closure implementing document, EPA-00061 *(Reference 12)*. The total quantitative amount of radioactive material and waste present at the SSFL (including current and proposed D&D projects) is currently estimated to be less than 7 curies, 4.63 curies of which are located at the RMHF (see Section 4.1).

3.6.1 Building 4021

Building 4021 is a decontamination and waste packaging facility. Waste is not routinely stored in the building unless it is scheduled for sampling, size reduction, or repackaging. This building houses the radioactively contaminated water evaporator (RWES). The evaporator generates radioactive solids as it evaporates the contaminated water, generating between ~5 and 55 gallons of low-level waste (LLW) per year depending on the level of D&D activities and the corresponding amount of water (~ 50 to 500 gallons of water per month) processed. The water is generated from the decontamination of tools, rinse water from equipment cleaning, and waste water generated by D&D activities at other facilities, such as concrete cutting.

3.6.2 Building 4022

The above ground area of Building 4022 is used primarily as a work area, so boxes of waste are not typically stored in Building 4022. However, large components moved from D&D areas that must be handled by the overhead crane are stored in the building pending size reduction or decontamination. A large waste compactor and HEPA filtered vacuums and air movers are also routinely kept in the building.

The below-grade vaults in the building are used to store containers of higher activity LLW. Currently, with D&D activities at a minimum and a recent shipping campaign completed, the vaults are empty. As discussed in Section 3.5.1, Vault 2 contains the RWES 8,000-gallon water tank (and secondary containment).

The below-grade vaults are typically designated as confined spaces and require training specified by the DOE Site Restoration (D/117) Training Plan *(Reference 19)*, in accordance with Boeing Canoga

Park SOPs. Personnel required to make a confined space entry must have current confined space entry training certifications or no entry is permitted.

3.6.3 Building 4075 and Yard

Building 4075 is currently empty and inactive. The yard to the east of Building 4075 is used for the temporary storage of packaged LLW during pre-shipment staging for off-site disposal. On the average, fewer than 40 waste containers (~ two shipments worth) are stored in this yard pending shipment.

3.6.4 Building 4621 and Yard

The radioactive materials stored at Building 4621 are source materials (calibration sources), smoke detectors that contain radioactive material (not regulated), and mixed low level waste stored in 55-gallon drums or 5-gallon pails.

The yard around Building 4621 is used primarily for the storage of packaged MLLW (IP2, 1A2, or 7A metal containers). Packaged LLW and/or the RWTT is also stored in separate areas (segregated from the MLLW) of the 4621 yard.

3.6.5 Activity Levels

Typical activity levels at the RMHF and the general site background levels are listed in Table 3. Regulatory limits are listed in Table 4. The radiation levels at the fence line are well within regulatory limits. The dose rate to SSFL facilities outside the fence line and to the surrounding population centers is insignificant. The levels vary depending on the number of containers of packaged waste and the level of activities at the RMHF.

3.7 AUXILIARY SYSTEMS

Facility operations, potential radiological hazards, and in-place radiological controls no longer require facility emergency auxiliary power *(Reference 20)*.

3.8 RMHF PERSONNEL REQUIREMENTS

3.8.1 Personnel Medical Surveillance

Boeing-Canoga Park maintains a formal Medical Surveillance program that is specified in SOP C-303 *(Reference 21)*. This program complies with applicable California *(Reference 22)* and Federal *(Reference 23)* regulations. It specifies that employees exposed to certain toxic substances or physiologically stressful environments be placed on an appropriate medical surveillance program to ensure early detection of conditions possibly related to workplace exposure. All employees assigned to work at the RMHF are required to take an annual medical examination as part of the Medical Surveillance Program. The employee's manager initiates the medical examination process by filling out a Medical Surveillance Program Application (Form

625-J-3), which identifies the applicable "On the Job" exposures. This form provides guidance to the types of medical tests that are appropriate for the employee.

3.8.2 Personnel Training

The Boeing Canoga Park training policy is presented in SOP 18.0 *(Reference 24)* and related procedures SOP A-506 (Training and Certification) *(Reference 25)* and SOP A-507 (Special Skills) *(Reference 26)*. The requirement for certification training may be regulatory, company imposed, or a contract requirement. In addition, "special skills" training may be required by local management to ensure the effective performance of a task. Employees assigned to special skill or certification tasks must:

1. Ensure that their personal certifications, including any needed medical or eye exams, are up to date
2. Not perform any task for which they are not trained, or under the circumstances of expired certifications or medical/eye exams
3. Inform their management of the expiration of any required special skill certification or medical/eye exam, and attend certification training when scheduled

Supplemental training guidance is provided in the ETEC Closure Training Plan *(Reference 19)*. Regulatory required training related to the permitted (RCRA TSD) facility activities are documented in records maintained on specific forms at the RMHF. General training records are maintained electronically by the Boeing Training Department. The RMHF PIC and the DOE Site Restoration team manager select the required training and arrange course attendance. Similarly, the PIC and DOE Site Restoration team manager assist in ensuring personnel training requirements are up to date.

3.8.3 Personal Protective Equipment

The RMHF personal protective equipment (PPE) requirements are specified for each new task or when the nature of an on-going task changes. Non-routine RMHF tasks are described in detail on an EWR (Form R 94-L). A CWP (Form 719L) is completed for general facility tasks and for new or non-routine tasks, and the HP identifies PPE requirements based on task radiological considerations. Similarly, any special PPE requirements other than radiological are specified by a SHEA Health & Safety or Environmental representative on the same CWP. While PPE requirements related to chemical activities would be specified, it is unusual at the RMHF because the radiological activities at the facility preclude the presence of chemicals where practical to prevent the possible generation of mixed waste.

4.0 SAFETY ANALYSIS

The RMHF Safety Analysis consists of three parts: (1) a Hazard Categorization in accordance with DOE-STD-1027-92 *(Reference 27)* to determine the sum of fractions of the radioactive materials present at the facility and the corresponding Hazard Category; (2) a Risk Assessment in accordance with OAK-STD-5481.1-B *(Reference 5)* to determine the facility "risk" level; and (3) an Accident Analysis in accordance with DOE-STD-1027-92 to validate the basis for the hazard categorization and demonstrate that doses associated with any accident conditions are within specified limits.

4.1 HAZARD CATEGORIZATION

The radiological inventory at the RMHF was updated effective 12/19/02, following the transfer of all transuranic waste to the DOE Hanford site. There it was placed in interim storage for final characterization and subsequent shipment to the Waste Isolation Pilot Plant (WIPP) for ultimate disposal. The RMHF hazard categorization was determined in accordance with DOE-STD-1027-92 *(Reference 27)* based on the updated inventory. Table 5 presents the detailed analysis, resulting in a sum of fractions of 0.227. That validates the downgrading of the RMHF from a Category 3 nuclear facility (prior to shipment of the TRU) to a radiological facility, based on a sum of fractions < 1.0. The total curie content of the radioactive material at the RMHF was calculated to be 4.63 curies (Table 5).

4.2 RISK ASSESSMENT

The risk assessment conducted for the RMHF resulted in a "Low" risk rating as defined in *Reference 5*. Table 6 summarizes the results of the assessment and identifies the hazards to personnel and the environment, the possible initiating events, and the potential effects considered. The risk assessment identifies the protective measures to detect and to prevent or mitigate the identified hazards. That includes actions required in response to the alarm instrumentation warning signals (identified in Table 2)

Based on engineering experience and operating history, a subjective risk assessment was performed using a graded approach to establish a qualitative probability and an associated consequence for each possible incident following the procedure described in Appendix D of OAK-SD-5481.1-B *(Reference 5)*. This risk assessment assumes that management surveillance, training, and procedures are inherent to the operations. Therefore, the probability of each event is the probability of occurrence with safety precautions in place. Definitions of the probability and consequence rating levels, taken from *Reference 5*, are listed in Table 7 and Table 8. The risk is a function of both the probability and the consequence. The risk matrix is shown in Table 9.

Because of planned monitoring, training, procedures, and the use of protective clothing as required for the processing and packaging of radioactive waste materials, the risk of significant exposure to, skin contamination with, inhalation of, or ingestion of, the very small amounts of hazardous or

radioactive species at the RMHF is rated low to negligible. Radiation safety procedures are detailed in *References 9* and *16*.

Injury due to accidents involving equipment operation, heat/cold/work stress, and excessive noise are potential hazards. Procedures, training, and monitoring are implemented to reduce these risks to the lowest possible level. Burns to personnel from the hot (200 ^{o}F) water in the evaporator have an extremely low probability, due to the automatic operation of the evaporator, the presence of an overflow line to the sump, and a berm around the area. In addition, the evaporator is enclosed to prevent personnel contact with the water.

Protective action for fire includes the clearing of weeds, grass, brush, and other combustible material from the perimeter area. There is also a perimeter sprinkler system. The risks associated with spreading contamination off-site are extremely low to negligible. The nearest public residences are 2 to 3 miles away. As detailed in Section 4.2, airborne contamination from a fire involving radioactive materials would have an extremely low consequence, because radioactive materials are stored in steel (non-flammable) containers. As shown in Table 5, the total curie content of the radioactive material at the RMHF is less than 5 curies. And as shown in the analysis of Section 4.3, in the worst case of a fire involving all the radioactive waste containers, it was calculated that it would result in an effective dose no more than 17 mrem at the site boundary and no more than 1.1 mrem at the nearest residence. All combustible radioactive material (paper, plastic, etc.) is stored in steel containers.

A HEPA filter failure would result in a dose to the maximally exposed off-site individual (see Section 4.3) of 0.0006 mrem/year. That theoretical dose is two orders of magnitude less than the limit requiring monitoring, and four orders of magnitude less than regulatory dose limits to the general public. It is based on a detailed calculation made previously to evaluate the effect of a HEPA filter failure on off-site airborne releases *(Reference 28)*, ratioed to the 2002 theoretical airborne release exposure value (Section 4.3.3).

Transport by water runoff is controlled by the catch basin. Accumulated runoff is analyzed periodically. During periods of heavy rainfall, the pumping system has not always been able to prevent catch basin overflow. In each case the runoff was analyzed and verified to contain no radioactivity. Historical data show that the runoff water from RMHF is not radioactive because all radioactive material stored outside the RMHF is packaged in externally clean (uncontaminated) steel containers and all decontamination activities take place inside Building 4021. Water entering Buildings 4021 and 4022 from any source (rain, emergency sprinklers, etc.) is collected in the sump tank and subsequently treated as radioactive water.

Personnel and equipment leaving the facility are monitored to verify decontamination. In addition, all packaged radioactive waste is surveying or sampling and documented prior to off-site transport for disposal.

As a result of this risk assessment, the RMHF facility has a “low risk” classification rating.

Table 5. RMHF Hazard Categorization (Sum of Fractions)

Isotope	Units	Specific Activity (Ci/g)	RMHF Evap. Sludge	Radioactive Sources	RMHF LLRW	Total (curies or grams)	Category 3 TQ Limits (curies or grams)	Units	Fraction	Total Curies	Category 2 TQ Limits (Curies or grams)	Units	Fraction	Isotope
A	B	C	D	E	F	G	H	I	J	K	N	O	P	Q
						D+E+F			G/H	G (Ci)			I/O	
H-3	Ci	9.6E+03			8.6E-01	8.6E-01	1.6E+04	Ci	5.4E-05	8.6E-01	3.0E+05	Ci	2.9E-06	H-3
Mn-54	Ci	8.0E+03		3.1E-09		3.1E-09	8.8E+02	Ci	3.5E-12	3.1E-09		Ci		Mn-54
Co-57	Ci	8.4E+03	9.7E-05	6.6E-09		9.7E-05	6.0E+03	Ci	1.6E-08	9.7E-05		Ci		Co-57
Co-60	Ci	1.1E+03	4.6E-03		1.4E-01	1.4E-01	2.8E+02	Ci	5.1E-04	1.4E-01	1.9E+05	Ci	7.5E-07	Co-60
Sr-90	Ci	1.4E+02	5.1E-01	3.5E-09	5.4E-01	1.0E+00	1.6E+01	Ci	6.6E-02	1.0E+00	2.2E+04	Ci	4.8E-05	Sr-90
Cs-134	Ci	1.3E+03	5.8E-05		1.1E-05	6.9E-05	4.2E+01	Ci	1.6E-06	6.9E-05	6.0E+04	Ci	1.1E-09	Cs-134
Cs-137	Ci	8.6E+01	2.2E-01	1.4E-02	3.9E-01	6.3E-01	6.0E+01	Ci	1.0E-02	6.3E-01	8.9E+04	Ci	7.0E-06	Cs-137
Eu-152	Ci	1.7E+02			6.2E-03	6.2E-03	2.0E+02	Ci	3.1E-05	6.2E-03	1.3E+05	Ci	4.8E-08	Eu-152
Eu-154	Ci	2.7E+02				0.0E+00	2.0E+02	Ci	0.0E+00	0.0E+00	1.1E+05	Ci	0.0E+00	Eu-154
Ir-192	Ci	9.2E+03		1.3E-14		1.3E-14	9.4E+02	Ci	1.4E-17	1.3E-14	1.2E+06	Ci	1.1E-20	Ir-192
Pb-210	Ci	7.6E+01	2.1E-03	8.2E-09		2.1E-03	3.6E-01	Ci	5.7E-03	2.1E-03	2.2E+03	Ci	9.4E-07	Pb-210
										G*C (g)				
Th-232	g	1.1E-07	1.9E+02		1.3E-07	1.9E+02	9.1E+05	g	2.1E-04	2.1E-05	1.6E+08	g	1.2E-06	Th-232
U-234	g	6.2E-03	4.9E-02	3.1E+00	5.9E-02	3.3E+00	6.7E+02	g	4.9E-03	2.0E-02	3.5E+04	g	9.3E-05	U-234
U-235	g	2.2E-06	1.6E+01	4.1E+02	4.3E+01	4.7E+02	1.9E+06	g	2.5E-04	1.0E-03	1.1E+08	g	4.3E-06	U-235
U-238	g	3.4E-07	3.3E+02	1.0E+05	2.7E+02	1.0E+05	1.3E+07	g	8.0E-03	3.5E-02	7.1E+08	g	1.5E-04	U-238
Pu-238	g	1.7E+01	1.0E-05		2.8E-04	2.9E-04	3.6E-02	g	8.1E-03	5.0E-03	3.6E+00	g	8.1E-05	Pu-238
Pu-239	g	6.2E-02	1.8E-01		1.9E-02	2.0E-01	8.4E+00	g	2.3E-02	1.2E-02	9.0E+02	g	2.2E-04	Pu-239
Pu-240	g	2.3E-01	9.7E-03		5.3E-04	1.0E-02	2.3E+00	g	4.5E-03	2.3E-03		g		Pu-240
Pu-241	g	1.0E+02	9.0E-05		1.8E-02	1.8E-02	3.1E-01	g	5.8E-02	1.8E+00	2.8E+01	g	6.4E-04	Pu-241
Pu-242	g	3.9E-03	0.0E+00		3.8E-04	3.8E-04	1.6E+02	g	2.4E-06	1.5E-06		g		Pu-242
Am-241	g	3.4E+00	4.4E-04		5.2E-03	5.6E-03	1.5E-01	g	3.8E-02	1.9E-02	1.6E+01	g	3.5E-04	Am-241
Cf-252	g	5.4E+02		3.6E-11		3.6E-11	5.9E-03	g	6.0E-09	1.9E-08	4.1E-01	g	8.7E-11	Cf-252
Sums:			0.188	0.000	0.038				**0.227**	**4.63**			**0.0016**	
			Pu (g)	Pu (g)	Pu (g)				fractions	Ci			fractions	

Table 1 shows the radioisotope inventory for all waste streams.
Physical inventories for the various waste streams are shown in Columns D-F and totaled in Column G.
The inventory isotopic values (Column G) divided by the Category 3 threshold quantities (Column H) are shown as fractions in Column J.
The inventory isotopic values (Column G) divided by the Category 2 threshold quantities (Column N) are shown as fractions in Column P.
The physical inventory in Curies is given in Column K.

Table 6. Risk Assessment Summary Table *(Sheet 1 of 5)*

Potential Hazard	Initiating Events	Potential Effects	Protective Measures	Risk Assessment		
				Probability	Consequence	Risk
Radioactive Materials Radioactive waste Sources Contaminated equipment Contaminated materials	Improper storage	Radiation exposure above occupational limit, inhalation, ingestion	Training, procedures, shielding, monitoring, radiation alarms	Extremely low	Low	Negligible
	Improper handling	Radiation exposure above occupational limit	Training, procedures, shielding, radiation alarms	Extremely low	Low	Negligible
	Prolonged exposure	Radiation exposure above occupational limit	Procedures, posting, monitoring, film badges, dosimeters	Low	Low	Negligible
	Airborne release during handling or decontamination	Inhalation of airborne radioactive materials	Breathing zone & continuous air sampling, training, procedures, protective clothing, respiratory devices	Low	Low	Negligible
	Insufficient decontamination of personnel	Ingestion, inhalation	Decontamination procedures and monitoring	Low	Extremely low	Negligible
		Environmental contamination	Decontamination procedures and monitoring	Low	Extremely low	Negligible
	Ventilation system failure	Inhalation of airborne radioactive materials	Automatic backup blower and alarm	Extremely low	Low	Negligible
	Evaporator system leakage or overflow	Skin contamination or inhalation of airborne radioactive materials	Evaporator automatic shutdown; overflow line or leakage to sump tank	Medium	Low	Low
	Radioactive liquid spill during operations	Skin contamination	Procedures, training, protective clothing	Medium	Low	Low

Table 6. Risk Assessment Summary Table *(Sheet 2 of 5)*

Potential Hazard	Initiating Events	Potential Effects	Protective Measures	Risk Assessment		
				Probability	Consequence	Risk
Radioactive Materials (con.) Radioactive waste Sources Contaminated equipment Contaminated materials	Leakage of container or vault	Skin contamination	Procedures, training, protective clothing	Low	Low	Negligible
	Fire involving radioactive materials	Inhalation of airborne radioactive materials	Smoke detectors, procedures, sprinklers, extinguishers	Extremely low	Low	Negligible
		Environmental contamination	On-site fire department, fire-extinguishing equipment, perimeter sprinklers, steel waste containers, incombustible wastes (concrete/steel)	Low	Extremely low	Negligible
	Skin injury while working with radioactive materials	Skin contamination	Procedures, training, protective clothing	Medium	Low	Low
	Smoking or eating in radioactive area	Ingestion of radioactive materials	Procedures, training	Low	Low	Negligible
	Loss of containment	Skin contamination, inhalation, ingestion	All metal containers, procedures, training	Medium	Low	Low
	Failure of HEPA stack filter	Environmental contamination (insignificant)	Stack radioactive exhaust monitor and alarm, periodic filter checks	Medium	Extremely low	Negligible
	HEPA filter ducting leak	Environmental contamination	Negative pressure maintained in duct	Medium	Extremely low	Negligible
	Overflow of RMHF catch basin	Environmental contamination	Manual level checks during rainy periods, emergency pumps & hoses; overflow alarm	Medium	Extremely low	Negligible

Table 6. Risk Assessment Summary Table *(Sheet 3 of 5)*

Potential Hazard	Initiating Events	Potential Effects	Protective Measures	Risk Assessment		
				Probability	Consequence	Risk
Radioactive Materials (con.) Radioactive waste Sources Contaminated equipment Contaminated materials	Pumping radioactive water from RMHF catch basin to SSFL holding pond	Environmental contamination	Radiation alarm for RMHF catch basin and monthly sampling	Low	Extremely low	Negligible
	Spillage or accident during on-site or off-site transfer of radioactive material	Environmental contamination	Procedures, training, regulations, on-site emergency response team	Medium	Extremely low	Negligible
	Incorrect disposal of waste off-site	Environmental contamination	Surveying, Quality Assurance oversight, procedures, documentation	Low	Extremely low	Negligible
	External event (brush fire, seismic event, airplane crash, terrorist attack)	Environmental contamination	Safe storage, emergency response teams, procedures, training	Low (fire, seismic) Extremely low (crash, attack)	Low	Negligible
Hazardous materials Waste material Cleaning agents	Airborne release of toxic material, including dangerous gases and asbestos	Inhalation or ingestion of material	Procedures, training, personal protective equipment	Medium	Low	Low
	Spill or release of corrosive material	Skin damage; equipment and/or material damage	Procedures, training, personal protective equipment	Medium	Low	Low
	Heat or spark ignition of ignitable material (e.g., size-reduction operations)	Injury to personnel (burns); fire	Smoke detectors, fire-watch, procedures, sprinkler systems, extinguishers	Low	Low	Negligible
	Chemical reaction of reactive material	Inhalation of fumes, skin damage; damage to equipment	Procedures, training; reactives generally prohibited	Extremely low	Low	Negligible

Table 6. Risk Assessment Summary Table *(Sheet 4 of 5)*

Potential Hazard	Initiating Events	Potential Effects	Protective Measures	Risk Assessment		
				Probability	Consequence	Risk
Energetic Sources Electrical systems Hot surfaces Compressed gases Pressurized systems Explosives	Electrical short or arcing	Injury to personnel (burns, electrocution); fire	Procedures, equipment maintenance, smoke detectors, sprinkler systems, extinguishers, skilled craftsmen	Low	Low	Negligible
	Circuit overload	Injury to personnel (burns); fire	Transformer over-temperature alarm, fire alarms, sprinkler systems, extinguishers	Low	Low	Negligible
	Contact with hot surfaces or exhausts	Injury to personnel (burns)	Procedures, training, protective covers	Low	Low	Negligible
	Compressed gas release (K bottles) by operator error or equipment failure	Injury to personnel	Procedures, training, equipment maintenance	Low	Low	Negligible
	Pressurized system failure (hydraulic, pneumatic)	Minor injury to personnel	Procedures, training, equipment maintenance	Low	Low	Negligible
	Energetic material explosion	None – no explosives on site				None
Confined Spaces	Inadequate breathing air (poor circulation or presence of inert gases)	Asphyxiation	Procedures, training, controlled access, respirator (where required), monitoring by personnel located outside	Low	Low	Negligible
	Egress blocked by outside event	Personnel injury or stress	Procedures, training, controlled access, monitoring by personnel located outside	Low	Low	Negligible

Table 6. Risk Assessment Summary Table *(Sheet 5 of 5)*

Potential Hazard	Initiating Events	Potential Effects	Protective Measures	Risk Assessment		
				Probability	Consequence	Risk
Mechanical Systems Cranes Compactor Fork lifts, trucks	Equipment failure	Injury to personnel	Procedures, training, monitoring, equipment checks	Low	Low	Negligible
	Operator error	Injury to personnel	Procedures, training, monitoring	Low	Low	Negligible
Overhead Objects Cranes Elevated objects	Crane component failure, resulting in crane or load drop	Injury to personnel	Procedures, training, personal protective equipment	Medium	Low	Low
	Falling objects (tools, etc.)	Injury to personnel	Procedures, training, personal protective equipment	Low	Low	Negligible
Elevated Work Areas	Fall from elevated work area (e.g., roof, work basket)	Injury to personnel	Procedures, training, controlled access, safety harness	Low	Medium	Low
	Fall from ladder	Injury to personnel	Procedures, training	Medium	Low	Low
	Fall into vault or pit	Injury to personnel	Procedures, training, controlled access, safety harness, railings installed when vaults open for extended periods	Low	Medium	Low
Work Environment	Working condition temperature extremes	Minor occupational illness	Procedures, training, monitoring, work scheduling, routine physical examinations	Medium	Low	Low
	Work load or schedule	Work stress leading to minor occupational illness	Procedures, training, monitoring, work scheduling, routine physical examinations	Low	Low	Negligible
	Excessive noise	Injury to personnel	Monitoring and hearing protection where required	Low	Low	Negligible

Table 7. Probability Rating Levels

Category	Symbol	Description
Incredible		Probability of occurrence is so small that a reasonable scenario is not conceivable. These events are not considered in the design or accident analysis.
Extremely Low	A	Probability of occurrence is extremely unlikely or the event is not expected to occur during the life of the facility or operation. Events are limiting faults considered in design (design basis accidents).
Low	B	Probability of occurrence is unlikely or the event is not expected to occur but may occur during the life of the facility or operation.
Medium	C	Event may occur during the facility or operation lifetime.
High	D	Event is likely to occur several times during the facility or operation lifetime.

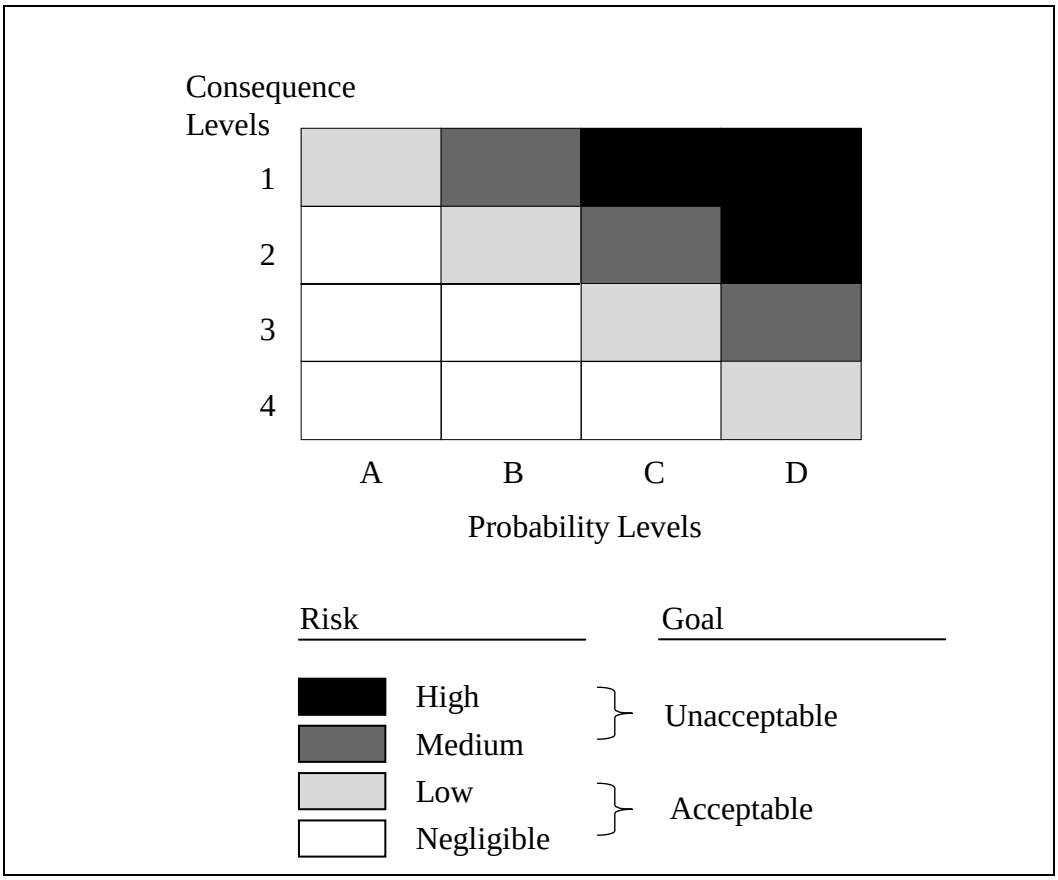
Source: OAK SD 5481.1-B *(Reference 5)*

Table 8. Consequence Rating Levels

Consequence Level	Descriptive Word(s)	Maximum Consequence
1	High	Serious impact on-site or off-site. May cause deaths or loss of the facility/operation. Major impact on the environment.
2	Medium	Major impact on-site or minor impact off-site. May cause death, severe injury, or severe occupational illness to personnel or major damage to a facility/operation or minor impact on the environment. Capable of returning to operation.
3	Low	Minor on-site with no off-site impact. May cause minor injury or minor occupational illness or minor impact on the environment.
4	Extremely Low	Will not result in a significant injury or occupational illness or provide a significant impact on the environment.

Source: OAK SD 5481.1-B *(Reference 5)*

Table 9. Risk Matrix



4.3 RADIONUCLIDE ACCIDENT ANALYSIS

4.3.1 Accident Analysis Methodology

A bounding accident analysis was performed using RMHF radionuclide inventories. Assumptions were intentionally made as non-scenario-specific as possible. Thus, conservative release assumptions were made which could result from any serious accident initiator (e.g., fire, seismic event, aircraft impact, etc.). The following assumptions were used in the analysis:

1. Airborne release fractions (ARFs) as recommended in NUREG 1140 *(Reference 29)* are assumed to be released by the generic accident (See Tables 10 and 11 below).
2. The inventory of all waste stored at the RMHF is assumed to be involved in the same generic accident. (See Table 11 below.)
3. Dispersion of radionuclides was calculated using a χ/Q method as specified in NRC Regulatory Guide 1.145 *(Reference 30)*.
4. Worst-case meteorological conditions are assumed with a wind speed of 1 m/sec and stability class G.
5. Radionuclides are assumed to be released in 2 hours as recommended in 10 CFR 100 *(Reference 31)*.

6. All debris and the ARF of each radionuclide in inventory are assumed to escape directly from the facility at ground level. Effluent is subsequently blown directly toward the nearest site boundary and the off-site location of the "maximally exposed individual (MEI)." This maximizes the dose at the nearest site boundary. Doses at the MEI are unaffected by release height assumptions.

Table 10. Airborne Release Fractions

Properties	RMHF Radionuclides	RMHF ARFs
Gases	H-3	1
Highly volatile/ combustible	None	0.5
Semi-volatile	Cs-137, Cs-134	0.01
Solid/powder/liquid	All others	0.001

Table 11. RMHF Activities for χ/Q Accident Analysis

Isotope	Specific Activity (Ci/g)	Total (Ci or g)	Units	Total Curies	ARF	ARF-Adjusted Curies
H-3	9.6E+03	8.6E-01	Ci	8.6E-01	1	8.6E-01
Mn-54	8.0E+03	3.1E-09	Ci	3.1E-09	0.001	3.1E-12
Co-57	8.4E+03	9.7E-05	Ci	9.7E-05	0.001	9.7E-08
Co-60	1.1E+03	1.4E-01	Ci	1.4E-01	0.001	1.4E-04
Sr-90	1.4E+02	1.0E+00	Ci	1.0E+00	0.001	1.0E-03
Cs-134	1.3E+03	6.9E-05	Ci	6.9E-05	0.01	6.9E-07
Cs-137	8.6E+01	6.3E-01	Ci	6.3E-01	0.01	6.3E-03
Eu-152	1.7E+02	6.2E-03	Ci	6.2E-03	0.001	6.2E-06
Eu-154	2.7E+02	0.0E+00	Ci	0.0E+00	0.001	0.0E+00
Ir-192	9.2E+03	1.3E-14	Ci	1.3E-14	0.001	1.3E-17
Pb-210	7.6E+01	2.1E-03	Ci	2.1E-03	0.001	2.1E-06
Th-232	1.1E-07	1.9E+02	g	2.1E-05	0.001	2.1E-08
U-234	6.2E-03	3.3E+00	g	2.0E-02	0.001	2.0E-05
U-235	2.2E-06	4.7E+02	g	1.0E-03	0.001	1.0E-06
U-238	3.4E-07	1.0E+05	g	3.5E-02	0.001	3.5E-05
Pu-238	1.7E+01	2.9E-04	g	5.0E-03	0.001	5.0E-06
Pu-239	6.2E-02	2.0E-01	g	1.2E-02	0.001	1.2E-05
Pu-240	2.3E-01	1.0E-02	g	2.3E-03	0.001	2.3E-06
Pu-241	1.0E+02	1.8E-02	g	1.8E+00	0.001	1.8E-03
Pu-242	3.9E-03	3.8E-04	g	1.5E-06	0.001	1.5E-09
Am-241	3.4E+00	5.6E-03	g	1.9E-02	0.001	1.9E-05
Cf-252	5.4E+02	3.6E-11	g	1.9E-08	0.001	1.9E-11
Totals:				**4.63**		**0.87**

4.3.2 Results

Doses were calculated at two distances:

1. 300 meters, corresponding to the nearest SSFL site boundary
2. 2,867 meters, corresponding to the location of the maximally exposed off-site individual (MEI).

Doses and risks are shown in Table 12. Risks were based on a 5 x 10^{-7} risk per mrem equivalence *(Reference 32)*. The dose at the site boundary is 17 mrem (risk = 8.5 x 10^{-6}) and the dose at the MEI is 1.1 mrem (risk = 5.5 x 10^{-7}). These doses are negligible compared to the NRC post-accident exclusion area limit of 25,000 mrem (risk = 0.0125) from *Reference 31* and the EPA post-accident protective action guideline (PAG) of 10,000 mrem (risk = 5 x 10^{-3}) from *Reference 33*. It is also less than the background exposure of 300 mrem per year (risk/year = 1. 5 x 10^{-4}).

Table 12. Accident Doses and Risks

Generic Accident with Ground Level Release	Location	
	SSFL Site Boundary (300 m)	Maximally Exposed Individual (2,867 m)
Individual Dose	17 mrem	1.1 mrem
Individual Risk	8.5 x 10^{-6}	5.5 x 10^{-7}

4.3.3 Routine Operations

Doses to the site boundary and the MEI are calculated each year and reported to DOE and EPA as required by NESHAPS (National Emission Standards for Hazardous Air Pollutants – Radionuclides) *(Reference 34)*. Results are also reported each year in the Annual Site Environmental Reports for DOE operations at SSFL. For 2002, the theoretical exposure to the MEI was 1.5 x 10^{-6} mrem/year (risk/year = 0.75 x 10^{-12}) *(Reference 35)*. This is well below the NESHAPS limit for airborne effluent of 10 mrem/year (risk/year = 5 x 10^{-6}) and the dose from naturally occurring indoor radon of 200 mrem/year (risk/year = 1 x 10^{-4}).

5.0 TECHNICAL SAFETY REQUIREMENTS

Technical safety requirements (TSRs) are conditions, limitations, or controls to assure safe operation of a facility (i.e., the RMHF). The TSRs are auditable requirements and are upper bound limits for safe facility operation. Operational Safety Requirements (OSRs) are the equivalent of TSRs for non-nuclear facilities *(Reference 5)*.

The greatest potential consequence to personnel is from radiation exposure, contamination, and airborne radioactivity. Numerous precautions are in-place and implemented through surveillance, procedures, and training to prevent these occurrences. The "Quality Assurance Program for ETEC Closure," QA-00001 *(Reference 36)*, provides additional oversight and assurance that the precautions are implemented. Because the risk associated with each potential hazard is rated low or negligible in accordance with definitions of the probability and consequence rating taken from OAK-SD 5481.1-B *(Reference 5)*, there are no OSRs or TSRs required for this operation.

6.0 QUALITY ASSURANCE

Documents QA-00001 *(Reference 36)*, "Quality Assurance Program Plan for ETEC Closure," and QA-00002 *(Reference 37)*, "Quality Assurance Inspection Requirements for Radioactive Shipments," define the requirements that assure that established Quality Assurance objectives for the RMHF program are satisfied. The requirements include surveying, sampling, and handling requirements and procedures; checking, auditing, and verification requirements; and inspections, documentation, and records requirements.

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21. Boeing Canoga Park System of Procedures, “Medical Surveillance Program,” SOP C-303

22. California Code of Regulations (CCR) Title 8, “Industrial Relations,” Division 1, Chapter 4, Subchapter 7, “General Industry Safety Orders,” including Article 105, “Control of Noise Exposure,” and Article 107, “Dusts, Fumes, Mists, Vapors and Gases”

23. Code of Federal Regulations 29, Labor, Part 1910 (29CFR1910), “Occupational Safety and Health Standards” [4]

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25. Boeing Canoga Park System of Procedures, “Training and Certification,” SOP A-506

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ACRONYMS

A/C	Air conditioning
ALARA	As low as reasonably achievable
ARF	Airborne Release Fraction
BCC	Boeing Communications Center
CFR	Code of Federal Regulations
CWP	Controlled Work Permit
D&D	Decontamination and decommissioning
DOE	Department of Energy
DOE-OAK	Department of Energy Oakland Operations Office
EAA	Emergency Assembly Area
EMT	Emergency Medical Technicians
EPA	Environmental Protection Agency
ETEC	Energy Technology Engineering Center
EWR	Engineering Work Request
HASP	Health and Safety Plan
HEPA	High-efficiency particulate air (filter)
HP	Health Physicist
ISMS	Integrated Safety Management System
LLW	Low-level waste
MEI	Maximally exposed individual
MLLW	Mixed low-level waste
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NRC	Nuclear Regulatory Commission
OSR	Operational Safety Requirement
PAG	Protective action guideline
PHA	Process Hazard Analysis
PIC	Person In Charge
PPE	Personal protective equipment
R/A	Radioactive
RCRA	Resource Conservation and Recovery Act
RMHF	Radioactive Materials Handling Facility
RTS	RMHF Tracking System
RWES	Radioactive Water Evaporation System
RWTT	Radioactive water transfer tank
SHEA	Safety, Health and Environmental Affairs
SNAP	Systems for Nuclear Auxiliary Power
SNM	Special nuclear materials
SOP	System of Procedures (Boeing Canoga Park)
SSFL	Santa Susana Field Laboratory
TRU	Transuranic
TSD	Treatment, storage, and disposal
TSR	Technical Safety Requirement
UBC	Uniform Building Code
WIPP	Waste Isolation Pilot Plant