2016 Site Description: Santa Susana Field Laboratory (SSFL)

Proposed Corrections to Technical Basis Documents 1 & 2

ORAUT-TKBS-0038-1 / ORAUT-TKBS-0038-2

CORE Advocacy for Nuclear & Aerospace Workers

Prepared by:
CORE Advocacy for Nuclear & Aerospace Workers • COREAdvocacy.org

For Review by:
National Institute for Occupational Safety and Health (NIOSH)
Presidential Advisory Board on Radiation and Worker Health (ABRWH)

Presented to NIOSH / ABRWH at the Idaho Falls, ID ABRWH Meeting, August 9, 2016

Note: Building numbers and operations are non-sequential at SSFL.
Table 3 (p. 28) contains a numerical list of buildings and their page numbers.

The table also provides radionuclides of concern at each location, operations, number of incidents, whether operations may have involved DOE-NASA or Area I, II & III workers, and whether the location was included/excluded from the 2006 Site Profile.

This document pertains to DOE - LMEC - ETEC Operations at SSFL.

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* Table 3 provides the following information: SSFL buildings/functions in numerical order; changes to building numbering schemes; Visitor Log Entry Codes (partial list); radionuclides used at each location; existence of Tritium / Neptunium; specifies DOE-NASA joint projects; number of incidents associated with each location; and shows whether the location was included/omitted from the 2006 Site Profile.

(* Add t ona Hot Laboratory and Van de Graaf Part c e Acce erator, exc uded from 2006 S te Descr pt on.)

LIST OF ACRONYMS & ABBREVIATIONS

ABRWH	Advisory Board on Radiation and Worker Health
ABTSWH	Advisory Board on Toxic Substances and Worker Health
AEC	U.S. Atomic Energy Commission
ARRA	American Recovery and Reinvestment Act
AETR	Advanced Epithermal Thorium Reactor
AI	Atomics International Division, North American Aviation
Atomics International	Atomics International Division, North American Aviation
CDPHE	California Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	Curie
COC	Contaminants of Concern
CRIEPI	Central Research Institute of the Electrical Power Industry
DEEOIC	Division of Energy Employee Occupational Illness Compensation
D&D	decontamination and decommissioning
DD&D	decontamination, decommissioning and demolition
DHS	Department of Health Services
DOE	U.S. Department of Energy
DOD	Department of Defense
DOL	U.S. Department of Labor
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DTSC	Department of Toxic Substances Control
EEOICPA	Energy Employee Occupational Illness Compensation Program Act
EPA	U.S. Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
FAB	Final Adjudication Branch
FCEL	Fast Critical Experiment Laboratory
FOIA	Freedom of Information Act
HEPA	high-efficiency particulate air
HGL	HydroGeoLogic, Inc.
HSA	Historical Site Assessment
HWMF	Hazardous Waste Materials Facility
HQ	headquarters
KEWB	Kinetic Experiment Water Boiler
KHI	Kawasaki Heavy Industries
kW	kilowatt
kWt	thermal kilowatt
LLTR	Large Leak Test Rig
LMEC	Liquid Metal Engineering Center
LMFBR	Liquid Metal Fast Breeder Reactor
μR/hr	micro roentgen per hour
mR/hr	milli roentgen per hour
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual

MCP	maximum permissible concentration
MDA	minimum detectable activity
MFP	"mixed fission products"
MOU	memorandum of understanding
MWd	megawatts per day
NASA	National Aeronautics and Space Administration
NBZ	Northern Buffer Zone
NIOSH	National Institute for Occupational Safety and Health
NMDF	Nuclear Materials Disposal Facility
NRC	Nuclear Regulatory Commission
NSA	nuclear safety analysis
ORISE	Oak Ridge Institute for Science and Education
PDU	Plant Development Unit
pCi/g	picocuries per gram
POC	Probability of Causation
R/A	radioactive
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RHB	Radiological Health Branch
RMHF	Radioactive Material Handling Facility
RMF	Radioactive Measurements Facility
S2DR	SNAP 2 Demonstration Reactor
S8DR	SNAP 2 Development Reactor
SB	Senate Bill
SBZ	Southern Buffer Zone
SC&A	Sanford Cohen & Associates
SCTI	Sodium Components Test Installation
SCTL	Small Components Test Laboratory
SETF	SNAP Environmental Test Facility
SGR	sodium graphite reactor
SHEA	Safety Health and Environmental Affairs
SNAP	Systems for Nuclear Auxiliary Power
SNAPFS	SNAP Flight Systems
SNAPTRANS	SNAP Transient Reactor
SPTF	Sodium Pump Test Facility
SRE	Sodium Reactor Experiment
SSFL	Santa Susana Field Laboratory
SEM	*Site Exposure Matrix*
TM	Technical Memorandum
TO	Task Order
TRU	Transuranic
TRUMP-S	TRU Management by Pyropartitioning - Separation

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1.0 Introduction

CORE ADVOCACY FOR NUCLEAR & AEROSPACE WORKERS

CORE Advocacy for Nuclear & Aerospace Workers provides advocacy and Authorized Representation for Santa Susana Field Laboratory (SSFL), Canoga, Van Owen, DeSoto, and Downey claimants of the Energy Employee Occupational Illness Compensation Program (EEOICPA or, “the Act”). We are members of the Alliance of Nuclear Worker Advocacy Groups (ANWAG), the Energy Employee Claimant Assistance Project (EECAP), and the former Division of Energy Employee Occupational Illness Compensation Interim Advisory Board (DIAB). CORE Advocacy participates in annual meetings held in the spirit of improving EEOICPA, which are attended by advocates and members of federal agencies tasked with EEOICPA’s administration.

CORE Advocacy supports full disclosure of SSFL site operations and history to better understand work environment and practices, and to effectively implement EEOICPA legislation. Our extensive research into SSFL and contractor history is based on official documentation, original facility records, and technical reports authored by the Atomic Energy Commission (AEC), Department of Energy (DOE), the National Aeronautics and Space Administration (NASA), Department of Defense (DOD), state and federal regulatory agencies, North American Aviation (NAA) Atomics International, Rocketdyne, Rockwell International, Energy Systems Group, Boeing, and actual worker records generated during employment.

1.1 The Purpose of the 2016 SSFL Site Description

CORE Advocacy for Nuclear and Aerospace Workers submits the following 2016 Santa Susana Field Laboratory (SSFL) Site Description ("2016 SSFL Site Description") for review by the National Institute for Occupational Safety and Health (NIOSH) and the Presidential Advisory Board on Radiation and Worker Health (ABRWH). This document is intended to revise and replace the 2006 Site Introduction / Site Description, which are currently considered part of the SSFL Site Profile.

As indicated by NIOSH, the purpose of a Site Profile is to provide an accurate physical description of the work site's appearance and layout, work processes, types of materials used at the site, potential sources of radiation, exposure monitoring practices employed over time, and other details that were/are relevant to the worksite. In addition, a Site Profile is intended to assist NIOSH with completing dose reconstructions when there is a need to understand or add to an energy worker's personal exposure information. A Site Profile should provide a robust, comprehensive and accurate depiction of site operations. It should be consistent with historical facility data, employment records, incident reports, and current environmental and scientific studies.

The SSFL Site Profile was issued as six separate Technical Basis Documents (TBDs) numbered ORAUT-TKBS-0038-1 through ORAUT-TKBS-0038-6. It has not been updated or revised since 2006. Several problems have been identified but remain unaddressed, including an insufficient description of operations, processes, incidents, and the omission of several important radiological facilities. The 2006 Site Profile provides an inaccurate depiction of facility operations that calls into question current environmental data currently used in the dose reconstruction process. In addition, several of the issues identified have direct bearing on the Special Exposure Cohort (SEC).

NIOSH indicates that that TBDs "are general working documents that will be revised in the event additional relevant information is obtained." CORE Advocacy has obtained the following additional relevant information about SSFL for inclusion in the Site Profile, beginning with the Site Introduction (ORAUT-TKBS-0038-1) and Site Description (ORAUT-TKBS-0038-2).

Thank you for the opportunity to provide additional information on behalf of former personnel of the Santa Susana Field Laboratory (SSFL) and its associated facilities, and Energy Employee Occupational Illness Compensation Program Act (EEOICPA) claimants.

D'Lanie Blaze
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1.2 Information Provided in the 2016 SSFL Site Description

For the purposes of this document, the word “facility” is used as a general term for an area, building, or group of buildings that served a specific purpose at SSFL or its associated sites. It does not necessarily connote an “atomic weapons employer facility” or a “Department of Energy (DOE) Facility” as defined in the Energy Employee Occupational Illness Compensation Program Act (EEOICPA) under 42 U.S.C. § 73841(5) and (12).

This document follows the original format of the 2006 Site Profile; buildings/facilities are listed according to operations. In each category, additional relevant buildings and facilities that were omitted from the 2006 document are described. Section 17.0 provides information about entire site projects and operational programs that should be included to the Site Profile to ensure an accurate site characterization.

The 2016 SSFL Site Description contains the following information about SSFL:

- Corrects and clarifies facility nomenclature and years of operation
- Describes site’s physical appearance, history, DOE operations & processes, environmental and worker monitoring practices
- Summarizes incident reports involving each location
- Provides a partial list of Visitor Log Entry Building Account Codes to locate monitored workers
- Summarizes radionuclides of concern at each building/facilities, according to EPA
- Provides EPA MARSSIM Classifications for each location

“MARSSIM" refers to Multi-Agency Radiation Survey & Site Investigation Manual Classifications. The United States Environmental Protection Agency (EPA) assigned MARSSIM Classifications to each building/facility contained in the 2016 SSFL Site Description. The United States Environmental Protection Agency (EPA) based these classifications on historical data documenting building operations, incidents, and other information that may aid NIOSH in assessing the potential radiological exposures among workers during past site operations.

MARSSIM Classifications are assigned based on the following criteria:

- **Class One:** Applies to areas with the highest potential for contamination that meet the following criteria: impacted; has had, or currently has the potential for delivering dose above the release criterion; has had, or currently has the potential for small areas of elevated activity; and where insufficient evidence exists to support a lower classification (Class 2 or Class 3) under MARSSIM.

- **Class Two:** Applies to areas that are impacted; has had, or currently has low potential for delivering a dose above the release criterion; has had or currently has little or no potential for small areas of elevated activity.

- **Class Three:** Applies to areas that are impacted; has had, or currently has little or no potential for delivering a dose above the release criterion; and has had or currently has little or no potential for small areas of elevated activity.

1.3 Source Documents Used in the 2016 SSFL Site Description

In 2009, EPA conducted a radiological characterization study within the area of SSFL known as "Area IV" and the Northern Buffer Zone (NBZ). This combined study-area is hereafter called the "Area IV Study."[1] The Area IV Study was conducted with the participation of DOE and its contractor, The Boeing Company ("Boeing"). It was prepared by HydroGeologic, Inc. (HGL).

EPA's Area IV Study consisted of a Historical Site Assessment (HSA), gamma scanning of accessible areas, geophysical surveys, and evaluation of past soil sampling results. The HSA component of the study involved a comprehensive investigation that identified, collected, organized and evaluated historical information relevant to nuclear research operations that resulted in radiological contamination of the Area IV Study area. EPA published the HSA in 2012 as an eight-volume set of DVDs.

The EPA conducted a physical inspection of the site and a review of documents that were obtained through a series of formal information requests sent to Boeing, DOE, the Nuclear Regulatory Commission (NRC), the California Department of Public Health (CDPH) under § 104(e) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), and the National Aeronautics and Space Administration (NASA).

In addition, EPA directed Boeing to identify and provide pertinent documents within a number of document databases comprising approximately 1.4 million documents relating to all areas of the SSFL including Area IV and some off-site facilities. In response to EPA's request, Boeing provided an Incident Database containing original incident reports documenting a variety of incidents over the course of site history, many of which resulted in releases of radionuclides to the environment and/or worker exposure.

EPA reviewed individual documents and photographs, first screening over 80,000 documents amassed for the project. In addition, the documents requested from the document databases comprising approximately 1.4 million documents were reviewed. EPA's screening effort produced 720 documents relevant to past operations at SSFL, which warranted in-depth evaluation. In addition, EPA and DOE jointly conducted over 300 formal employee interviews as part of the HSA. The interviews (in their entirety) are provided on the disk that accompanies the 2016 SSFL Site Description.

The quality of data gathered by EPA exceeds NIOSH's criteria for a robust, comprehensive Site Profile. CORE Advocacy has drawn largely from the EPA HSA and other official historical documents, including employment records. In the interest of worker confidentiality, cited worker records and/or Case File numbers will be provided to NIOSH and/or ABRWH upon request.

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[1] Final Technical Memorandum, *Historical Site Assessment, Santa Susana Field Laboratory Site, Area IV Radiological Study*, 2012. Environmental Protection Agency (EPA) and HydroGeologic, Inc (HGL)

1.4 Acceptance of Source Documents by Federal Agencies

As summarized in the preceding section, in response to EPA's directive to provide information for use in the Area IV Radiological Study and HSA, DOE and Boeing provided historical documentation authored by the Atomic Energy Commission (AEC), DOE, facility contractors over the course of site operations, NASA, and state and federal regulatory agencies. In addition, Boeing provided EPA with an Incident Database that contained hundreds of incident reports pertaining to SSFL (all areas of operation), Canoga, VanOwen, DeSoto, and Downey Facilities. There are indications that Boeing may have provided an identical Incident Database to NIOSH.

In addition, EPA and DOE conducted over 300 formal interviews with former personnel. EPA cross-referenced the Incident Database, historical documents, and worker interviews during the site investigation.

Based on DOE and Boeing's participation in the Area IV Study and HSA, and what appears to be NIOSH's possession of the Incident Database, it is reasonable to expect that DOE, NIOSH and Boeing will accept the same information, which is cited herein, for inclusion to the SSFL Site Profile.

2.0 OVERVIEW: The 2006 Site Profile

This section provides an overview of the 2006 Site Introduction (ORAU-TKBS-0038-1, "Atomics International - Introduction") and the 2006 Site Description (ORAUT-TKBS-0038-2, "Energy Technology Engineering Center Site Description").

In 2008, ABRWH directed Sanford Cohen and Associates (SC&A) to evaluate all six Technical Basis Documents (TBDs) that comprise the 2006 Site Profile. SC&A identified numerous issues that were likely to interfere with dose reconstruction, many of which have direct bearing on the Special Exposure Cohort (SEC). SC&A provided recommendations based on its review.

SC&A noted that the 2006 Site Profile contained an incomplete and insufficient characterization of facilities, operations, and processes associated with DOE activities at SSFL. In addition, SC&A noted that the presentation of incidents and environmental releases was incomplete and inaccurate. These inaccuracies call into question the validity of environmental data, and cast doubt upon the relevance of dose reconstruction outcomes for employees of SSFL and its associated facilities. In addition, SC&A brought attention to inaccurate site and contractor nomenclature, and incorrect years of facility operations.[1] [2]

To date, it does not appear that SC&A's observations have been fully investigated; their recommendations have not been implemented. CORE Advocacy has identified numerous other issues that are in need of correction.

2.1 Site Nomenclature: 2006 Site Introduction & Site Description

SSFL began site operations in 1948. Currently, SSFL Area IV is considered the "covered area" under EEOICPA, beginning in 1955.[3] Area IV is comprised of SSFL's westernmost 290 acres.

In 1966, the AEC established the Liquid Metals Engineering Center (LMEC) on a 90-acre area located *inside Area IV.* This area became known as the Energy Technology Engineering Center (ETEC) in 1978. "ETEC" and "Area IV" are the most common terms used to identify the "covered area" under EEOICPA.

The 2006 Site Introduction and Site Description state: "This document describes the features and history of the Energy Technology Engineering Center (ETEC) … The AEC established ETEC in 1966." The statement implies that ETEC is the extent of the covered area and that EEOICPA coverage does not begin until 1966, likely creating confusion about the site's nomenclature, years of operations, and locations of some facilities.

The SSFL Site Profile should indicate that it contains information about DOE operations involving Area IV, ETEC, and LMEC, without exception. Both should clearly indicate that EEOICPA coverage begins in 1955.

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[1] SC&A, "*Review of the NIOSH Site Profile for the Santa Susana Field Laboratory,"* August, 2008. Task Order No. I SCA-TR-TASK1-0027

[2] SC&A, *"Issues Resolution Matrix for the Santa Susana Site Profile Review,"* November, 2008.

[3] http://webapps.dol.gov/FederalRegister/HtmlDisplay.aspx?DocId=26761&AgencyId=13

2.2 Overview: 2006 ETEC Site Description - ORAUT-TKBS-0038-2

The 2006 Site Description is severely flawed. Below is an overview of the general problems, which are explained in detail in this section.

Questionable Source Data

- Boeing assumed SSFL operations in 1996, nearly 48 years after the site's inception (1948). However, the majority of source documents cited in the 2006 Site Profile consist of Boeing's own summary data and reports authored by Boeing contractors, after 1996.
- Historical facility documents and technical reports authored by DOE and Boeing's predecessors are abundant and widely available. Yet, citations to historically significant documents are severely lacking throughout the 2006 Site Profile.
- When the post-1996 summary data and Boeing-contracted reports are compared alongside original historical documents, persistent conflicts and irregularities are apparent. The post-1996 summary data and Boeing-contracted reports consistently conflict with original facility documents, employee records, and the Incident Report database.
- It is reasonable to expect that any summary data provided by Boeing would be accompanied by supportive, authentic historical documents from a wide variety of sources.

Misrepresentation of Buildings/Facilities, Operations & Processes

- In many instances, the years of facility, reactor, building, and program operations contained in the 2006 Site Profile, and the description of operations, are incomplete or incorrect.
- Descriptions of processes, materials, incidents, and releases are incomplete or incorrect.

Buildings, Facilities, Operations Excluded from 2006 Site Profile

- Numerous radiological facilities have been excluded in their entirety, along with all corresponding incident reports, descriptions of operations, documented releases, and environmental data.

“Non-Radiological” Facilities Involved in Radiological Processes

- Several designated “non-radiological” facilities have documented involvement in radioactive processes. These facilities have been excluded from the 2006 Site Profile, along with all corresponding incident reports, descriptions of operations, documented releases, and environmental data.
- These locations may have lacked proper licensing and radiological use authorizations. In addition, they may have failed to meet criteria for safe handling of radioactive materials.
- There are strong suggestions that worker monitoring practices were determined based on a worker's designated work location. An employee assigned to a “non-radiological” facility may not have been adequately monitored for radiation exposure or considered to be a “radiation worker,” yet historical documentation shows the assigned location regularly participated in radiological processes. This problem, especially when combined with worker rotation, has resulted in an inability to reliably determine a worker's likelihood of exposure based on work location designation, job title, assignment to a “non-radiological” location or duties, or a lack of dosimetry data in employment records. In addition, this problem likely creates difficulty in assigning appropriate co-worker data, when the need arises.

3.0 SSFL: Site Description & General Information

This document describes the features and history of Department of Energy (DOE) facilities at Santa Susana Field Laboratory (SSFL), including the site areas or buildings, site processes, periods of operation, radionuclides of concern, incidents resulting in releases to the environment or worker exposure, and other information that is relevant to estimating worker radiation dose.

3.1 Brief Description and History

SSFL occupies 2,850 acres of rocky terrain located in the Santa Susana mountains between Simi and San Fernando Valleys, approximately 30 miles northwest of Los Angeles, California (Ventura County). The site's elevation is 1,880-2,150 feet feet above sea level. The terrain consists largely of weathered bedrock and alluvium that have been eroded primarily from the surrounding Chatsworth and Santa Susana formations. Several geological faults cross the area. The climate is classified as Mediterranean Subtropical, corresponding to an average temperature of 50 degrees Fahrenheit in the winter and 70 degrees Fahrenheit in the summer. Rainfall averages approximately 18 inches per year.

SSFL was established by North American Aviation (NAA) in 1947 to meet requirements for a remote field test laboratory to test static-fire large rocket engines and to conduct nuclear research for the Atomic Energy Commission (AEC, DOE's predecessor agency). On February 28, 1948 the AEC entered into a contract with NAA to perform research and to develop nuclear reactors. NAA was permitted its discretionary use of its facilities and locations owned by the company *or* leased by AEC to perform functions affiliated with fulfilling its contractual obligations.[1] AEC-sponsored nuclear research began under contract with NAA at SSFL in 1953.

SSFL is divided into four areas of operation (Areas I, II, III and IV). Currently, under EEOICPA, Area IV is the "covered area" from 1955-present. Area IV is comprised of the site's westernmost 290-acre area. A Special Exposure Cohort (SEC) is in effect from 1955-1958 and 1959-1964. Expansion of the SEC into subsequent years is being considered by NIOSH and ABRWH.

The Liquid Metal Engineering Center (LMEC) was created in 1966 as a government-owned and contractor-operated organization to provide development of non-nuclear testing of Liquid Metal Reactor (LMR) components, and to establish the Liquid Metal Information Center (LMIC) for the AEC's Liquid Metal Fast-Breeder Reactor (LMFBR) program. LMEC was renamed the Energy Technology Engineering Center (ETEC) in 1978 to reflect DOE's desire to broaden its mission beyond the LMFBR program.

LMEC-ETEC consisted of a 90-acre area located within the confines of Area IV. Use of the term, "ETEC" is understood to encompass all DOE operations associated with Area IV, ETEC and LMEC.

ETEC conducted a broad range of energy-related research, testing and development projects that included component testing for the U.S. liquid metal reactor program. Liquid metal test

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[1] Division of Energy Employees Occupational Illness Compensation (DEEOIC) Peter M. Turcic Memorandum to Christy Long, District Director of Seattle, Subject: *Atomics International and Energy Technology Engineering Center,* September 7, 2005

facilities were maintained and operated for evaluating components such as heat exchangers, steam generators, pumps, valves, piping, vessels and instrumentation. In addition to the reactor component testing program, ETEC provided engineering support, technical management and monitoring for a number of DOE solar, conservation, geothermal, coal liquefaction and gasification, laser, and fusion energy programs.

CORE Advocacy recommends that all Technical Basis Documents (TBDs) related to SSFL's Site Profile be updated to correct and clarify the use of site nomenclature, the entirety of important radiological facilities located throughout Area IV, the years of facility operations, and the years of EEOICPA coverage.

3.2 AEC's Support of Space-Nuclear Research

During the 1950's the Atoms for Peace Initiative resulted in AEC's pursuit and sponsorship of civilian uses for atomic power. AEC Chairman, Glenn Seaborg referred to the "marriage between space and the atom" as "something that was bound to occur."[1] NASA and AEC formed joint committees and enthusiastically pursued funding and projects to foster space-nuclear propulsion research; SSFL was well suited for this type of research and development (R&D).

In 1955, coinciding with NAA's creation of Rocketdyne as its own division, AEC invited industry to bid on the development of a space nuclear reactor system. A concept by NAA Atomics International was chosen in 1956. Shortly thereafter, a need for a small atomic battery to power space missions was recognized. Under AEC-NASA-NAA contract, the Systems for Nuclear Auxiliary Power (SNAP) program resulted in several zirconium hydride uranium reactors (SNAP 2, 6, 8 and 10) that were researched and tested at SSFL.[2] In 1965, the SNAP 10-A Space Nuclear Reactor was successfully launched into orbit (where it remains). In its 1965 Annual Report, NAA heralded SNAP's success as the result of the company's philosophy of interdivisional collaboration.[3] AEC celebrated NASA's commitment to perfection, which inspired AEC's approach to devising nuclear safety standards for use in the operation of terrestrial power plants here on earth.

Throughout SSFL's well documented history, NASA is shown to have operated in Area IV while DOE is documented as having operated in Areas I, II and III. In addition, DOE facilities, operations and proprietary interests in Areas I, II and III fulfill statutory criteria used to determine a DOE Facility under the Act, pursuant to U.S.C. § 73841.

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[1] Roger D. Launius, *Powering Space Exploration: U.S. Space Nuclear Power, Public Perceptions, and Outer Planetary Probes*, Smithsonian Institution, 6th International Energy Conversion Engineering Conference (IECEC), July 28-30, 2008, Cleveland, Ohio.

[2] George P. Dix and Susan S. Voss, *The Pied Piper - A Historical Overview of the U.S. Space Power Reactor Program*

[3] NAA, *Annual Report,* 1965.

3.3 Corporate Mergers & Nomenclature

Several corporate mergers and organizational changes occurred over the years. In 1967 North American Aviation (NAA) merged with Rockwell Standard to become North American Rockwell. In 1973 the corporate name changed to Rockwell International (RI). RI with Atomics International and Rocketdyne continued to exist as independent divisions until 1984, although “Rocketdyne” or “Rockwell” were common terms used to identify the contractor during this period. In 1984, Atomics International was absorbed by the Rocketdyne division. The Boeing Company purchased RI in 1996, becoming Boeing North American (BNA), and Rocketdyne became a division of Boeing. During this period, “Rocketdyne” was typical terminology used to identify the contractor. Currently, any of these terms, including “ETEC” are used to identify both the contractor and covered area at SSFL.

The review of historical documents authored over the course of several eras of facility operations can be confusing because the contractor is routinely identified by any combination of the above-referenced company names. For instance, an incident report authored in the 1960’s may identify “Atomics International,” but a radiological investigation of the site conducted in the 1980’s may refer to “Rockwell” or “Rocketdyne” when referencing the same report, while a D&D contract authored in the 1990’s may refer to “Boeing.”

For the purposes of this report, any references to North American Aviation, Atomics International, Rocketdyne, Rockwell, Rockwell International, Energy Systems Group (a division of Rockwell International), Boeing North American, or Boeing refers to the DOE Contractor. References to Area IV, ETEC and LMEC refer to the covered area, under EEOICPA.

CORE Advocacy recommends that an explanation and clarification of corporate mergers and changes in DOE contractors be reflected in every Technical Basis Document (TBD) associated with SSFL throughout the SSFL Site Profile.

3.4 Environmental Monitoring and Sampling Practices

On July 12, 1989 the U.S. EPA assessed the relative magnitude of health hazards, health risks, past, present, and future environmental problems, and how those concerns may be addressed with the site contractor.[1] EPA reviewed previous Rockwell-Rocketdyne environmental reports, contractor reports, DOE site reviews, and conducted interviews with laboratory personnel to review procedures for sampling. In addition, EPA visited specific locations at the site, and took samples and measurements.

EPA questioned the validity of some, if not all, of the environmental data. According to laboratory personnel, the laboratory had never had a thorough review or audit by Rockwell-Rocketdyne or DOE (DOE’s environmental audit had yet to be finalized at the time of the EPA site visit).

[1] Dempsey, Gregg: *“Site Visit to Santa Susana Field Laboratory,”* EPA Memorandum to Daniel M. Shane, On-Scene Coordinator, Emergency Response Unit. July 28, 1989

3.4.1 Soil - Questionable Sampling Practices Observed by EPA

EPA found that the SSFL laboratory personnel used poor methods for assessing environmental radioactivity, including procedures that resulted in temperatures sufficient to volatilize most man-made radionuclides of concern, including cesium-137 and strontium-90. In addition, the Rocketdyne procedure had highly variable results due to attempt to make corrections, which were inadequate. Further, the SSFL laboratory personnel were consistently applying the wrong procedure to measure alpha and beta activity in the soil (the procedure applied was applicable to the analysis of americium-241 by alpha spectroscopy, which is entirely different). Laboratory technicians could not provide EPA with any documentation or references on the procedure.

Further, EPA discovered that spike samples had never been prepared, or run through a procedure to provide any internal quality control. EPA concluded that gross alpha and beta data on soil, even though it has indicated some radiation areas on the site, is not a true representation of conditions that were present in the environment.

3.4.2 Water - Questionable Sampling Practices Observed by EPA

EPA then inspected water monitoring practices, and again found that alpha and beta self-absorption was likely to be a problem. EPA doubted the validity of the Rockwell-Rocketdyne water analyses, as well, and noted that Rocketdyne had never had a procedure for testing for tritium.

3.4.3 Vegetation - Questionable Sampling Practices Observed by EPA

Vegetation samples were collected by Rocketdyne until 1986, but was stopped two years after an internal SSFL review determined that problems existed with alpha and beta counting, and that changes should be made. EPA reviewed the procedure and found it to be similar to the soil counting procedure, in that vegetation was essentially “ashed” before counting, and only one gram of ash was analyzed.

EPA noted that the procedure manual instructed laboratory technicians to “gently wash the vegetation with warm tap water to remove external foreign matter.” EPA points out that past operations that had produced airborne contamination that settled on the surface of the vegetation (instead of being absorbed through the roots) would be washed off before counting. Or, it would likely be volatilized off during the ashing process (500˚ C). EPA noted that animals at SSFL were not sampled.

3.4.5 Environmental Dosimetry - Questionable Monitoring Observed by EPA

The SSFL laboratory also provided environmental thermoluminescent dosimetry for the facility and offsite areas. EPA noted that certain questionable practices were alluded to, in the environmental report. The first was that data obtained by dosimeters was normalized to a 1,000-foot altitude, by using an adjustment factor to 15 mR/1000 ft. elevation difference to obtain site averages. EPA spoke to two nationally recognized dosimeter experts, and neither had ever heard of such a practice. Both experts felt the normalization was meaningless.

EPA noted that in both the calendar year of 1987 and the unpublished calendar year of 1988 SSFL environmental reports, comparisons for the dosimeters placed by the State of California and a DOE inter-comparison project were “not available” for inclusion at the time the report was published. Bill Watson of CDHS EMB assured EPA that the data was available, and provided to Rockwell-Rocketdyne. Even if the data was unavailable for inclusion in the previous year’s report, it should have been added as an addendum for the following year’s report. The unpublished 1988 report did not contain information about 1987 emissions, leading EPA to conclude that the SSFL dosimetry program might not compare favorably with the other groups. Systematic error that might be present in dosimetry analyses might make SSFL dosimetry data look comparable to itself but still may make these analyses invalid or suspect. EPA recommended more thorough review.

EPA commented on the audit conducted by DOE in February, 1989. The preliminary copy was supplied to EPA to assist in the 1989 site visit. EPA notes that DOE attempted to review many aspects of the SSFL Environmental Program within the 1989 document, and EPA echoed their concerns about the well and air sampling at SSFL and offsite. EPA agreed with DOE’s conclusions that well and air sampling, in addition to environmental sampling in general, needed to be reviewed for adequacy. According to EPA, DOE also identified some problems in the Radiological Laboratory but did not do an extensive review.

EPA echoes DOE’s concerns that the lack of a meteorological tower onsite presented problems. SSFL used the EPA code AIRDOS to define dose to affected offsite areas. However, tower information used was from the Burbank Airport, nearly 25-miles away from the site.

EPA’s conclusions at the end of its 1989 site visit were that the SSFL sampling, placement of sample locations, and analyses cannot guarantee that past actions have not caused offsite impacts. EPA advised that, if the environmental program were to stay uncorrected, SSFL could not guarantee that unforeseen or undetected problems onsite would not impact the offsite environment in the future.

EPA made it clear: “Rocketdyne does not have a good “handle” on where radiation has been inadvertently or intentionally dumped onsite. Most of the evidence of on-site spills is incompletely documented or anecdotal.”

3.4.6 DOE Environmental Audit & Tiger Team Observations on Environmental Data

In 1989 and 1991, DOE’s Office of Environmental Audit[1] and Tiger Team[2] concluded that worker and environmental monitoring practices at SSFL were inadequate and provided unreliable dose assessments among the worker population throughout the site’s operational history.

Both the Office of Environmental Audit and the Tiger Team concluded that SSFL’s lack of a meteorological tower presented inaccurate dose assessments following radiation releases. Both noted that on-site sampling locations were inappropriate because they had been chosen based

[1] U.S. DOE Office of Environmental Audit, *“Environmental Survey Preliminary Report, U.S. DOE Activities at SSFL,”* 1989.

[2] DOE Office of Environment, Safety and Health (ES&H), Tiger Team Assessment - ETEC, April 1991.

on the intended locations of reactor operations. However, the selected locations for reactor operations were finalized, the sampling locations did not change accordingly.

Both research teams noted no formal chain of custody for sampling data; no quality environmental surveillance program had been implemented; insufficient monitoring of radioactive airborne particulate releases created consistent difficulties in estimating worker dose; and failure to adequately monitor radionuclide emissions from point sources (including those from remedial actions) resulted in misleading and inappropriate worker dose estimations. Moreover, both research teams called attention to consistently poor filter changing-and-handling practices, which resulted in a loss of particulate matter and inaccurate radioactivity measurements.

Both the Office of Environmental Audit and the Tiger Team noted Rockwell International's unilateral decision to cease all manner of soil and water sampling by notifying the Nuclear Regulatory Commission (NRC) that future sampling would only occur on an "as needed" basis. Rockwell International failed to inform the NRC of legitimate reasoning behind ceasing the environmental sampling program, and did not provide a definition of its conditional approach to sampling going forward. It is interesting to note that the timing of this decision coincided with EPA's observation that incorrect and insufficient practices were being used for soil sample analysis.

DOE's Office of Environmental Audit and the Tiger Team address DOE operations at SSFL that occurred outside Area IV; worker rotation site-wide; joint DOE-NASA projects that involved employees from both divisions of North American Aviation (Atomics International and Rocketdyne); and a degree of site operations verses a lack of adequate environmental and worker monitoring practices that call into question the validity of dose reconstruction outcome for SSFL workers.

4.0 Nuclear Research and Development

Nuclear R&D increased rapidly at SSFL from 1953 into the late 1960's. Ten experimental nuclear reactors are typically acknowledged as having functioned at SSFL. However, NASA operated a nuclear reactor in Building 4012 (SNAP Critical Test Facility). The HMRFSR operated from 1970-1972. It was excluded from the 2006 Site Profile, and is described in Section 6.1.2, pertaining to Building 4012.

The 2006 Site Profile indicates that by 1988, all nuclear operations at SSFL had ceased. However, a document authored in 1990[1] indicates that Building 4009 (OMR/SGR Critical Facility described in Section 7.1) was still being used for Rocketdyne projects requiring radioactive materials. In addition, the 2006 Site Profile omitted a second Hot Laboratory in Building 4009, as well as a second Van de Graaf Particle Accelerator at the same location.

[1] Internal Letter, Rockwell International, *"DOE Authority for Release of Certain Facilities at SSFL,"* to A.J. Adduci, Nuclear Energy Division, DOE. January 11, 1990. Document retrieved from publicly accessible historical archive courtesy of California Department of Toxic Substances Control (DTSC). File: HDMSe00413848.pdf

There were seven criticality test facilities at SSFL (i.e. facilities housing operations involving masses of fissionable material capable of sustaining a nuclear chain reaction). Reactors and criticality test facilities located at SSFL are listed below in the following tables.

Other nuclear facilities in Area IV included the Radioactive Materials Handling / Disposal Facility (RMDF / RMHF). The 2006 Site Profile excluded several important buildings and facilities associated with this facility, including a low-level radioactive waste incinerator that functioned from 1964 into the 1980's. This particular facility was among the most notable generators of radioactivity at SSFL.

4.8.1 ISOTOPES OF CONCERN

The 2006 Site Profile addresses potential radiological contaminants associated with specific nuclear operations at SSFL in terms of isotopes of concern. The guidance for the preparation of a Site Profile (ORAU 2005) requires for a table to include dose reconstruction parameters such as the solubility type and assumed particle size of the contaminants, although the same information is also required in Section 5, *Internal Dosimetry.* According to Section 2 of the 2006 Site Description, the section is for informational use only and the data provided in Section 5 of the 2006 Site Description "should be used for dose reconstruction, regardless." However, the 2006 Site Description specifies that facility-specific solubility and particle size data for SSFL "has not been found."

Given the number of radiological facilities that have been excluded from the 2006 Site Profile, the insufficient information provided about years of reactor operations, incidents, releases, and building operations, CORE Advocacy recommends careful evaluation of the Isotopes of Concern alongside the information provided in the following tables, which was sourced from EPA's Area IV Study (2009).

4.8.2 MAGNITUDE OF SITE ACTIVITY

The 2006 Site Profile provides a table intended to "provide a perspective of the magnitude of the nuclear operations at SSFL," in accordance with the Site Profile Preparation Guide (ORAU, 2005). The guide requires that the magnitude of operations is expressed in radioactivity (Ci) of the isotopes of concern. Again, the same information is required in Section 5, *Internal Dosimetry.* The 2006 Site Profile recommends that the radioactivity values in Section 5 should be used for dose reconstruction, and instructs the use of "descriptive text" that gives the magnitude of nuclear operations in cases where numeric data is not available.

Given the insufficient data provided that pertains to years of nuclear reactor operations, incidents and releases, building use and operations, and several important nuclear facilities that were excluded from the 2006 Site Profile, CORE Advocacy recommends careful evaluation of all radioactivity values provided, which should be compared to those derived by EPA during the Area IV Study (2009), referenced in this document.

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Table 1: Research Reactors at the Santa Susana Field Laboratory[1]

Reactor	BLDG#	Facility Name	Power Level (kW)	Period of Operation	Power Generated (MWd)	Radioactivity at End of Operation(10
KEWB	4073	Kinetic Experiment Water Boiler / Neutron Pulse Test Facility	1	1956-1966	1	6
WBNS / L-85 / AE-6	4093	Water Boiler Neutron Source L-85	3	1956-1980	2	18
SRE	4143	Sodium Reactor Experiment	20,000	1957-1964	6,700	120,000
SER	4010	SNAP Experimental Reactor Facility	50	1959-1960	13	300
S2DR	4024	SNAP Environmental Test Facility	65	4/1961-12/1962	13	390
STR	4028	Shield Test Irradiation Facility	50	12/1961 - 7/1964	1	300
S8ER	4010	SNAP 8 Experimental Reactor Test Facility	600	5/1963 - 4/1965	215	3,600
STIR	4028	Shield Test Irradiation Facility	1,000	8/1964-1974	28	3,714
SNAP-10 FS3	4024	SNAP Environmental Test Facility	37	1/1965 - 3/1966	16	6,000
S8DR	4059	SNAP 8 Developmental Reactor	619	5/1968 - 12/1969	182	220
HMR-FSR	4012	NASA Nuclear Reactor SNAP Critical Facility		1970-1972		

[1] U.S. Environmental Protection Agency (EPA), Historical Site Assessment (HSA), Santa Susana Field Laboratory Site, Area IV Radiological Study, December 2012. Citation 1:

[1] Oldenkamp, R.D. and Mills, J. C., Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective, Rockwell International; Report No. N001ER000017, September 6, 1991, p. 23.

Table 2: Criticality Test Facilities Located at the Santa Susana Field Laboratory[1]

Facility Name	Building #	Period of Operation	Notes
SNAP Critical Test	4373	1957-1963	First SNAP-2 Criticality Tests
Organic Moderated Reactor	4009	1958-1967	Basic tests of reactor concept
Sodium Graphite Reactor	4009	1958-1967	Basic tests of reactor concept
SNAP Critical Experiment	4012	1961-1971	Later SNAP criticality tests
Fast Critical Experiment	4100	1961-1972	Started as Advanced Epithermal Thorium Reactor (AETR)
SNAP Flight Systems	4019	1962	SNAP Flight System Criticality
SNAP Transient Test	4024	1967-1969	SNAP Transient Response Tests

Systems for Nuclear Auxiliary Power (SNAP): AEC/DOE - NASA - North American Aviation Program

[1] EPA HSA 5-A, SSFL. Citation 3:

[1] Oldenkamp, R.D. and Mills, J. C., *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, Rockwell International; Report No. N001ER000017, September 6, 1991, p. 23.

Table 3: SSFL FACILITIES: RADIONUCLIDES & BUILDING USE

The table below provides a numerical listing of SSFL buildings and facilities that should be included in the Site Profile. Changes in numbering schemes over the years are provided. A partial list of Visitor Log Entry Codes, which correspond to worker dosimeter badges and can aid in proving a monitored worker's location, are provided. A list of radionuclides of concern for each location is provided, with a special column indicating Tritium and/or Neptunium use. The number of incidents associated with each facility is indicated. In addition, locations where DOE-NASA or NASA operations occurred (which likely required the participation of Rocketdyne workers affiliated with Area I, II or III Time Clock Locations), are indicated. If the location was excluded from the 2006 Site Profile, it is indicated. The description of the building/facility operations, processes, materials, and incidents can be found on the page number provided.

*Visitor Log Entry Code T034 may apply to any/all buildings at the RMHF, since "T034" or "Building 4034" was considered to be the primary Use Authorization Building, out of which all operations, use permits, etc. were designated and/or assigned.

**SNAP was a joint project between DOE-NASA to research and develop nuclear space propulsion systems. SNAP's research and development relied on collaboration between North American Aviation's atomic energy and space divisions, Atomics International and Rocketdyne. Some Rocketdyne Space & Information Division employees frequently performed job duties in Area IV, as needed, after clock-in at an Area I, II or III location.

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4003 003 T003		ETB Hot Cave	Uranium, thorium, transuranic elements, mixed fission products, and activation products. U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-228, Th-232, Th-234, **H-3,** C-14, Na-22, Na-24, Cr-51, Mn-54, Ni-59, Ni-63, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-144, Ba-La-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151, Eu-152, Ra-226, Ac-228			6			226
4005 005 T005		UCFPP	U-238, U-234, U-235, C-14, Mn-54, S-35, Th-231, P-32, Fe-59, Co-60, Pa-234m			8	X		239

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4006 006 T006		SCTI	Predominantly a non-radiological facility; records of minor uses of radioactive materials. Cs-137, Mn-54, **H-3**, and natural and U-234, U-235, U-238. Potential migration from SNAP 4010, 4012, and 4024 include: Sb-125, Am- 241, Cs-134, Cs-137, Co-60, Eu-152, Eu-154, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, **H-3**, and U-234, U-235, U- 238.	X		1+		X	381
4009 009 T009		OMR Reactor SGR Reactor **SGR Hot Lab** **[2 HOT LABS ON SITE]** **Van de Graaf Particle Accelerator** **[2 ON SITE]** Eng. Dev. Fac. HERF	Decay products from U-235, U-238, and Th-232 decay chains include Th-234, Th-228, actinium-228 (Ac-228), radium-226 (Ra-226), lead- 214 (Pb-214), bismuth-214 (Bi-214), Pb-212, Bi212, and thallium-208 (Tl-208). In addition, **H-3**, Sr-90 and Cs-137, Na-24, Co-57, Co-60, Eu-152, and Am-243 would have been formed.	X					218
4010 010 T010		SNAP SER S8ER **(DOE-NASA program)**	Sb-125, Am-241, Cs-134, Cs-137, Co-60, Eu-152, Eu-154, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, **H-3**, U-234, U-235, U-238. Be-10 is a potential radionuclide of concern at Building 4010 because beryllium reflectors were used in the SNAP reactor.	X		3	X		124
4011 011 T011		Rad Inst. Calib. Lab	Am-241, Cs-137, Co-60, Eu-152, Eu-154, Ir-192, Pb-210, Pu-238, Pu-239, Pu-240, Pu-241, K-40, Ra-226, Sr-90, Ta-182, Tc-99, Th-230, Th-232, **H-3**, U-234, U-235, U-238.	X		8		X	396

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4012 012 T012		SNAP Critical Tests Neutron Pulse Generator **NASA Reactor: HMRFSR** Radiography & X-Ray (ETEC) **(DOE-NASA program)**	Am-241, Be, Cs-137, **H-3**, Pu-Be, Pu-238, Pu-239, Pu-240, Pu- 241, Sr-90, U-234, U-235, U-238	X		41	X		173
4013 013 T013		SNAP Component Assembly & Performance Bldg. X-Ray Booth ETEC Thermal Transient Test Facility (TTF) **(DOE-NASA program)**	Am-241, Cs-137, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, U-234, U-235 and U-238				X	X	198
4019 019 T019		SNAP10AFS1 Fissile Material Storage ETEC Const. Staging & Comp. Facility **(DOE-NASA program)**	Am-241, Cs-137, H-3, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, U-234, U-235, U-238	X		3	X		179

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4020 020 T020	6012 T020 AIHL 6001F 6000C	Hot Lab *Material transported to 4023 included items with Neptunium.	U-235, U-238, and Th-232 decay chains include Th-234, Th-228, Ac-228, Ra-226, Pb-214, Bi-214, Pb-212, Bi-212, and Tl- 208. In addition, **H-3**, Sr-90, Cs-137, Na-24, Co-57, Co-60, Eu-152, and Am-243. Solid reactor fuel materials (including but not limited to) U-Mo, UO2, U-ZrH, plutonium-bearing fuels, (in addition to cladding materials: aluminum, sintered aluminum powder, stainless steel, zirconium, Hastelloy alloys, Sodium, and NaK bonded capsules)	X	X	129			252
4021 021 T021	6017 T022 TO34 6000E 6001R	RMHF 1959 - present	157 Radionuclides were potentially present at this location. They include: Uranium Fuel Materials: U-234, U-235, U-238. Transuranic: Pu-238, Pu-239, Pu-240, Pu-242, Am-241. Fission: Cs-137, Sr-90, Kr-85, Pm-147. Thorium Breeder Material: Th-228, Th-232. Neutron Activation Products: Co-60, Eu-152, Eu-154, **H-3**, Fe-55, Ni-59, Ni-63, Mn-54, K-40, Na-22.	X		24			286
4022 022 T022	6017 T022 TO34 6000E 6001R	RMHF	Uranium Fuel Materials: U-234, U-235, U-238. Transuranic: Pu-238, Pu-239, Pu-240, Pu-242, Am-241. Fission: Cs-137, Sr-90, Kr-85, Pm-147. Thorium Breeder Material: Th-228, Th-232. Neutron Activation Products: Co-60, Eu-152, Eu-154, **H-3**, Fe-55, Ni-59, Ni-63, Mn-54, K-40, Na-22.	X		22			298
4023 023 T023		SNAP CTL/STL *Material was transported from 4020 to 4023. **(DOE-NASA program)**	Am-241, Pu-238, Pu-239, Pu-240, and Pu-241,Cs-134, Cs-137, Sr-90; Th-228, Th-232, U-234, U- 235, U-238; **isotopes of neptunium (Np-237)**; Co-60, Mn-54, Eu-152, Eu-154, **H-3**, Ni-63, Fe-55,Ta-182	X	X	2	X		359

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4024 024 T024		SNAP2DR SNAP 10 SNAP TTF **(DOE-NASA program)**	Co-60, Eu-152, Cs-137, Sr-90, **H-3**, Eu-154, Fe-55, Ni-59, Ni-63, Mn-54, K-40, Na-22, (neutron activation products); Th-232, U-234, U-235, U-238 (nuclear fuel material); Am-241, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242 (transuranic elements)	X		3	X		28182
4025 025 T025		SNAP Remote Handling Mock-up Bldg. **(DOE-NASA program)**	Co-60 (Suggesting another sealed source in the building); Radionuclides associated with potential migration from the RMHF Building 4075 include isotopes of uranium, thorium, plutonium, and mixed fission products. Radionuclides associated with nearby SNAP Building 4024 include Am-241, Cs-137, Co-60, Eu-152, Eu-154, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, H-3, U-234, U-235, U-238	X		1	X	X	200
4026 026 T026		SCTL	Proximity to SNAP 4010, 4012, 4019				X	X	388
4027 027 T027		SNAP **(DOE-NASA program)**	Proximity to RMHF results in higher ambient radiation conditions. U-234, U-235, U-238, Pu-238, Pu-239, Pu-240, Pu-242, Am-241, Cs-137, Sr-90, Kr-85, Pm-147, Th-228, Th-232, Co-60, Eu-152, Eu-154, **H-3**, Fe-55, Ni-59, Ni-63, Mn-54, K-40, Na-22, Y-90	X		1	X	X	202
4028 028 T028		STR STIR LMFBR **Radiography of S8DR Fuel Following Major Incident** **(DOE-NASA program)**	depleted uranium (U-234, U-235, U-238), Pu-Be, N-16, Po-210, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Cs-137, Co-60, Eu-152, Eu-154, **H-3**, Sr-90	X		9	X		143

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4029 029 TO29		RMF HWMF	Co-60, Ra-226, Cs-137, Po-Be, Pu-Be			4			272
4030 030 T030		Van de Graaf Particle Accelerator	**H-3, He3** - Primary concern is Tritium. Tritium contamination documented.	X		0	X		348
4032 032 T032		SNAP LMFBR Clinch River ISSS **(DOE-NASA program)**	Co-62, Ir-192			5	X	X	206
4034 034 T034	6017 TO34 6000E 6001R	RMHF RMDF	U-234, U-235, U-238,Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Cs-137, Sr-90, Th-228, Th-232, Co-60, Eu-152, Eu-154, **H-3**, Fe-55, Ni-59, Ni-63, Mn-54, K-40, Na-22.	X		0			305
4036 036 T036		SNAP **(DOE-NASA program)**	The EPA research team did not find evidence that high activity radioactive materials were used or stored within Building 4036. However, its proximity to RMHF may have resulted in direct radiation and sky-shine from the RMHF, and affected ambient radiation conditions in the area. Radionuclides of concern at the RMHF include all radionuclides addressed in the background study plus any additional radionuclides identified during the EPA HSA. EPA expressed concern about radioactive materials release and potential drainage from the RMHF, which may have resulted in residual contamination at this location.			0	X	X	210

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4041 041 T041		SRE Component & R/A Waste Storage Building	U-238, U-234, U-235, U- 236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-228, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn- 54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)- 140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151	X		0			95
4042 042 T042		SNAP LMFBR **(DOE-NASA program)**					X	X	212
4044 044 T044	6017 T022 TO34 6000E 6001R	RMHF	Bi-210, Pb-210, Pu-239, Sr-90, Tc-99, and Th-230. An historical photo (c. 1990) shows two small containers labeled “Radioactive Material” and “Radioactive Material - Contaminated Waste” under a desk in Building 4044. Incident documents mixed fission products. Proximity to 4022 raises concern about contaminant migration of U-234, U-235, U-238, Pu-238, Pu-239, Pu- 240, Pu-241, Pu-242, Am-241, Cs-137, Sr-90, Th-228, Th-232, Co-60, Eu-152, Eu-154, **H-3**, Fe-55, Ni-59, Ni-63, Mn-54, K-40, and Na-22.	X		1			307
4048 048 T048		PDU Coal Gasification	Potential Radium			0	X	X	372
4049 049 T049		Hydraulic Tests Piqua Test Loop PDU Coal Gas.	C-14, S-35, P-32, Fe-59, Co-60, Mn-54, N -59, Fe-55			4	X	X	373

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4055 055 T055	T055 6013	NMDF	The primary special nuclear materials handled in Bldg. 4055 were plutonium and uranium. Accordingly the radionuclides of concern are uranium, Pu-239, and their decay and daughter products, primarily Am-241, decay products from U-235, U-238, and Th-232 decay chains include Th-234, Th-228, Ac-228, Ra-226, Pb-214, Bi-214, Pb- 212, Bi212, and Tl-208. In addition, **H-3**, Sr-90, Cs-137, Na-24, Co-57, Co-60, Eu-152, and Am-243 would have been formed.	X		20			232
4057 057 T057		SNAP **(DOE-NASA program)**	U-238, U-234, U-235, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Cs-137, Sr-90, **H-3**, Fe-55, Co-58, Co-60, N -63, Ba-133, Eu-152, Eu-154, Eu- 155, Pm-147, Ta-182	X			X	X	214
4059 059 T059		S2DR LLTR **MAJOR INCIDENT 1969**	The S8DR contained 211 fuel/ moderator elements of zirconium-uranium hydride ((Zr-U)H_x agents. Some parts of Building 4059 became activated by neutrons produced by the reactors. Tritium was produced and was detected in groundwater. Potential radioactive contaminants include U-238, U-234, U-235, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Cs-137, Sr-90, **H-3**, Fe-55, Co-58, Co-60, Ni-63, Ba- 133, Eu-152, Eu-154, Eu-155, Pm-147, and Ta-182.	X	19		X		151
4064 064 T064		FSF Special Nuclear Materials Storage	U-233, U-234, U-235, U-236, U-238, Th-228, Th-232, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Ra-226, Cs-134, Cs-137, Sr-90, **H-3**, Na-22, K-40, Mn-54, Fe-55, Co-60, Ni-59, Ni-63, Eu-152, Eu-154, Pm-147, Ta-182	X	X	8			245

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4066 066 T066		Instrument Repair / Calibration Bldg.	U-238, U-234, U-235, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Cs-137, Sr-90, **H-3**, Fe-55, Co-58, Co-60, Ni-63, Ba-133, Eu-152, Eu-154, Eu-155, Pm-147, Ta-182	X		2	X	X	400
4073 073 T073		KEWB Reactor	Co-60, Cs-137, Eu-152, Eu-154, Eu-155, Mn-54, Pb-210, Ra-226, Sr-90, U-235, U-238			3	X		46
4074 074 T074		KEWB	Proximity to RMHF results in higher ambient radiation conditions.					X	57
4075 075 T075	6017 T022 TO34 6000E 6001R	RMHF	uranium, plutonium, thorium, mixed fission products, cobalt, europium.			1			310
4083 083 T083		KEWB	Proximity to KEWB					X	58
4093 093 T093		AE6 Reactor L-85 Reactor	Xenon-135, Co-60, Cs-137, Eu-152, Eu-154, Sr-90, U-238, and U-235			4			52
4100 100 T100		AETR Reactor FECL LMFBR Reactor **NASA** CT-SCAN (SSME - ISS)	U-233, U-234, U-235, U-236, U-238, Th-232, Np-237, Pu-238, Pu-239, Pu-240, and Pu-241 in the AETR and in January 1972 for use in the FCEL. Decay products would include Th-228, Ra-228, Th-230, Ra-226, Pb-210, Pa-231, and Ac-227.	X	X	2	X		223
4103 03 T03		KEWB Support Office / Control Instrument-ation	Considered “Non-Radiological.” Proximity to RMHF and AE6/ L85 affected ambient radiation. Max. ambient exposure rate found to be 23.1 µR/hr. Limit was listed at 19.7 µR/hr.					X	
4123 123 T123		KEWB	Co-60, Cs-137, Eu-152, Eu-154, Eu-155, Mn-54, Pb-210, Ra-226, Sr-90, U-235 and U-238					X	59
4133		HWMF	Cs-137			0		X	393

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4143 143 T143	6026	SRE Reactor **Major Incident 1959**	U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, neptunium-237 (Np-237), Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, technetium-99 (Tc-99), Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151.	X		41			64
4153 153 T153		SRE Support	U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151	X		6		X	111
4163 163 T163		SRE BOX SHOP CERF	U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba, (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151.	X		6			98
4226 226 T226		SCTL	Proximity to SNAP 4010, 4012, 4019					X	388
4228 228 T228		SNAP/SCTI	The HSA research team did not find evidence that radioactive materials were used in Building 4228. However, radionuclides resulting from former reactor operations in Building 4012, which supported the northwest end of Building 4228, include Am-241, Cs-137, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, U-234, U-235, U-238. In addition, H-3 due to Building 4012 operations.	X					216

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4273 273 T273 4283 283 T283		Radioactive Laundry *Area II Drainage	U-238, U-234, U-235, U-236, Pu- 239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co- 60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151	X		0		X	392
4355 355 T355		SCTI	Proximity to SNAP 4010, 4012, 4019					X	383
4356 356 T356		SCTI	Sealed source use of Cs-137 and Ir-192 are noted below in Radiological Use Authorizations and Radiological Incident Reports. This suggests potential use of other sealed sources as well. Radionuclides associated with potential migration from SNAP Buildings 4010 and 4012 include: Sb-125, Am-241, Cs-134, Cs-137, Co-60, Eu-152, Eu-154, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, tritiated titanium H-3, and natural and enriched U-234, U-235, U-238	X		4		X	378
4357 357 T357		SCTI	Proximity to SNAP 4010, 4012, 4019					X	385
4358 358 T358		SCTL	Proximity to SNAP 4010, 4012, 4019					X	388
4359 359 T359		SCTI	Proximity to SNAP 4010, 4012, 4019					X	377
4360 360 T361		SCTI	Proximity to SNAP 4010, 4012, 4019					X	377
4361 361 T361		SCTI	Proximity to SNAP 4010, 4012, 4019					X	377

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4373 373 T373		SNAP Critical Fac. Rocket Fuel Storage **(DOE-NASA program)**	U, Pu: U-235, U-238, Th-232, Th-234, Th-228, Ac-228, Ra-226, Pb-214, Bi-214, Pb-212, Bi212, Tl-208, **H-3**, Sr-90, Cs-137, Na-24, Co-57, Co-60, Eu-152, Am-243, Gd-64, Sm-153	X		log	X	X	162
4392 392 T392		SCTI	Proximity to SNAP 4010, 4012, 4019					X	377
4453 453 T453		AE-6 L-85	Co-60, Cs-137, Eu-152, Eu-154, Sr-90, U-238 and U-235			0		X	62
4457 457 T457		SCTI	Proximity to SNAP 4010, 4012, 4019					X	377
4563 563 T563	6017 T022 TO34 6000E 6001R	RMHF	uranium, plutonium, thorium, and mixed fission products			0		X	324
4621 621 T621	6017 T022 TO34 6000E 6001R	RMHF	Co-60, Cs-137, Sr-90, Th-232, Am-241, Co-60, Cs-137, Ir-192, PuBe, and “Th-170” [sic, possibly Tm-170],” Bi-210, Cf-252, Cs-137, Cr-51, Co-56, Co-57, Co-58, and Co-60, Ir-192, Pb-210, Kr-85, Mn-52, and Mn-54, Ra-226, Sr-90, and Tm-170.			4		X	325
4622 622 T622	6017 T022 TO34 6000E 6001R	RMHF	U-234, U-235, U-238, Pu-238, Pu-239, Pu-240, Pu-242, Am-241, Cs-137, Sr-90, Kr-85, Pm-147, Th-228, Th-232, Co-60, Eu-152, Eu-154, **H-3**, Fe-55, Ni-59, Ni-63, Mn-54, K-40, Na-22, Y-90	X		0		X	298
4641 641 T641		SHIPPING RECEIVING	All known isotopes at SSFL; entrance and exit point for all Area IV arrivals and shipments.					X	399
4643 643 T643		KEWB STACK	Co-60, Cs-137, Eu-152, Eu-154, Eu-155, Mn-54, Pb-210, Ra-226, Sr-90, U-235, and U-238			0		X	61

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4653 653 T653		SRE R/A Waste Vault	U-238, U-234, U-235, U- 236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe- 59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb- 95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151	X		1			104
4654 654 T654		Interim Radioactive Waste Storage Area	uranium, mixed fission and activation products			2			106
4656 656 T656		SCTI	Proximity to SNAP 4010, 4012, 4019					X	377
4658 658 T658	6017 TO34 6000E 6001R	RMHF	All known to RMHF, due to location being “entrance / exit”			0		X	329
4663 663 T663	6017 TO34 6000E 6001R	RMHF	uranium, plutonium, thorium, mixed fission products			1		X	330
4664 664 T664	6017 TO34 6000E 6001R	RMHF R/A Waste **INCINERATOR** **MAJOR SOURCE OF AIRBORNE PARTICULATE AND RADIOACTIVE EMISSIONS AT SSFL.**	Isotopes of uranium, plutonium, and thorium, and mixed fission products.			4		**X**	333
4665 665 T665	6017 TO34 6000E 6001R	RMHF	uranium, plutonium, thorium, mixed fission products, cobalt, europium.			2			317
4668 668 T068	6017 TO34 6000E 6001R	RMHF	Isotopes of uranium, plutonium, and thorium, and mixed fission products			0		X	338

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4756 756 T756		SCTI	Proximity to SNAP 4010, 4012, 4019					X	385
Leach Field	6017 TO34 6000E 6001R	RMHF	U-234, U-235, U-238, Pu-238, Pu-239, Pu-240, Pu-242, Am-241, Cs-137, Sr-90, Kr-85, Pm-147, Th-228, Th-232, Co-60, Eu-152, Eu-154, **H-3**, Fe-55, Ni-59, Ni-63, Mn-54, K-40, Na-22, Y-90	X					318
4686 686 T686		SRE Temp. Hot Waste Storage Building	U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151	X		1			96
4689 689 T689		SRE Inter. Contaminated Storage Area	U-238, U-234, U-235, U-236, Pu- 239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co- 60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru- 103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151	X		0			109
4695 695 T695		Cold Trap Vault	U-238, U-234, U- 235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151	X					103
4723 723 T723		SRE Steam Cleaning Pad *Area II Drainage	U-238, U-234, U-235, U-236, Pu- 239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co- 60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151	X		1		X	115

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
4733 733 T733		SRE Sodium Cleaning Pad *Area II Drainage	U-238, U-234, U-235, U-236, Pu- 239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co- 60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151	X		1		X	117
4773 773 T773		Sodium Waste Pond *Area II Drainage	U-238, U-234, U-235, U-236, Pu- 239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co- 60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151	X		2		X	119
4886		Sodium Burn Pit	U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th- 232, H-3, Na-22, Na-24, Cr-51, Mn-54, Fe-55, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-131, Cs-134, Cs-137, Ce-141, Ce-144, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xe-133, Xe-135, Pm- 147, Eu-152, Eu-154, and Sm-151	X					365
VTS I		Coal Gasification	Potential Radium				X	X	375
VTS II		Coal Gasification	Potential Radium				X	X	375
VTS III		SABER (SPTF Support)	Sealed Sources				X	X	375 386
B923		Civil Works / Structure	Sealed Sources				X	X	375
B924		Steam System (Saber / SPTF)	Sealed Sources				X	X	386
B934		Control Room (Coal Gasification)	Sealed Sources				X	X	375
B901		Pre-Test	N/A				X	X	375
LETF		Laser Engineering Test Facility	Sealed Sources				X	X	390

Bldg. #	Visitor Log Entry Codes	Building Name	Radionuclides of Concern	H-3	Np	INC. RPTS	DOE-NASA AREA I,II,III Time Clocks	Not in 2006 Site Profile	Page #
1		Downey	The AE6 was developed at Downey Facility and moved to SSFL in 1955-56.						
		Canoga / VanOwen	L-47 / L-77 Reactors - 1954-1960 The L-47 was lost; never located.						
104 004 HQ	6001	DeSoto	L-77 Reactor 1960-1976						

*Visitor Log Entry Code T034 may apply to any/all buildings at the RMHF, since “T034” or “Building 4034” was considered to be the primary Use Authorization Building, out of which all operations, use permits, etc. were designated and/or assigned.

**SNAP was a joint project between DOE-NASA to research and develop nuclear space propulsion systems. SNAP’s research and development relied on collaboration between North American Aviation’s atomic energy and space divisions, Atomics International and Rocketdyne. Some Rocketdyne Space & Information Division employees frequently performed job duties in Area IV, as needed, after clock-in at an Area I, II or III location.

5.0 Development and Testing of Nuclear Reactors

Between 1954 and 1980, several nuclear reactors were built, tested, and operated in Area IV. These included both nuclear reactors and critical test assemblies. Nuclear reactor programs focused on the research, development, experimentation and operation of homogeneous water boiler-type reactors, sodium-cooled graphite-moderated reactors, and uranium-zirconium hydride reactors.

>> Interesting Fact: Some nuclear reactor development at SSFL involved both North American Aviation's Atomics International and Rocketdyne. The AEC and NASA were jointly invested in the research, development, and success of the Systems Nuclear Auxiliary Power (SNAP) program; NASA operated the HMRFSR reactor in Area IV; and undertook Space Shuttle and International Space Station development in buildings and facilities operated by DOE, in Area IV. These activities routinely involved employees of Rocketdyne whose clock-in locations at Areas I, II and III have led to a determination of ineligibility to EEOICPA. More information on NASA-DOE projects can be found in Sections 5.5-6.2, pertaining to SNAP Reactors & Criticality Facilities.

5.1 HOMOGENOUS WATER BOILER REACTORS

The water boiler reactors were operated in Buildings 4073 and 4093, and relied on the support of several other buildings located throughout SSFL. These reactors used a 93% enriched uranyl sulfate solution held in a critical configuration in a spherical vessels. Rather than actually boil, the neutron and gamma flux caused radiolytic decomposition of water into hydrogen and oxygen in the form of tiny bubbles, which gave the impression of boiling. Two Homogenous Water Boiler Reactors were developed and tested at SSFL Area IV. A description of their operations, and the neighboring facilities and processes required to support these operations, are provided on the following pages.

Several buildings and facilities associated with homogenous water boiler reactor operations were excluded from the 2006 SSFL Site Profile. Information about their operations and processes can be found in Section 5.2.

Section 5.1.1

Building Number: **4073**
Building Alias: **073 / T073**

Building Name: **Kinetics Experiment Water Boiler (KEWB) - Neutron Burst Facility**

Building Function: **Homogenous Water Boiler Reactor**

Supportive Buildings in the Vicinity:

4123 (123 / T123): Waste Storage / Fuel Storage
4643 (643 / T643): Exhaust Blower Building
4793 (793 / T793): Electrical Control Building

Note: North American Aviation Space & Information Division (Rocketdyne) participation.[1]

Radionuclides of Concern: Reactor fuel for the KEWB reactor was U-235 dissolved as uranyl sulfate in solution. Based on radiological investigations and historical documents, the radionuclides of concern include Co-60, Cs-137, Eu-152, Eu-154, Eu-155, Mn-54, Pb-210, Ra-226, Sr-90, U-235, and U-238.[2]

5.1.1.1 Description of Operations & Processes

Building 4073 was constructed in 1955 and served as the KEWB reactor building. Other buildings within the vicinity of Building 4073 include Building 4123 (Waste and Fuel Storage), Building 4643 (Exhaust Blower Building), and Building 4793 (Electrical Control Building). The EPA HSA provides a detailed description of all associated building features.

KEWB operations began in 1956. The KEWB was a small graphite-encased research reactor that used a water solution of uranyl sulfate as fuel. From the autumn of 1956 to the summer of 1959, more than 900 transient tests were conducted under a variety of initial core conditions and for various reactivity inputs and injection rates. Following these tests, the “A” Core (spherical) was replaced by the “B” Core (cylindrical) that was used in a series of experiments utilizing the cylindrical core geometry. The reactor had a capacity of 50 kWt, but did not normally operate at full power; it has been reported that the majority of reactor operations were conducted at a power level of 1 kWt or less.[3]

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[1] EPA/HGL, *Final HSA 5-A,* p. 63, citation 290:

> [290] Atomics International, Document NAA-SR-7300 Special, “*Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*,” May 25, 1962.

[2] EPA/HGL, *Final HSA 5-A,* p. 73, citation 332:

> *[332] Rocketdyne Report, N001ER000017, “Nuclear Operations at Rockwell’s Santa Susana Field Laboratory – A Factual Perspective,” September 1991.*

[3] EPA/HGL, *Final HSA 5-A,* p. 64, citation 295:

> *[295] Rocketdyne Report, N001ER000017, “Nuclear Operations at Rockwell’s Santa Susana Field Laboratory – A Factual Perspective,” September 1991.*

In May 1962, the KEWB was operating as a neutron burst facility with 30% of its operating time devoted to the investigation of void formation in organic reactor transients and the remaining operation time being used by outside organizations, such as the Space Technology Laboratory, University of California, and DOE-Contractor North American Aviation's Space & Information Division (S&ID) Rocketdyne.[1]

The KEWB building's 1,000-gallon tank, originally used to retain reactor cooling water, drained to an open drainage channel to its eventual discharge in the Area II R-2A Pond. [The R-2A Pond functioned as part of the Site-Wide Water Reclaim System that provided all Rocketdyne test-stands in Areas I, II and III with water used to conduct rocket engine testing and hose down work areas].[2]

As of August 1966, inspection of Building 4073 indicated that activities at the building had been reduced to "caretaker status" and out-of-reactor fuel inventories had been reduced accordingly. Operations in the building halted in November, 1966. A June 4, 1969 nuclear safety analysis provided information for the removal of fuel from the KEWB reactor as part of the KEWB deactivation. According to the nuclear safety analysis, the nuclear fuel at the KEWB comprised 18 liters of 93% enriched uranium, uranyl sulfate solution containing 1,800 grams of U-235. The analysis indicated that the fuel would be loaded in five 912 containers and stored temporarily at the "Santa Susana Vault" prior to being shipped for reprocessing. As of June 1969, the fuel was located in the storage tank of the KEWB reactor. According to a nuclear safety analysis, it was to be transferred to polyethylene bottles. The repackaging was to occur in the decontamination room of Building 4021 (RMHF).[3]

The KEWB reactor facility (including Building 4073) was demolished in 1975. Contaminated or activated equipment and materials were removed and sent to the Radioactive Materials Handling Facility (RMHF) for decontamination and disposal for unrestricted use, or packaged for shipment to the Nuclear Engineering company burial site in Beatty, Nevada, for burial. The above-grade structures and roof of Building 4073 were demolished. The remaining concrete floors and walls were decontaminated to levels that were "as low as practicable," and levels that were established as "acceptable" by Rockwell International. Beta-gammer emitter contamination limits were defined, totaled as 0.1 mead at 1 cm with 7 mg/cm2 absorber; removable

[1] EPA/HGL, *Final HSA 5-A,* p. 64, citation 296:

> [296] Atomics International, Document NAA-SR-7300 Special, *"Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities," May 25, 1962.*

[2] U.S. DOE Office of Environmental Audit, *"Environmental Survey Preliminary Report, U.S. DOE Activities at SSFL,"* 1989.

[3] EPA/HGL, *Final HSA 5-A,* p. 64, citation 298:

> [298] Atomics International, Document PP-704-990-002, *Decontamination and Disposition of Facilities Program Plan*, January 23, 1975.

contamination limits were set at 100 dpm/100 cm^2. Alpha Emitter totals were 100 dpm/100cm^2, and removable contamination limits were 20 dpm/100cm^2.[1]

During decontamination and decommissioning, six of the graphite logs located directly beneath the reactor vessel on the floor of the enclosures were contaminated with what appeared to be uranium salts. The source of the uranium salts could not be determined from the information provided in the report. The graphite logs were wrapped in plastic sheet, tagged as radioactive waste, and transferred to the RMHF.[2] While smear surveys of the concrete pad directly below the reactor and the concrete wall adjacent to the reactor revealed no removable contamination, concrete samples from these areas did indicate induced radioactivity. All concrete contained detectable induced radioactivity and was removed, so the levels documented in final totals became the “natural radiation level” of the concrete.[3]

The fuel handling room contained the process systems for controlling, mixing, monitoring and storing the reactor fuel. Reactor liquids had been drained during the reactor deactivation in 1968, and during the D&D the systems were thought to be empty and dry. However, when cutting through a horizontal line to the gas recombiner, a dark brown liquid spilled out and contaminated the protective and personal clothing of a technician. The contamination measured 40 mrad/hr.

The EPA-HSA contains sequential details and a complete chronology of the D&D of the KEWB. However, it should be noted that upon completion of D&D processes, it was confirmed by a final survey that Building 4073 was within “prescribed limits.” The prescribed limits, as defined in the 1974 dismantling plan, were 100 dpm/cm^2 removable beta and 20 dpm/100 cm^2 removable alpha. A total of 3,045 cubic feet of radioactive waste was removed during D&D efforts and the site was released for unrestricted use by ERDA on March 3, 1976.

5.1.1.2 Building 4073 Radiological Incident Reports

The 2006 Site Description indicates that “there have been no incidents of consequence involving the KEWB.” However, there have been several incidents associated with KEWB

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[1] EPA/HGL, *Final HSA 5-A,* p. 64, citations 30-302:

> *[300] Rockwell International Report, AI-ERDA-13159, “KEWB Facilities Decontamination and Disposition Final Report,” February 25, 1976.*
>
> *[301] Argonne National Laboratory Report, no document number, “Surplus Facilities Management Program, Interim Post Remedial Action Survey Report for Kinetic Experiment Water Boiler (KEWB) Facility, Santa Susana Field Laboratory, Rockwell International, Canoga Park, California,” May 1983.*
>
> *[302] Rockwell International Report, FDP-704-990-002, Dismantling Plan for KEW Facility (Bldgs 073, 123, and 793), October 17, 1974.*

[2] EPA/HGL, *Final HSA 5-A,* p. 65, citation 303:

> *[303] Rockwell International Report, AI-ERDA-13159, “KEWB Facilities Decontamination and Disposition Final Report,” February 25, 1976.*

[3] EPA/HGL, *Final HSA 5-A,* p. 66, citation 304:

> *[304] Rockwell International Report, AI-ERDA-13159, “KEWB Facilities Decontamination and Disposition Final Report,” February 25, 1976.*

operations in Building 4073 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in the Incidents Database provided by Boeing. Summaries of available incident reports are provided below.

Additionally, it is worth noting that EPA felt it was appropriate to include several excerpts from worker interviews in their investigation of the KEWB. CORE Advocacy does not include excerpts from worker interviews in this document, but has included all worker interviews in their entirety on the accompanying disk, which contains the EPA-HSA in its totality.

5.1.1.3 Building 4073 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0522	2/10/1958	KEWB	None Identified	KEWB reactor operators received exposures above weekly guidelines.
A0504	4/1/1961	SS KEWB Building	None Identified	KEWB reactor core experiments caused exposure above guidelines to employee.
A0291	9/26/1961	KEWB Reactor	Mixed Fission Products*	Radiation exposure in excess of guidelines.

- On February 10, 1958 KEWB reactor operators received weekly exposures greater than 300 mrem while performing core maintenance activities. Upon further investigation, it was concluded that the elevated levels were a result of dosimeter error, and that actual exposures were within permissible levels. (A0522).[1]

  It should be noted that incident reports involving worker exposure frequently indicate that dosimeter badges were faulty. The frequency of this phenomenon suggests that SSFL employees at large may have been routinely provided with unreliable dosimeter badges. This, in turn, raises questions about the reliability of dosimetry data provided for monitored workers.

- From April 1 to June 30, 1961 a research engineer conducting KEWB reactor core experiments received a quarterly exposure to gamma and neutron radiation at levels greater than 3 rem. These core experiments were required for successful termination of the KEWB Program and resulted in high radiation levels in the reactor room, and consequently caused the employee's exposure. The employee was aware of his high cumulative exposure in early May; however due to the importance of the tests and lack of other qualified operators, he continued to conduct "unreflected" core experiments, and it is reported that he did not obtain the required prior approval to exceed the 3 rem quarterly limit (A0504 and A0291).

  It should be noted that this report reflects an employee's ability to exceed permissible exposure levels without prior approval. If employees were routinely motivated to subject themselves to greater-than-permissible exposure levels without prior permission or the knowledge of their superiors, questions are raised about the control of employee exposure and the company's protocol in ensuring worker safety, or enforcing safety standards on site.

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[1] EPA/HGL, *Final HSA 5-A,* p. 71, citation 314:

> *[314] Gerber, L.A., Atomics International Inter-Office Letter Re: Personnel Radiation Exposures, Incident A0522, March 5, 1958.*

5.1.1.4 Building 4073 Undocumented Radiological Incidents

Based on Health Physicist Log Book entries for the KEWB, there may have been other incidents associated with KEWB operations. On May 18, 1960, a log book entry at 1100 hours indicated that “oil from EG&G experiment leaked out - this area contamination level from 18 to 132 dpm. Area marked off to be cleaned A.S.A.P.” An entry on the same day at 1300 hours read, “contamination level in Reactor Room 3 100 dpm. Decontamination A.S.A.P.” At 1400 hours on the same day, an entry described as a smear of the “oil spot from dumping” indicated a contamination level of $3x10^4$ dpm. At 1415 hours, the log book reports that equipment from the reactor room was covered with oil and smears of the equipment found a contamination level of $28x10^4$ dpm. “EG&G” personnel were checked at 1445 hours that day and were found to have contaminated hands and shoes. The log entry indicates that complete decontamination of hands and shoes were performed. The next entry in the log books was made on May 19, 1960 at 900 hours, and indicates the building was opened and surveyed. The maximum reading was documented to have been 2 R/hr.

On May 20, 1960, the Health Physicist entered the following into the log book: “Survey and smear all EG&G equipment used in test building. All equipment packed and sealed for shipment to EG&G Boston, Mass.” At 1330 hours on the same day, the test building was cleaned and decontaminated. The log book did not provide the results of any additional surveys in relation to this incident.[1]

The EPA-HSA provides a chronology of Radiological Investigations and Decontamination / Cleanup of Releases that occurred at the KEWB. It is noteworthy that investigations conducted by Rockwell International did not include specific information about the level of contamination or sampling procedures that were used. Rockwell International only reported that survey results were below the 1976 acceptable limits and that it had found no levels of beta-gamma surface contamination above the measured background. In May 1983, Argonne National Laboratories performed a post-remediation radiological survey that included a surface scan to determine ambient gamma exposure rate and low-level radiation levels. Soil samples were taken and analyzed for gamma radiation and uranium. While the survey reportedly found no measurements above background, according to the 1983 report conducted by Argonne National Laboratories, background levels were relatively high **(40 μR/hr and 8,000 cts/min)** due to shine from the nearby RMHF Buildings 4021 and 4022.

According to a 1975 site-wide D&D program plan, the KEWB was exempt from licensing requirements as a U.S. Energy Research and Development Administration (ERDA) facility. The plan noted; however, that in the event the facilities and associated ERDA-optioned land would be reverted to Atomics International, the regulations of the State of California Bureau of

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[1] EPA/HGL, *Final HSA 5-A,* p. 72, citation 318 & 319:

[318] Sessions, Health Physicist, KEWB and AE-6 Log Book, pg 44-50.

[319] Additional information regarding this apparent incident could not be located. The research team has been unable to identify EG&G or determine the precise location of the oil spill or the contents of the oil.

Radiological Health would apply to the site. As a result, the facilities included in the plan were to be decontaminated to a level that was “acceptable to the State of California.”[1]

Radiological Use Authorization No. 84 was issued January 16, 1975 for the D&D of the KEWB facility. It listed enriched uranium, activation products, and mixed fission products of unknown quantity as being distributed throughout the facility.[2]

The preliminary MARSSIM Classification for the Building 4073 area and its associated structures is Class 1 because of previous site use, incident reports, and radioactive materials used during building operations.

[1] EPA/HGL, *Final HSA 5-A,* p. 73, citation 328:

> [328] Atomics International, Document PP-704-990-002, *Decontamination and Disposition of Facilities Program Plan*, January 23, 1975.

[2] EPA/HGL, *Final HSA 5-A,* p. 74, citation 329:

> *[329] Heine, W., Authorization No. 84, January 16, 1975.*

Section 5.1.2

Building Number: **4093**
Building Alias: **093 / T093**

Building Name: **Water Boiler Neutron Source (WBNS)**
a.k.a. AE-6 Reactor
a.k.a. L-85 Reactor

Building Function: **Homogenous Water Boiler Reactor**

Associated Buildings: **4643 (643/T643): Fuel Handling & Storage**
4893 (893/T893): Pad
Sanitary Leach Field

Building 4093 Radionuclides of Concern: Reactor fuel for the L-85/AE-6 reactor consisted of U-235 (93.11% enrichment), dissolved as uranyl sulfate in 12.5*l* of .35 molar H2SO solution. As a result the radionuclides of concern are xenon-135, Co-60, Cs-137, Eu-152, Eu-154, Sr-90, U-238, and U-235.

5.1.2.1 Description of Operations & Processes

Building 4093 was constructed in approximately 1958 to house the AE-6 Reactor. The AE-6 Reactor was originally called the Water Boiler Neutron Source (WBNS) Reactor. Built at the Downey Facility (Downey, California) in 1952, the WBNS had a maximum power of .5 Wt. The WBNS was modified to produce a maximum power of 3 kWt and moved to SSFL, where it became referred to as the AE-6 Reactor.

The AE-6 and its associated experimental facilities were specifically designed to provide a thermal neutron source for evaluating neutron behavior in subcritical exponential-type assemblies, and for irradiating foils and other materials. A 1959 Atomics International brochure also indicated the reactor was “utilized for the performance of exponential experiments, lattice, buckling, and other reactor physics studies.” In 1972 the name of the reactor was changed to “L-85.” The reactor operated one-and-off for 24 years, from November 1956 to February 1980.

THE AE-6/L-85 installation consisted of a reactor building that housed the reactor and control room, and a separate building used for fuel handling and storage (Building 4643).

The reactor bay had an open ceiling approximately 10 meters high with an overhead crane.[1] The EPA-HSA provides a detailed description of the building features. The neutron flux was available in various magnitudes for experimental purposes.[2] In 1974, polyethylene shielding was

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[1] EPA/HGL, *Final HSA 5-A,* p. 83, citation 371:

> [371] Oak Ridge Associated Universities, *Confirmatory Radiological Survey of the L-85 Reactor Facility, Rocketdyne Division, Rockwell International Corporation, Santa Susana, California*, December 1986.

[2] EPA/HGL, *Final HSA 5-A,* p. 83, citation 372:

> [372] Atomics International, NAA-SR-7300, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.

added to the top of the reactor and along the east side wall shield. Following the addition of the shielding, it was determined the radiation levels for reactor operation at the 2.75 kW power level were within “acceptable limits;” however, the document does not indicate what the 1974 acceptable limits were.[1] The building did not include a stack.

The L-85 reactor operated as a commercial operation for central station power plant operator training and for neutron radiography inspection of precision forgings, castings, and electronic and explosive devices for manufacturing defects.

The preliminary MARSSIM Classification for the Building 4093 area is Class 1 because of the building’s previous site use, known radiological use, and previous incident reports.

5.1.2.2 Building 4093 Radiological Incident Reports

According to the 2006 SSFL Site Description, only one incident occurred at Building 4093 on March 25, 1959, and there is no reference to worker exposure. However, the Incident Report related to that particular incident is referenced in the table below, along with several others that could have resulted in a release to the environment and worker exposure. The information is presented in an Incidents Database that was provided to NIOSH by Boeing in 2009. Summaries of all available incident reports are also provided below and in Attachment A of the HSA.

5.1.2.3 Building 4093 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
AO275	3/25/1959	AE-6 Reactor	Mixed Fission Products*	Fission gas release contaminated employees and part of the building.
A0512	10/6/1960	AE-6 Fuel Building	None Identified	High radiation alarm malfunctioned during fuel handling.
A0106	7/30/1982	L-85 Reactor Room	U/Mixed Fission Products*	Purging of reactor core resulted in contamination of employee and floor
A0661	5/24/1995	Building 4093, SSFL	Cs-137	Radioactive material in a non-controlled area

*Mixed fission products have been identified as typically including Cs-137 and Sr-90.

- On March 25, 1959 one of the instruments controlling the power of the AE-6 malfunctioned and allowed the reactor to exceed the normal power level of 3kWt and approach 4kWt. The operation at the higher power level lasted approximately one minute. A release of fission gas contaminated part of the high bay and employees. Contamination levels were measured from 7.5 mR/hr to 13 mR/hr. The maximum release estimated was 10 mCi of principally xenon-135 (A0257). However, the Atomics International IOL Report by G.L. Blackshaw, who was present at the time of the event, specified that the primary contamination was with fission products, not

[1] EPA/HGL, *Final HSA 5-A,* p. 83, citation 373:
[373] *Felten, L.D. Internal Letter Re: Review of L-85 Reactor-Building 093, May 19, 1972.*

xenon-135.[1]

Blackshaw detailed employee contamination as a result of personnel removing shielding blocks while radiation levels near the recombiner were still 25 R and replacing the shielding blocks without wearing gloves. Due to the heavy concrete dust in the region of the recombiner, employees' hands faces and clothing became contaminated at 1.5-2.0 mr. The employees were sent to the ETB (Building 4003) for showers, where subsequent examination apparently showed that their contamination had been removed by showering.

Blackshaw described heavy air contamination in the control room, and Building 4093's bay doors were opened to release it to the outdoors. A sample of vacuum pump oil revealed a count rate of 111,000 cpm that decreased to 500 cpm the following day, showing evidence of short-half-lived fission products. Moreover, Blackshaw described specific reactor functions that supported his assertions such a degree of contamination could have been caused by fission gas. According to Blackshaw's description of events, the principle contamination at the AE-6 was with fission products, not xenon-135.

- The report states that, "Due to the 25 R field in the immediate vicinity of the recombined (as compared to the usual value of 100-200 mr after an overnight wait), only 8 shielding blocks had been removed instead of the usual 16. This made it difficult to reach the exhaust tank in its usual position in a wooden container next to the reflector." This suggests that the readings close to the recombined were still in excess of the agreed-upon levels for personnel in the work area.

- On October 6, 1960 an alarm malfunctioned as a result of an "electrical transient." Two employees were handling AE-6 fuel at the time the alarm sounded; however, the nature of the alarm was discovered and the area was released (A0512).[2]

- On July 30, 1982 rinse water contaminated with 5 ml of U-235 was spilled during the fuel draining operation, contaminating an employee and an area of the high bay floor. According to the incident report, after all the L-85 fuel solution was drained from the core, and the rinse water was drained without incident, an inline absolute filter was connected to the drain line and nitrogen was flowered through the system to dry it out. More moisture was in the system than anticipated, and it got through the absolute filter and dripped off of the plastic covered shield block onto the floor. The employee present observed the spill, stopped the flow of nitrogen, and used "kimwipes" to move the absolute filter further back on the shield block. The incident report indicated that a check of the alpha air monitor located in the reactor room indicated no airborne release, while a smear survey of the reactor room floor spill area showed contamination levels of **930,000 beta,** and dropped down to 1,000 dpm further from the spill/work area. According to the 2005 HSA, the area was partially decontaminated at the

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[1] EPA/HGL, *Final HSA 5-A,* p. 88, citation 394 & 395:

> *[394] Unknown, Building 4093 – L-85 (AE-6) Research Reactor, Unknown Date.*
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> *[395] Blackshaw, G.L., NAA-SR-Memo 3757, "Release of Fission Gases from the AE-6 Reactor on March 25, 1959," April 15, 1959.*

[2] EPA/HGL, *Final HSA 5-A,* p. 88, citation 396:

> *[396] Sessions, S.D., Atomics International Inter-Office Letter Re: Radiological Safety Incident Report A0512, November 17, 1960.*

time and fully decontaminated during facility decommissioning. The incident report does not document how the area was partially decontaminated (A0106).[1]

- On May 24, 1995 an encased radioactive high efficiency particulate air (HEPA) filter was found in a pile of debris during the demolition of buildings 4453 and 4093. While it was not obvious from which building the filter originated, the incident report indicated the filter most likely came from the roof of Building 4093. The incident report did not provide an estimated age of the filter. A survey of the inside of the filter using a Ludlum 12 GM frisker indicated an average of 22 to 3000 cpm and a maximum of 500 cpm fixed beta. While below the facility release limits of 5,000 dpm/100 cm2 average and 15,000 dpm/100 cm2 maximum, it did exceed the free release limits of “no detectable activity” for fixed contamination. No detectable fixed beta radiation was observed on the outside of the encased unit. The incident report indicated that smears of the filter showed no removable alpha or beta contamination. The filter was taken to the RMHF for further evaluation. Scanning with a portable NOMAD gamma spectrometer indicated the presence of Cs-137. The report did not provide the activity levels of Cs-137. At the RMHF, the filter was packaged for disposal as low-level radioactive waste (A0661).[2]

- Gamma radiation was found to be 1,000 mr/hr on the east side of the building directly opposite the core. In order to determine the need for access restrictions on the area surrounding Building 4093, a radiation survey of the perimeter of the AE-6 reactor was conducted August 13, 1970. The reactor was at a power level of 2 kW, and was operating with the shield doors on the east side open and a plastic Lucite rod, approximately six feet long, inserted in the one-inch diameter beam hole. The EPA research team has been unable to determine if the building operated with the shield doors open frequently.[3]

The EPA HSA provides a detailed chronology of radiological investigations associated with Building 4093 and its surrounding area, as well as a sequential description of decontamination and decommissioning activities.

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[1] EPA/HGL, *Final HSA 5-A,* p. 88, citation 397 & 398:

. [397] Wallace, J.H., Rockwell International Internal Letter Re: Radiological Safety Incident Report A0106, August 4, 1982.

[398] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California*, *Volume 2 – Area IV Site Summaries,* May 2005.

[2] EPA/HGL, *Final HSA 5-A,* p. 88, citation 399:

[399] Rutherford, P.D., Rockwell Internal Letter Re: Radiological Incident Report A0661, June 7, 1995.

[3] EPA/HGL, *Final HSA 5-A,* p. 95, citation 426:

[426] Johnson, B.I., Internal Letter Re: Radiation Survey of the AE-6 Reactor, Building 093, August 13, 1970.

Section 5.2 HWBR: Additional Locations / Operations

Several buildings and facilities associated with Homogenous Water Boiler Reactor operations were excluded from the 2006 Site Profile. This section provides a partial list and a description of important facilities that should be included in the Site Profile.

Some of the locations have documented processes that involved radiological materials. In some cases, the locations may have been designated as ‘non-radiological’ facilities despite their location within Area IV, involvement in radiological processes, and/or proximity to known sources of radiation exposure.

Section 5.2.1

Building Number: **4074**
Building Alias: **074/T074**

Building Name: **KEWB Reactor Support Building**

Building Function: **Storage**
Film Processing

Note: Designated "non-radiological." Proximity to RMHF affected ambient radiation levels.

Radionuclides of Concern:

5.2.1.1 Description of Operations & Processes

Building 4074 was constructed in 1958 for use as a storage and film processing building where personnel processed photographic oscillograph paper for the KEWB. It featured a sampling station for measuring the ambient air radioactivity concentration on a quarterly basis. To date, no incident reports associated with Building 4074 operation have been located, and there are no indications that radioactive materials were handled or used at this location.

The maximum ambient exposure rate presented in the survey report for Building 4074 included other buildings located in its vicinity - 4074, 4083, and 4453. The maximum ambient exposure rate was found to be 23.1 µR/hr. The limit was listed as being 19.7 µR/hr. It is important to note the report did not provide information to indicate how the ambient exposure rate was measured or how the limit was derived; however, the report did attribute ambient exposure rates over the limit to the nearby RMHF, and were reported not to represent residual contamination.

The preliminary MARSSIM Classification for the Building 4074 area is Class 1 because of the building's proximity to Building 4093 (Water Boiler Reactor) and the limited operational information for the building.

Section 5.2.2

Building Number: **4083 / 4103**
Building Alias: **083/T083 / 103 / T103**

Building Name: **KEWB Reactor Support Building**

Building Function: **Office**
Control Building
Instrumentation / Recording of Transient Tests

Note: Designated "non-radiological." Proximity to AE-6, L-85 and RMHF affected ambient radiation levels.

5.2.2.1 Description of Operations & Processes

Building 4083 and Building 4103 were constructed in 1958 to serve as the office and control building for the KEWB reactor in Building 4073. These locations were included in the Nuclear Regulatory Commission (NRC) license, dated January 5, 1972 (R-118 DOCKET NO. 50-375) for the L-85 reactor (Building 4093); however, EPA's research team was not able to locate any documentation indicating that Building 4083/4103 was included in the license for the L-85 reactor located in Building 4093.

The maximum ambient exposure rate presented in the survey report for Building 4074 included other buildings located in its vicinity - 4074, 4083, and 4453. The maximum ambient exposure rate was found to be 23.1 μR/hr. The limit was listed as being 19.7 μR/hr. It is important to note the report did not provide information to indicate how the ambient exposure rate was measured or how the limit was derived; however, the report did attribute ambient exposure rates over the limit to the nearby RMHF, and were reported not to represent residual contamination.

The preliminary MARSSIM Classification for the Building 4074 area is Class 1 because of the building's proximity to Building 4093 (L-85 Water Boiler Reactor) and the limited operational information for the building.

Section 5.2.3

Building Number: **4123**
Building Alias: **123/T123**

Building Name: **KEWB Reactor Support Building**

Building Function: **Radiological Waste Storage (KEWB, Bldg. 4073)**

Radionuclides of Concern: Reactor fuel for the KEWB reactor was U-235 dissolved as uranyl sulfate in solution. Based on radiological investigations and historical documents, the radionuclides of concern include Co-60, Cs-137, Eu-152, Eu-154, Eu-155, Mn-54, Pb-210, Ra-226, Sr-90, U-235 and U-238.[1]

5.2.3.1 Description of Operations & Processes

Building 4123 was constructed sometime between 1957 and 1962. Surrounding buildings include Building 4073, 4643, and 4893. It was used for the temporary storage of radiological wastes material associated with the operations of building 4073, the KEWB Reactor. This included the storage of uranyl sulfate and mixed fission products.[2]

EPA determined it was appropriate to include an excerpt from the employee interviews, which included a former employee's assertion that upon the KEWB core's replacement of the spherical core with the cylindrical core, the spherical core was stored at Building 4123. According to the employee, the workers tasked with the transfer of the spherical core to storage in room Building 4123 resulted in "getting our yearly dose." No incident reports were identified by the EPA research team.

EPA HSA provides a detailed chronology of radiological investigations and decontamination of Building 4123. In May, 1983 Argonne National Laboratories performed a post remediation radiological survey to verify that the site was free of radioactivity except for normal background. Argonne National Laboratories determined that background was relatively high (40 µR/hr and 8,000 cts/min) due to the "shine" from nearby Buildings 4021 and 4022 (RMHF). The survey concluded the site could be released for unrestricted use.

In August 1988, Rocketdyne performed a surface scan between the KEWB facilities and the RMHF measuring ambient gamma exposure rate to ensure no contamination existed as a result of radioactive materials movement. The survey results were below the 1988 acceptable limits. However, the findings are inconsistent with the findings of the Argonne National Laboratory's report that determined background levels to be 40 µR/hr (the limit was 17.0 µR/hr). The August

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[1] EPA/HGL, *Final HSA 5-A,* p. 99, citations 444:

> [444] Rocketdyne Report, N001ER000017, *"Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective," September 1991.*

[2] EPA/HGL, *Final HSA 5-A,* p. 96, citations 429 & 430:

> [429] Author unknown*, Vanowen and SSFL Operations 1959, Laboratory Status Reports, undated.*
>
> [430] Rocketdyne Report, N001ER000017, *"Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective," September 1991.*

1988 report did not provide any comparison of findings with previous reports to provide any reasons for the discrepancy.[1]

The preliminary MARSSIM Classification for the Building 4123 area is Class 1 because of the building's purpose as a temporary radioactive waste storage facility, the location of the building within ETEC, and its proximity to Building 4073.

[1] EPA/HGL, *Final HSA 5-A,* p. 98, citations 440:

> [440] Argonne National Laboratory, "*Surplus Facilities Management Program, Interim Post Remedial Action Survey Report for Kinetic Experiment Water Boiler (KEWB) Facility, Santa Susana Field Laboratory, Rockwell International, Canoga Park, California,"* May 1983.

Section 5.2.4

Building Number: **4643**
Building Alias: **4643/T643**

Building Name: **KEWB Reactor Support Building**

Building Function: **Exhaust Stack / Mechanical Building**

Radionuclides of Concern: Reactor fuel for the KEWB reactor was U-235 dissolved as uranyl sulfate in solution. Based on radiological investigations and historical documents, the radionuclides of concern include Co-60, Cs-137, Eu-152, Eu-154, Eu-155, Mn-54, Pb-210, Ra-226, Sr-90, U-235, and U-238.[1]

5.2.4.1 Description of Operations & Processes

Building 4643 was a small mechanical building with a 60-foot exhaust stack that had a 2,000-cubic foot per minute blower system. The building was connected to a 300-gallon underground storage tank that was connected to Building 4073 and held radioactive gases released from the core for a half-life period prior to expelling the exhaust to the atmosphere.[2]

Constructed in the early 1960's, Building 4643 was an exhaust building that provided ventilation for the KEWB reactor building. During D&D in 1975, a contamination survey of Building 4643 and the associated equipment indicated the floor of the exhaust building was contaminated with removable beta contamination levels of up to 600 dpm/100cm^2. The exhaust blower and filter plenum were also contaminated and were removed and sent to the RMHF for disposal.

In August 1988, Rocketdyne performed a surface scan of the terrain between the KEWB facilities and the RMHF measuring ambient gamma exposure rates to ensure no contamination existed as a result of radioactive materials movement. Again, Rocketdyne's findings were inconsistent with those of Argonne National Laboratories report that determined background levels to be 40 µR/hr. The August 1988 report did not provide any comparison of findings with previous reports, or any explanation for the discrepancy. The EPA-HSA provides a detailed chronology of facility radiological investigations and D&D.

The EPA research team did not locate any documented radiological incidents associated with Building 4643.

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[1] EPA/HGL, *Final HSA 5-A,* p. 73, citation 332:

> [332] *Rocketdyne Report, N001ER000017, "Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective," September 1991.*

[2] EPA/HGL, *Final HSA 5-A,* p. 107, citations 463 & 464:

> [463] Rockwell International, AI-ERDA-13159, *"KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.*
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> [464] Atomics International, Document NAA-SR-7300 Special, *"Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities," May 25, 1962.*

Section 5.2.5

Building Number: **4453**
Building Alias: **453/T453**

Building Name: **AE-6 / L-85 Reactor Support Building**

Building Function: **Fuel Handling Facility**
Measuring Background for Facilities Related to AE-6/L-85
Neutron Radiography Storage Building (1984)

Notes: Despite technical designations as "non-radiological" facility, this location has documented use and storage of radiological material.

Radionuclides of Concern: Co-60, Cs-137, Eu-152, Eu- 154, Sr-90, U-238 and U-235.

5.2.5.1 Description of Operations & Processes

Located approximately 165 feet southeast of Building 4093 (AE-6 / L-85 Reactor Building), Building 4453 was constructed in approximately 1958. It was used for fuel handling and for measuring background for facilities associated with AE-6 / L-85 reactor operations. The EPA research team notes that the Use Authorization for Building 4093 allowed for the storage of 200 grams of U-235 within a metal safe at Building 4093, but "Fissile materials, other than the fuel solution in the reactor and what is stored in the metal safe, must be stored in approved safe-geometry containers in an array no more reactive than authorized for the containers." While documents do not provide the location of these storage containers, EPA's research team noted it is possible that the materials were stored in Building 4453.[1] In 1984, Building 4453 is listed as a "Neutron Radiography Storage Building."[2] The above-average ambient exposure rates for Building 4453, 4083 and 4074 were attributed to the nearby RMHF and were reported not to represent residual contamination.

Building 4453 was located outside the restricted area surrounding the AE-6 / L-85 reactor and was reported to have had no history of non-sealed source radioactive materials use, and no documented radiological incidents. However, documents indicate the building served as the fuel handling facility for Building 4093.Because the building is stated to have served as a fuel handling facility for Building 4093, there is a possibility of elevated radionuclide concentrations in the soil. The preliminary MARSSIM Classification for Building 4453 is Class 1.

The EPA research team did not locate any radiological incidents associated with Building 4453.

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[1] EPA/HGL, *Final HSA 5-A,* p. 101, citation 450:

[450] Skoholt, Donald, *North American Rockwell Corporation, Docket No. 50-375, Facility License No R-118*, January 5, 1972.

[2] EPA/HGL, *Final HSA 5-A,* p. 101, citations 451:

[451] Olson, P, et. al, GEN-ZR-0002, *CERCLA Program Phase II – Site Characterization*, May 29, 1987.

5.3 SODIUM-COOLED GRAPHITE-MODERATED REACTORS

The 2006 Site Description provides an insufficient, incomplete and inaccurate description of operations associated with the Sodium Reactor Experiment (SRE). The 2006 Site Description indicates the reactor was shut down in 1964, missing nearly three years of reactor operations under the SRE-PEP (Power Expansion Program).

In addition, the 2006 Site Description only references one incident at the SRE (July 12, 1959 - “Power Run 14”), and provides information about the event that conflicts with numerous historical reports authored by the AEC and Atomics International, as well as with the Incident Database.

The Incident Database contains 45 incident reports associated with Building 4143 alone, which could have resulted in releases to the environment and worker exposure.

The 2006 Site Profile provides an incomplete list of buildings/facilities associated with SRE operations, for which no descriptions of facility function or incidents are provided. CORE Advocacy provides a description of operations and incidents for these facilities in this section.

Several buildings/facilities involved in SRE operations were excluded from the 2006 Site Profile. A partial list of the excluded buildings/facilities, with descriptions of operations and incident report summaries, is provided in Section 5.4.

>> Interesting Fact: DOE maintained a facility in Area I that was used to support SRE operations in Area IV. The location was known as the Area I Atomics International MOC Fuel Rod Tower. It was constructed in the 1950’s and supported Area IV operations, until 1974. In 2009, the California Department of Toxic Substances Control (DTSC) identified Area I as a “point of radiological interest” as a result of DOE operations and facilities in Area I.[1]

[1] California Department of Toxic Substances Control (DTSC) RFI Data Gap Work Plan, Boeing RFI Subarea 1A North. File: 66074_1Anorth_PublicMeeting_051613_rev8_draft.pdf Page 21 & Page 24

Section 5.3.1

Building Number: **4143**
Building Alias: **143 / T143**

Building Name: **Sodium Reactor Experiment (SRE) Reactor Building**

Building Function: **1957 - 1964: Sodium Graphite Reactor (SRE)**
1965 - 1967: SRE PEP Program

Note: **Major Nuclear Incident (July 12, 1959).**
Tritium

Radionuclides of Concern: U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, neptunium-237 (Np-237), Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, technetium-99 (Tc-99), Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151.

5.3.1.1 Building 4143 Description of Operations & Processes

The Sodium Reactor Experiment (SRE) was a nuclear reactor developed to demonstrate a sodium-cooled graphite moderated reactor for civilian use. It reached full power (20 MW) in May, 1958 and provided 37 gigawatt hours of power to the Southern California Edison Company (SCE), powering the City of Moorpark as part of its demonstration. The SRE experienced a major incident July 12, 1959 that is documented below. In addition, several other incidents occurred that involved the SRE, which are also documented below. The HSA did not identify any Radiological Use Authorizations issued for Building 4143 prior to 1975.

The 2006 Site Profile indicates that the SRE was “shut down for the last time February 14, 1964 and maintained in a safe shutdown condition until September, 1967.” However, the SRE operated from 1965-1967 as part of the SRE Power Expansion Program (PEP).[1]

Building 4143 was constructed between April 1955 and February 1957. According to the HSA, the SRE was a high-temperature reactor with a slightly enriched uranium metal fuel (Core I) and sodium-cooled, hexagonal zirconium-clad graphite moderator elements. Following an accident in 1959, the enriched uranium fuel was replaced with a 93% uranium-thorium metal alloy fuel (Core II).

Building 4143 was approximately 20,000 feet in area and included below-grade vaults and galleries for radioactive materials, a high bay, ground floor and mezzanine offices, rooms housing support equipment, a paved area surrounding the building, several out-buildings, and drainage channels. The HSA provides a detailed description of Building 4143’s features, including an inventory of equipment and a description of equipment operations. The HSA describes the SRE reactor core as a matrix of moderator elements containing the fuel elements, control rods, neutron source, and instruments for measuring temperature and sodium level.

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[1] EPA/HGL, *Final HSA 6,* p. 69, citation 5:

[5] Ureda, B. and Heine, W., *Facilities Dismantling Plan for SRE*, Atomics International Report No. FDP-704-990- 003, June 24, 1975, pp. 9, 13, 17-18.

According to the HSA, because the SRE was an "experimental reactor," the core geometry changed as test elements changed.[1]

SRE Reactor Operations 1965 - 1967: SRE-PEP Program

From May 1965 to September 1967, the SRE and Building 4143 were used for the SRE-PEP program. Atomics International operated the main primary sodium system for 4,386 hours at 700˚F and for 13,196 hours at 350˚F. The objective of the SRE PEP was to raise the sodium operating temperatures to 1,200˚F and thermal power levels to 30 MW with a stainless-steel-clad uranium carbide fuel loading.

The primary sodium system was shut down in September 1967. Atomics International's deactivation plan involved a "stored-in-place" configuration but nonessential equipment was removed, and the steam generator and uncontaminated support facilities were not maintained. Deactivation activities were completed in 1968. Decommissioning began in 1974 with an objective of removing significant radioactivity from the site and releasing the facility for unrestricted use. The SRE superstructure was retained to provide containment for airborne contamination released by decontamination operations. Once Building 4143 was released for unrestricted use, it was used for ETEC component storage. The reactor core was not removed until 1977.[2] The HSA provides substantive excerpts from SRE employee interviews, and a detailed chronology of DD&D operations related to the SRE and Building 4143, which was demolished in 1999.[3]

The EPA research team was unable to locate information about air monitoring results at the stack, although some information is provided in the Incident Reports Database. CORE Advocacy located the Atomics International Quarterly Report of Activity Released to the Atmosphere from Building 4143, dated November 20, 1959. Documentation of the activity released to the atmosphere at the SRE begins July 1, 1959 and ceases July 25, 1959. There is no data provided between July 25, 1959 and September 16, 1959 due to "slow release rates," according to the report.[4] It should be noted that, between the dates referenced above, fuel removal operations began and high radiation levels were recorded in numerous technical reports authored by Atomics International, and the original Incident Reports contained in the Incident Report Database. It should also be noted that, according to Incident Reports in the Incident Report Database, the SRE stack only exhausted hot cell and vent system effluent.

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[1] EPA/HGL, *Final HSA 6,* p. 30.

[2] EPA/HGL, *Final HSA 6,* p. 31, citations 3 &1:

> [3] Ureda, B. and Heine, W., *Facilities Dismantling Plan for SRE*, Atomics International Report No. FDP-704-990-003, June 26, 1975, pp. 9, 13, 17-18.
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> [1] Ureda, B. and Heine, W., *Facilities Dismantling Plan for SRE*, Atomics International Report No. FDP-704-990- 003, June 26, 1975, pp. 15-18.

[3] EPA/HGL, *Final HSA 6,* p. 32, *Information from Interviewees.*

[4] Atomics International Internal Memo, "*Quarterly Report of Activity Released to Atmosphere,*" November 20, 1959. File: HDMSe00581353.pdf

5.3.1.2 2006 Site Profile Overview of the SRE: Inaccurate / Incomplete

The 2006 Site Description provides incomplete and inaccurate information about Building 4143 SRE operations and incidents over the course of operation, as described above. In addition, the 2006 Site Description provides incomplete and inaccurate information about a major incident that occurred July 12, 1959 during what is known as "Power Run 14."

Atomics International technical reports describe reactor operations that occurred before, during and after Power Run 14.[1] [2] [3] However, when these technical reports are compared to incident reports contained in the Incident Report Database and Atomics International internal documents generated during the event, there are noted inconsistencies. In addition, several technical reports authored by Atomics International reflect worker dose estimations that, when all details are considered and radiation measurements in the work area are evaluated, appear to be suspect if not downright implausible.

During Power Run 14, the core scope was used and several courses of action describe lifting and/or rotating of the reactor face. These efforts were undertaken to assess the damage the SRE had suffered, and later in an effort to remove damaged fuel rods from within the reactor's core. Many summary reports authored in later years make the assertion that only krypton and xenon noble gases were released during these operations, and workers were never at serious risk of exposure to radiation. However, workers were tasked with scrubbing walls, floors and equipment with absorbent materials and decontamination solution; a task that would not have been necessary if contamination had been limited to noble gases, and more closely associated with decontamination procedures involving mixed fission products.

Several incident reports that are contained in the Incident Report Database, generated after Power Run 14, describe similar or identical operations involving use of the core-scope and/or the lifting and rotation of the reactor face, during what would be considered normal reactor conditions. In numerous instances, mixed fission products from the reactor core contaminated the work area, and the workers. Nasal smears document serious exposure, and in several incidents workers are tasked with similar decontamination procedures involving the use of absorbent materials and decontamination solutions to scrub the walls, floors, and equipment in the work area.

Since most employees involved in Power Run 14 lack dosimeter data, it would be reasonable to compare the worker dose estimations between those involved in Power Run 14 to those involved in later incidents involving similar operations with the core-scope and reactor face rotation. Moreover, in the event employees involved in Power Run 14 must rely on coworker data for dose reconstruction, it may be appropriate to apply that of fellow SRE employees

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[1] Atomics International, AEC Research and Development Report: SRE Fuel Element Damage - An Interim Report of the Atomics International Ad-Hoc Committee 1959. File: NAA-SR-4488.pdf

[2] Atomics International, Distribution of Fission Product Contamination in the SRE, by R.S. Hart, 1960. File: NAA-SR-6890.pdf

[3] Atomics International, AEC Research and Development Report: *SRE Fuel Element Damage - Final Report of the Atomics International Ad-Hoc Committee 1961*.
File: NAA-SR-4488_Suppl.pdf

involved in similar or identical job processes, whose exposures to mixed fission products are better documented.[1] [2]

While the 2006 Site Description only identified the one incident associated with Power Run 14 at Building 4143, the Incident Report Database provided by Boeing documents 45 incidents associated with this location that could have resulted in environmental release and worker exposure.

The preliminary MARSSIM classification for the Building 4143 area is Class 1 due to its documented releases and former use as the SRE reactor building.

5.3.1.3 Building 4143 Radiological Incident Reports

There have been several incidents associated with Building 4143 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

5.3.1.4 Building 4143 Radiological Incident Report Summary - Data Provided by Boeing

* “MFP” is likely to reference “Mixed Fission Products.”

Incident File Name	Date of Incident	Incident Occurred After 1964 “Shutdown”	Location of Incident	Isotopes MFP = Mixed Fission Products	Description of Incident
A0374	6/13/1958		SRE High Bay		Employee did not wear prescribed respiratory protection.
A0478	2/6/1959		SRE High Bay	MFP	Two employees handled contamination equipment without proper use of protective gloves.
A0315	6/4/1959 - 6/5/1959		Wash Cell	MFP	Explosion blew fuel element undergoing sodium cleaning out of the Wash Cell.
A0274 **MAJOR INCIDENT**	7/12/1959 - 5/21/1960		Reactor Core	MFP	SRE Fuel Element Damage
A0351	9/10/1959		R/A Storage	MFP	Employees entered controlled area without appropriate authority.

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[1] EPA/HGL, *Final HSA 6,* p. 58, citation 4:

> [4] Galperin, A. and Shannon, J. W., Atomics International Internal Letter, re*: Radiological Safety Incident Report, SRE High Bay, 5/25/60*, August 30, 1960.

[2] EPA/HGL, *Final HSA 6,* p. 59, citation 1:

> [1] Lane, W. D., Atomics International Internal Letter, re*: Radiological Incident Report, SRE High Bay, 6/9/60*, July 20, 1960.

Incident File Name	Date of Incident	Incident Occurred After 1964 "Shutdown"	Location of Incident	Isotopes MFP = Mixed Fission Products	Description of Incident
A0390	11/21/1959		SRE High Bay	MFP	Employee contaminated during modification of SRE Core Recovery Tool.
A0548	12/7/1959		SRE High Bay	MFP	Employee entered controlled area without prescribed protective clothing.
A0391	12/18/1959		SRE Hot Cell	MFP	Employee entered controlled area without required hood and exited without a survey.
A0510	4/11/1960		SRE High Bay	MFP	Leakage around viewing glass caused contamination of employee.
A0394	5/15/1960		SRE High Bay	MFP	SRE Sodium Fire in High Bay
A0393	5/26/1960		SRE High Bay	MFP	Employee contaminated by core cover gas escaping during core scope removal
A0460 Incident Report Missing	6/2/1960		SRE High Bay	MFP	Man slightly injured and contaminated while working on SRE Fuel Coffin.
A0005	6/9/1960		SRE High Bay	MFP	Core cover gas leak contaminated employees.
A0442	7/7/1960		SRE High Bay	MFP	Reactor cover gas escaped contaminating employee.
A0305	12/15/1960		Tent	Cs/Sr	Improperly sealed respirator caused high internal and external contamination.
A0435	5/17/1961		SRE High Bay	MFP	Protective boot leaked, contaminating shoes.
A0515	11/4/1961		SRE High Bay	MFP	Employee exposed to airborne activity while removing samples in High Bay
A0472	12/23/1961		SRE High Bay	MFP	Controlled area entered without proper authority, protection, and procedure.
A0534	2/6/1962		SRE HP Office	MFP	Unauthorized employee used HP equipment with faulty results.
A0015	4/4/1962		SRE High Bay	MFP	Airborne activity in SRE High Bay
A0373 Incident Report Missing	6/13/1962		SRE High Bay	MFP	Operator engulfed in fire during transfer of core heaters.

Incident File Name	Date of Incident	Incident Occurred After 1964 “Shutdown”	Location of Incident	Isotopes MFP = Mixed Fission Products	Description of Incident
A0404	7/30/1962		SRE West Pad	Sb-124	SRE source transfer operation caused employee exposure above guidelines.
A0379	10/20/1962		SRE West Pad		3 Employees size-reducing SRE Core Heaters became contaminated.
A0030	3/19/1964	X	SRE & Surface Drainage	MFP	R/A Liquid pumped onto ground as “clean.”
A0409	6/13/1964	X	SRE FHM PIT	MFP	Airborne activity in fuel handling machine pit contaminated employees.
A0493	6/17/1964	X	SRE FHM PIT	MFP	High airborne activity in fuel handling machine service pit contaminated two employees.
A0380	6/21/1964	X	SRE High Bay	MFP	Employees and area contaminated from improper doffing.
A0382	918/1964	X	Poor Man’s Cell		Work in the Poor Man’s Hot Cell caused airborne exposure to employees.
A0545	12/1/1964	X	SRE High Bay	MFP	Gamma survey of control-rod thimble contaminated probe and surveyor.
A0371	12/18/1964	X	SRE High Bay		Size reduction of reactor components caused exposure and contamination of employees.
A0296	1/14/1965	X	SRE High Bay		Movement of temperature probe caused exposure in excess of guidelines.
A0386	2/20/1965	X	SRE High Bay		Core light replacement contaminated employees when radioactive gas was released.
A0416	2/27/1965	X	SRE High Bay	MFP	Servicing moderator cask resulted in employee contamination.
A0444	4/24/1965	X	SRE High Bay	MFP	Employee drilled through finger during operation in SRE High Bay,
A0445	5/22/1965	X	NA Pipe Gallery	MFP	Employee lacerated thumb during operation in SRE High Bay.
A0041	8/19/1966	X	Tab Exposure Facility	MFP	Personnel exposed to primary sodium in TAB Exposure Facility.

Incident File Name	Date of Incident	Incident Occurred After 1964 "Shutdown"	Location of Incident	Isotopes MFP = Mixed Fission Products	Description of Incident
A0321	12/8/1967	X	Maintenance Cell	MFP	Radioactive water discovered in 8" pipes that penetrated maintenance cell floor.
A0289	10/23/1976	D&D Period	SRE High Bay		The bottom of a Cold Trap fell off during movement, contaminating floor.
A0059	8/1/1977		SRE High Bay	MFP ACP	Reactor vessel segments storage pit leaked water to the soil.
A0414	8/10/1977		SRE High Bay	MFP	Employee exposed to airborne activity during D&D operations.
A0578	6/24/1978		SRE		Employee injured when he tripped on culvert.

*Isotopes are written as they are presented in the Incident Database. The EPA research team believes that 'MFP' is an acronym for mixed fission products, and 'ACP' stands for activation products.

- On June 13, 1958 three employees failed to wear the respirators recommended and supplied by the health physicist while working beneath the fuel handling coffin. The incident report notes that compliance with health physics recommendations is expected. No other information about the incident is provided (A0374).[1]

- On February 6, 1959 two Atomics International personnel handled contaminated equipment without the proper use of protective gloves. The men were replacing a television camera that had been used on the reactor loading face, with a movie camera. After handling the television camera and its component parts, the television camera was removed. One man asked for the SRE Polaroid camera to take a picture of the camera setup. He received the Polaroid camera with contaminated gloves and when he was not able to make the camera adjustments he wanted, he removed the gloves by placing the fingers of the gloves between his teeth and withdrawing his hands. After continuing to have difficulty, both men handled the camera, one with gloves on and one without gloves. The picture was taken and the camera was returned to the SRE operations department. Both men then handled the movie camera and mounted it on the old television camera brackets. Again, one man had gloved hands and the other did not. The men then walked off the potentially contaminated plastic sheeting on the floor before removing their shoe covers. Smears of the plastic sheeting showed less than 30 dpm beta-gamma and smears of the television camera ranged from 1 to 200 dpm beta-gamma. The Polaroid camera and movie camera were not significantly contaminated. When questioned, the men stated they had used the hand and foot counter before leaving the building. No personnel contamination was found. One of the men was found to be new and had little knowledge of the hazards of radiation contamination. [This observation may speak to the level of training among nuclear personnel, as to the known risks and hazards associated with their

[1] EPA/HGL, *Final HSA 6,* p. 46, citation 1:

[1] Fisher, W.L., Internal Letter, re: Non-Compliance with Health Physics Recommendation, June 16, 1958.

job descriptions]. (A0478).[1]

- On June 4, 1959 a fuel element (R-56) was removed from the SRE reactor core for transport to Wash Cell B for sodium cleaning. The operator noted that the fuel element appeared "quite dirty." After cooling, the operator felt the fuel rod "appeared better, however, a dark material was noted near the upper part of the hanger rod, near the lower end of the hanger rod, at [the] top of [the] fuel cluster and at the lower extremity of the fuel cluster." The dark material was not definitively identified in the incident report; however, it is implied to be the hydrocarbon coolant and lubricant tetralin or one of its decomposition products.

  The fuel element was lowered into Wash Cell B by the transfer cask. A vacuum was started on the cell and wash water was pumped into the cell. When the vacuum was decreased to about 2 inches of mercury, the vent valve was opened. Some "pops" were heard, but that was typical of the sodium-water reaction that occurred in the cleaning process. At approximately 6:55 a.m., an abnormal rise in pressure occurred leading to an explosion, which blew the fuel element shield plug and hanger rod out of the wash cell and onto the reactor room floor. The fuel element cluster itself remained in the wash cell. Flames and smoke erupted from the wash cell, the radiation air monitor sounded, and the building was evacuated.

  A survey reading taken through a buckled door measured 125 mrad/hr approximately 10 feet from the hanger rod. Absolute filter banks on the SRE building roof were surveyed. Results were 250 mrad/h for the west filter bank and 150 mrad/h for the east filter bank. Personnel entered the high bay to collect samples. Liquid material, presumed to be sodium hydroxide, found on the floor measured 2.5 rad/h at 6 inches. The SRE control room, mazzanine area, and health physics office were surveyed, but only minor contamination was detected and these areas were quickly decontaminated. A high volume air sample was taken in the high bay near the wash cells at 2:00 p.m. and airborne activity was found to be 3 x 10^{9} µCi/cm3 beta-gamma.

  On June 5, 1959 the core plug and hanger rod were placed into a moderator can storage well. Measurements taken at that time found the core plug to be 1 rad/h at 6 inches, the hanger rod to be 2.5 rad/h at 6 inches, and the lid of the moderator can to be 30 mrem/h at the surface. A high volume air sample was taken at 11:25 a.m. and results showed airborne activity to be 2 x 10^{9} beta-gamma. Decontamination and re-surveying of the high bay began.

  An investigation board noted the most probable cause of the incident was a hydrogen-oxygen reaction. Oxygen from the wash cell vent pipe combined with hydrogen resulting from the sodium-water reaction that occurs in the cleaning process to create the pressure build-up and explosion. Additionally, a new wash cell procedure had just been put into place, and the "hold down" clips used to keep the fuel element components in place in the event of a pressure surge were not installed. Other areas for improvement were also noted in the incident report.

  A smear survey of the high bay area found results ranging from 1,700 beta-gamma near the center of the high bay to 214,000 dpm beta-gamma at the north end of the building near the wash cells. A smear survey of equipment in the high bay found contamination ranging from

[1] EPA/HGL, *Final HSA 6,* p. 47, citation 2:

[2] Young, C. L., Atomics International Internal Letter, re*: Potential Contamination of Personnel*, February 19, 1959.

719 dpm beta-gamma on an equipment panel to 469,836 dpm beta-gamma on the transfer cask vent hose.

A 1961 AI report titled, “SRE Fuel Element Damage: Final Report, NAA-SR-4488,” states that the maximum contamination level detected as a result of the incident was 700,000 dpm/100 cm^2 taken 24 hours after the incident and found on the fuel handling cask located 25 feet from Wash Cell B. An environmental survey of the area surrounding the SRE showed results ranging from 0.03 mrad/hr northwest of the building to 0.20 mrad/h at the southwest corner of the SRE perimeter. Normal background for the survey meter was between .03 and .05 mrad/hr. Soil samples collected on June 5 ranged from 9.36×10^{6} µCi/g outside the SSFL boundary line to 1.65×10^{5} µCi/g inside the SRE perimeter fence. The June 5 soil samples were comparable to samples taken two months earlier.[1] (A0315)

In 1969, Rockwell collected a 500-cm3 sample of groundwater for radiometric analysis from the SRE wash cell valve pit. Results showed a beta concentration of 7.4×10^{6} $\mu Ci/cm^3$. In November, 1969 Rockwell conducted a smear survey and found removable contamination of between 21 and 1,326 dpm/100 cm^2. Rockwell concluded that the soil surrounding the wash cells was contaminated, probably as a result of the explosion that occurred in Wash Cell B in 1959.[2]

- **July 12, 1959 - Major Incident**

On July 12, 1959, power run 14 of the SRE began, which resulted in the melting of 13 fuel elements. However, circumstances involved in the July 12, 1959 incident extended over the entire period of time from November 29, 1958 to July 26, 1959. AI reports describe the following sequence of events related to power runs 8 through 14 at the SRE (Incident Report A0274):

Note: [During operations described below, the core scope was used repeatedly. Releases from the SRE core are noted. It does not appear that employees were provided with nasal smears to determine possible contamination. Incident Reports A0393 (May 25, 1960) and A005 (June 9. 1960) describe removal of the core scope and release of core gas that was contaminated with mixed fission product; employee nasal smears tested positive for contamination. The data may apply to operations and potential contamination of employees involved in the July 12, 1959 incident and subsequent fuel recovery efforts. In addition, the contamination of walls, floors and equipment should be noted; such contamination is not characteristic of Xe-133 and Kr-85.

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[1] EPA/HGL, *Final HSA 6,* p. 48, citations 1-3:

[1] Investigating Board, Atomics International Internal Letter, re: SRE Wash Cell Incident of June 4, 1959, June 19, 1959.

[2] Borg, G., *Wash Cell Incident at the Sodium Reactor Experiment*, AI Memo 5155, Atomics International, April 6, 1960.

[3] Ashley, R. L., Beeley, R. J., Fillmore, F. L., Hallett, W. J., Hayward, Jr., B. R., and Jarrett, A. A., *SRE Fuel Element Damage, Final Report, NAA-SR-4488 (suppl.*), Atomics International, 1961.

[4] Ibid. 122119551

[2] EPA/HGL, *Final HSA 6,* p. 70, citation 1:

[1] North American Rockwell Corporation Internal Letter from R. K. Owen to W. F. Heine, re: *Water Seepage Hole in the SRE Wash Cell Valve Pit*, January 15, 1970.

Employee exposure to mixed fission products resulting from leaking core and cover gas may need to be reevaluated on review of the SRE Incident Report].

o Run 8 began on November 29, 1958 after a shutdown of two months in which considerable repairs and modifications were made to the primary sodium system. During this work, the primary sodium was pumped back and forth several times between the primary loop and the primary fill tank, which was known to contain a large amount of sodium oxide. A substantial amount of oxide was thus introduced into the primary sodium. At the beginning of run 8, an unusually large spread in the fuel channel exit temperature was detected and attributed to the high oxide content of the sodium. The reactor was shut down to reduce the oxide in the sodium by cold trapping. On December 12, 1958, two fuel elements that were excessively hot and had black foreign material on them were removed and washed. Washing the fuel elements proved to be the most successful to reduce the temperature spread. Reactor operations continued intermittently. Some improvement in fuel channel exit temperature spread was found in running the reactor at elevated temperatures as well as by jiggling the fuel element one inch or less. On December 23, 1959 the reactor was shut down to inspect the fuel elements. Fifteen fuel elements were washed and additional cold trapping was done to reduce exit temperature spreads. The reactor was started again and the spread in the fuel channel exit temperatures continued to improve until the end of run 8 on January 29, 1959. During the shutdown, the sodium was cold trapped to less than 5 parts per million of oxygen content. No reactivity anomalies were observed during the run, but a cover gas sample indicated that the hydrocarbon coolant and lubricant tetralin had entered the primary sodium.[1]The presence of tetralin indicates that the system was not functioning properly.

o Run 9 began on February 14, 1959, but continued difficulties with the fuel channel exit temperatures forced a shutdown four days later to wash fuel elements and do further cold trapping. Reactor operations resumed and the temperature spread improved. Reactivity increased 1⁄2 percent during this run. Two reactor scrams (automatic dropping of control rods into reactor core to shut down reactor) occurred because of an excessive temperature drop across a moderator can and several other scrams occurred because of power line transients. Run 9 ended February 26, 1959. A fuel element was removed for routine examination in the SRE hot cell and was found to have a thin black deposit. The element was washed and placed back in the reactor.[2]

o Run 10 lasted from March 6 to March 7, 1959. This run was conducted as a temperature test on a uranium oxide fuel element. No unusual circumstances were noted. A thimble was replaced at the end of the run. Later examination showed that a loss in reactivity of 1⁄4 percent occurred at the start of run 11.[3]

o Run 11 began on March 16, 1959. Difficulties with the fuel channel exit temperatures were still being experienced, but the reactor continued to operate up to 20 megawatts (MW). On March 27, 1959, several reactor scrams occurred caused by fluctuations in the main primary sodium

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[1] EPA/HGL, *Final HSA 6,* p. 49, citation 1:

> [1] Ashley, R. L., Beeley, R. J., Fillmore, F. L., Hallett, W. J., Hayward, Jr., B. R., and Jarrett, A. A., *SRE Fuel Element Damage: An Interim Report, NAA-SR-4488*, Atomics International, November 15, 1959.

[2] Ibid.

[3] Ibid.

flow due to helium leaking into the primary sodium. The reactor returned to power and ran at 19 to 20 MW until the run ended on April 6, 1959. An increase in reactivity of 1 percent occurred during the run. A reduction in fuel channel exit temperatures was noted. Twenty-one fuel elements were examined by television camera in the fuel handling cask and found to be in good condition. Ten days after the run, the radiation level in the main gallery was higher than expected. This was not surprising because it was realized that some fission product contamination had occurred in the primary sodium. A filter was installed in the primary system, which collected considerable carbon-containing (decomposed hydrocarbon coolant and lubricant tetralin) material.[1]

o **Run 12** lasted from May 14 to May 24, 1959. The reactor performed normally during this entire period. A fuel element was examined after shutdown and there was no measurable change in fuel dimensions.[2]

o **Run 13** lasted from May 27 to June 3, 1959. Prior to run 13, the core gas radioactivity was found to be 1.7 x 10 ^{3} µCi/cm ^{3}. It was assumed to be Xe-133 and considered normal. Xe activity had been observed after reactor operations for many months and was attributed to small pin hole leaks in the cladding of a few elements or to uranium contamination from the outside of new fuel elements. The filters were designed to remove particulates from the air; they did not stop noble gases from being released from the reactor building. With the exception of a scram caused by abnormal sodium flow rate, run 13 proceeded smoothly until May 30, 1959. At this time, several abnormalities in temperature measurements occurred. By June 2, 1959, it was clear that something occurred to impair the heat transfer characteristic of the reactor system. A tetralin leak was detected and the run was terminated on June 3, 1959. On June 4, 1959, an attempt was made to wash a fuel element from the core and that resulted in the incident described above. In order to remove the tetralin from the primary system, a nitrogen gas stripping operation was used. About 3 pints of tetralin and 1,500 cm of naphthalene crystals (assumed to be a breakdown product of tetralin) were removed from the primary sodium system.[3]

o **Run 14** lasted from July 12, 1959 to July 26, 1959. The SRE was brought to criticality on July 12, 1959, at 6:50 a.m. with rod positions at 46 inches as expected. At 8:35 a.m., as the reactor was increasing power to 0.5 MW, large temperature fluctuations were noted among the fuel channels. Fluctuations were about 10˚F compared to less than 5˚F fluctuation under normal operating conditions at 20 MW. Fuel channel exit temperatures also started to diverge more than normal. Operation continued until 11:42 a.m. when a reactor scram occurred due to loss of auxiliary primary sodium flow. The reactor outlet temperature at the time of the scram was 485˚F. Criticality was re-established at 12:15 p.m. and rod-positions were still at 46 inches, indicating no change in reactivity during the scram. Operation continued at slowly increasing power levels and temperatures.

At 3:30 p.m. both reactor room air monitors detected a sharp increase in activity. To reduce the activity level, the reactor pressure was lowered from 2 to 1 pounds per square inch gauge (psig). A survey of the reactor loading face shield revealed excessive radiation over the sodium

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[1] Ibid.

[2] Ibid.

[3] Ibid.

level coil thimble in core channel 7. The initial reading was 500 mrad/h. A high bay air sample showed activity of $3x10^{7}$ μCi/cm^3 after 15 minutes of decay, and $4.5x10^{8}$ μCi/cm^3 after 90 minutes of decay.

At 4:20 p.m., it was noted that the filter from the air sampler showed an activity level of 160,000 cpm. At 5:00 p.m., a sharp increase in the stack activity to 1.5×10^{4} μCi/cm^3 was noted. This returned to normal by 10:00 p.m. [Note: According to Incident Report A0015 (April 4, 1962) the stack only exhausted the hot cell and vent system effluent].

Also at 5:00 p.m., the radiation level over core channel 7 reached 25 rad/h and a decision was made to shut the reactor down and replace the thimble in channel 7 with a standard plug. At 8:57 p.m. the reactor was shut down. The sodium level was checked and found to be normal.

The reactor was brought to criticality again at 4:40 p.m., on July 13, 1959. Rod positions were 49.5 inches out. No significant activity was noted in the high bay. At 5:28 p.m., the reactor power was at 1.6 MW and a planned increase was started. The power level persisted in rising faster than expected and at 6:25 p.m., the reactor was manually scrammed. The peak power was about 14 MW.[1] After the scram, rod positions were 52 inches out as compared with 49.5 inches prior to the scram, but it was decided that the power excursion had not affected the reactor adversely. The reactor was brought up to criticality.

At 9:00 a.m. on July 14, radioactivity in the high bay increased to 14,000 cpm on the air monitor. Two hours later, the source of activity had been localized to channels 29 and 50 in the core loading face. Seal rings were placed on the channels and the contamination levels dropped. Another scram occurred at 1:00 p.m. when a short circuit was introduced into the demand circuit for the main primary pump. Rod positions were an average of 51.1 inches prior to the scram at a power level of 3.7 MW. The reactor was quickly brought back to criticality. Rod positions were an average of 51.9 inches at 3.5 MW after recovery from the scram.

The 1961 SRE Fuel Element Damage Final Report[2] notes that the 1959 SRE Fuel Element Damage Interim Report stated a peak power of 24 Mw was reached. However, this value was obtained from a linear extrapolation, which was not valid.[3]

On July 15, 1959, the reactor was pressurized and vented to reduce the radioactivity level caused by Xe in the reactor cover gas. This appears to have been released to the atmosphere. The filters were designed to remove particulates from the air; they did not stop noble gases from being released from the reactor building. It was then decided to shut the reactor down because it would not be able to reach the maximum power level necessary to continue getting the Edison turbine generator online while circulating through the steam generator. During the shutdown, the Edison loop was drained, the main airblast heat exchanger was filled, the reactor sodium level coil was reinstalled in core channel 7 and a complete helium leak check was conducted on the core loading face.

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[1] Ibid.

[2] Ibid.

[3] The 1961 SRE Fuel Element Damage Final Report notes that the 1959 SRE Fuel Damage Interim Report stated a pak power of 24 Mw was reached. However, this value was obtained from a linear extrapolation, which was not valid.

On July 16, 1959, the reactor again achieved criticality. The average rod position was 57 inches out, which indicated a substantial loss in reactivity (about 1.2 percent in the four days since the start of run 14). Intermittent operation continued at low power (less than 2 MW) until July 20, 1959. During this time, measurements of primary sodium plugging temperatures were made, the effects of core cover gas pressure on reactivity was studied, and the reactor outlet temperature was gradually raised to see if this improved reactor operating conditions (as it did on run 8).

On July 17, 1959 the following letter was written to R.E. Durand (Atomics International) by R.K. Owen, of the SSFL Health Physics Department:

> **July 17, 1959**
> **To: R.E. Durand**
> **From: R.K. Owen**
> **Subject: Airborne Radioactive Contamination in SRE High Bay During Reactor Operation.**
>
> **It is hereby recommended that the SRE be shut down until the sources of the airborne radioactive contamination in the High Bay are located and repaired.**
>
> **Intermittent airborne activity at SRE has long been a problem, but the primary reason for this recommendation was the condition occurring July 12, 1959 during power run #14 while the reactor was operating at about 1Mwt. At this time, the High Bay atmosphere became contaminated. A high volume air sample taken in the High Bay showed an airborne activity of 3x10-7 uc/cc. This concentration is 300 times the maximum permissible concentration in air for unidentified beta gamma emitters (MPC+10-9 uc/cc). An attempt to locate the cause of the release showed that reactor channel R7 containing a sodium level probe was the primary source of leakage.**
>
> **On subsequent days during this power run, other leaks were found in reactor channels R29 and R50 and possibly in the Cerrobend seal.**
>
> **Attempts at identifying this activity have to date been unsuccessful, however, the airborne contamination levels have in every case varied directly with reactor power. Even if identification of the activity showed it to have an MPC greater than 3x10-7, repair of the leaks would be desirable in order to prevent the release of more toxic materials in the event of a serious fuel rupture.**
>
> **/s/ R.K. Owen**
>
> **Health Physics Dept.**

On July 21, 1959 at 2:10 a.m., a scram was caused by a fast period indication. It is worth noting that “the reactor ha[d] a history of spurious scrams due to apparent period transients....Many so-called period scrams have been traced to voltage and frequency instability in the power suppl[y].”[1]

The reactor was critical at 2:25 a.m. at an average rod position of 49 inches. Operation continued at 2.5 MW. At 6:45 a.m., radioactivity in the reactor started building up as indicated by

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[1] Ibid.

continuous air monitoring system installed to protect personnel. At 10:00 a.m., two air monitors were reading 15,000 and 18,000 cpm. By 2:00 p.m., a high bay air sample found activity at $2x10^{9}$ $\mu Ci/cm^3$.

On July 21, 1959 at 9:45 a.m., a reactor scram was manually initiated when flow was lost in the main secondary loop. This loss-of-flow-scram was caused by a low sodium level in the secondary expansion tank resulting from a faulty level coil. After the scram, fuel channel exit temperatures dropped. When the main secondary loop was restored to service, temperature swings were noted in the reactor cold leg. At 11:30 a.m., the reactor was again critical at an average rod position of 54 inches. The spread of fuel channel temperatures was still present, but AI’s safety limits were not exceeded.

On July 22, 1959, the fuel temperature recorder on the element in core channel 55 showed fluctuating temperatures from 1,100 to 1,200˚F. This channel was composed of various experimental fuels and the point recording instrument found channel temperatures higher than recording instruments in the control room. The point recording instrument was felt by AI staff to be unreliable so no attempt was made to reduce the temperature. An instrument recorded a maximum temperature of 1,465˚F for the experimental fuel element on July 23, 1959. Operation continued at power levels up to 4.5 MW with sodium flow rates up to 1,500 gallons per minute (gpm), and reactor outlet temperatures up to 790˚F.

On July 23, 1959, it was decided to shut the reactor down in view of the high fuel temperature for the element in channel 55 and because the fuel channel exit temperature spread was not improving noticeably. Reactor outlet temperature was kept between 700 and 800˚F, although a few fuel channel exit temperatures reached 900 to 1,000˚F. At 9:50 a.m. on July 23, 1959, a reactor scram occurred due to a fast period indication, but the reactor was critical again at 10:15 a.m. Between midnight and 8:00 a.m. on July 24, fuel elements were jiggled in an attempt to dislodge any foreign material and lower the fuel channel outlet temperature. During this time it was noted that elements in core channels 10, 12, 35, and 76 were stuck in place. Another scram occurred at 12:50 p.m. on July 24, 1959. The reactor was critical again at 1:14 p.m. At 3:40 p.m., another scram was caused by loss of auxiliary primary flow. Criticality was reestablished at 3:56 p.m. Rod positions were an average of 54 inches out.

On July 26, 1959, it was noted that elements in channels 12 and 35 were no longer stuck and the element in channel 76 was somewhat freer. On July 26, 1959, at 11:20 a.m., the reactor was shut down after a total of 16 megawatt-days (MWd) on run 14. The shutdown was made to examine each fuel element that had been running hot and clear away any obstructions in the channels.

The first damaged fuel element was observed at 5:15 p.m. on July 26, 1959. By August 2, 1959, six parted fuel elements had been removed from the reactor and taken to the fuel storage facility before a parted fuel element from core channel 12 became lodged in the fuel handling cask forcing the suspension of operations. After it was determined that “a considerable amount of radiation exposure and contamination in the high bay area was resulting from the attempts to dislodge the jammed fuel element,” the plan shifted to modifying a moderator handling cask for fuel removal instead. The removal of the 19 remaining fuel elements began on October 8 and ended on October 19, 1959. The status of the fuel elements are shown in the Table 2.1 below. This is AI’s summary of events as of November 15, 1959.

AI did not issue a press release regarding the fuel element damage until August 29, 1959.[1]

The HSA provides a detailed description of each fuel rod, its date of removal, and its characteristics upon examination. Fuel element examination showed that 13 of the 43 fuel elements in the SRE during power run 14 had sustained substantial damage.

- Reactivity changes in power run 14 were also attributable to the presence of tetralin decomposition products in the reactor. The reactivity loss of 1.2 percent during the first four days of run 14 was caused by sodium entering the R-10 and R-42 moderator cans likely caused by abnormal conditions in the core. The reactivity increase of 0.3%, which produced an excursion to about 70% full power, was likely the result of sodium expulsion from several fuel channels in quick succession. The general conclusion of the *1961 SRE Fuel Element Damage* report is that "no important change in [the SRE's] physical condition [has occurred] as a result of the fuel element damage to the first core."[2]

- Following removal of the fuel elements, inspection of the core began. The radiation level at the bottom of the loading face shield was measured at 43 rad/h. The fuel slugs and cladding fragments remaining in the core were picked up by articulated grapples, scanned, and then stored with other damaged fuel. Removal of damaged moderator cans showed that sodium had leaked into cans R-10 and R-42. Later sodium leak checks found cans R-32, R-44 and R-45 also contained leaks. A total of 16 cans were replaced. As a result of the fuel cladding failures during power run 14, an estimated 5,000 to 10,000 Ci of fission products were released to the primary coolant system.[3]

  Although conducted after the end of the major incident, a gamma spectrometer scan of an air sample identified Xe-133 and Kr-85 as the principle remaining contaminants. AI extrapolated the decay of these two isotopes back to the date of the SRE shutdown on July 26, 1959 and estimated contamination levels of 7.4 µCi/cm^3 for Xe-133 and .016 µCi/cm^3 for Kr-85 by September 29, 1959. Fixed contamination of the primary sodium piping was found. Isotopes detected were Sr-89, Sr-90, zirconium-niobium-95 (Zr-Nb-95), Ce-144, and Cs-137.

  The cold trap (vapor condenser) was also found to collect radioactivity with dose rates ranging from 50 to 80 rad/h at 2 inches from the cold trap surface.[4] There are many caveats to

[1] EPA/HGL, *Final HSA 6,* p. 56, citation 1:

> [1] Hart, R. S., Distribution of Fission Product Contamination in the SRE, NAA-SR-6890, Atomics International, March 1, 1962.

[2] EPA/HGL, *Final HSA 6,* p. 53, citation 2:

> [2] Atomics International News Release, During Inspection of Fuel Elements – SRE – Parted Fuel Element..., August 29, 1959.

[3] EPA/HGL, *Final HSA 6,* p. 53, citation 2:

> [2] Atomics International News Release, During Inspection of Fuel Elements – SRE – Parted Fuel Element..., August 29, 1959.

[4] EPA/HGL, *Final HSA 6,* p. 56, citation 1:

> [1] Hart, R. S., Distribution of Fission Product Contamination in the SRE, NAA-SR-6890, Atomics International, March 1, 1962.

interpreting sample results following the SRE fuel cladding failures. Limited sampling opportunities and reactor recovery efforts imposed restrictions on the quantitative value of data collected.

- Constant monitoring for airborne contamination in the reactor room occurred during recovery efforts. The highest level recorded was reportedly $3x10^{8}$ μCi/cm^3 during core inspection on May 21, 1960. Operations had to be suspended for one hour. General contamination on the walls, floors, tools, etc. in the reactor room ranged from 100 to 1,500 dpm/cm^2 of beta-gamma activity. Occasional high counts of 150,000 dpm/100 cm^2 were detected and reportedly cleaned up.

  Several instances of minor contamination of the asphalt blacktop were reported just outside the SRE access door. These areas were reportedly cleaned up. According to the AI 1961 *SRE Fuel Element Damage* report, with the exception of the inert gases Xe-133 and Kr-85, all of the fission fragments remained in the sodium or were absorbed by the metal surfaces of the cladding or the piping. The principle fission products found in SRE primary piping were Sr-90, Ce-144 and Cs-137. During SRE recovery operations, several modification were made to the reactor system. Tetralin was eliminated as a coolant in favor of NaK, nitrogen gas, and kerosene. The sodium heat transfer system was modified. Instrument monitors were added to the system and the fuel element geometry was altered to provide more clearance between the fuel element and the channel.[1]

- **Incidents After the July 12, 1959 Major Incident**

  • On September 10, 1959 two AI employees entered a radioactive storage area west of the SRE without permission. The area contained highly radioactive, contaminated equipment and was normally barricaded with yellow and black rope and signs stating, “No Entry Without Tagged Entry Permit,” “Contact Health Physics Before Entering,” and “Contaminated Equipment.” Two AI health physicists discovered the barricade had been removed, a large trailer truck was parked 50 feet inside the barricade, and three outside contractors were loading radioactive waste onto the truck. These contractors were wearing protective clothing. In the southwest section of the area, three people (two AI employees and a contractor) were examining material without wearing any protective clothing. One of the health physicists requested that the men leave the area and one of the AI men responded that they were busy. When the men eventually started to leave, the health physicist requested that they remain for a contamination check and the men refused. One of the AI men stated they were late for a meeting and that the health physicist and his supervisor had better not interfere with the operation. As a result of this violation, the AI men and the contractor, subjected themselves to a high radiation field (A0351).[2]

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[1] EPA/HGL, *Final HSA 6,* p. 57, citation 1:

> [1] Ashley, R. L., Beeley, R. J., Fillmore, F. L., Hallett, W. J., Hayward, Jr., B. R., and Jarrett, A. A., *SRE Fuel Element Damage, Final Report, NAA-SR-4488 (suppl*.), Atomics International, 1961.

[2] EPA/HGL, *Final HSA 6,* p. 57, citation 2:

> [2] Borg, G., Atomics International Internal Letter, re: Account of Incident on September 10, 1959 at about 10 a.m. in the Radioactive Waste Storage Area West of the SRE as per G. Borg, September 11, 1959.

- On November 21, 1959, an employee was modifying an SRE core recovery tool when an exit survey found contamination on his nose, upper chest, and undershorts. The undershorts had to be discarded as contaminated waste. Nose swipes indicated contamination up to 3,600 dpm beta-gamma. Smears of the face and upper chest found contamination at 400 and 5,600 dpm beta-gamma, respectively. The employee's dosimeter worn at the time of the incident gave a reading of 50 mR. After a shower and repeated cleaning of the nostrils, no significant contamination was found. A positive urine specimen did come back and the employee was restricted from tagged areas until additional results were received (A0390).[1]

- On December 7, 1959 an employee violated standard operating procedures and did not notify the health physics department that he was entering the high bay area of the SRE, a red tagged area. He also failed to wear the proper clothing required for this high radioactive contamination area. The incident report notes the employee was reminded of proper procedure (A0548).[2]

- On December 18, 1959 an employee was found working in the SRE Hot Cell Service Area, a red tagged area highly contaminated with beta-gamma activity, without a protective hood. A health physicist verbally informed the employee that he was in violation of his entry permit and he needed to leave the area. The employee stated that no hoods were available and he continued to work. When the employee finally left the area, he did not check himself for radioactive contamination as required by his entry permit. The employee was informed that it was his responsibility to follow the requirements of his work permit (A0391).[3]

- On April 11, 1960 an employee's nose became contaminated up to 190 dpm beta-gamma when the viewing glass of the remote cell he was working in started leaking. He was immediately taken out of the area and decontaminated (A0510).[4]

- On May 15, 1960 a leak occurred in the tank used for containing sodium, removed from the reactor. The sodium ignited upon contact with the atmosphere causing a large volume of smoke. Approximately 200 g of sodium containing fission products was burned. A 30-minute air sample was taken about 10 minutes after the fire occurred. Beta-gamma activity was 1.3x10$_{10}$ µCi/cm^3 on immediate counting. After 1 hour the activity level decreased to 5.0 x

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[1] EPA/HGL, *Final HSA 6,* p. 57, citation 3:

> [3] Young, C. L., Atomics International Internal Letter, re: Radiological Safety Incident Report, Sodium Reactor Experiment, 11/21/59, December 7, 1959.

[2] EPA/HGL, *Final HSA 6,* p. 57, citation 4:

> [4] Bell, C. E., Atomics International Internal Letter, re*: Violation of Health Physics Practices*, December 11, 1959.

[3] EPA/HGL, *Final HSA 6,* p. 58, citation 1:

> [1] Lang, J. C., Atomics International Internal Letter, re*: Notice of Rule Infraction*, December 31, 1959.

[4] EPA/HGL, *Final HSA 6,* p. 58, citation 2:

> [2] Shannon, J. W., Atomics International Internal Letter, re: Radiological Safety Incident Report, SRE Hi Bay Area, 4/11/60, April 11, 1960.

10^{11} µCi/cm^3. (A0394).[1]

- **On May 25, 1960 a core scope** from the SRE core was being removed and came out of the gas lock because there were no markings to identify the upper limit of the equipment when it is in the gas lock. When the core scope came out, core gas contaminated with mixed fission products escaped for a short period. Two employees received nasal contamination ranging from 47 to 392 dpm beta-gamma. The employees were decontaminated and a recommendation was made to mark all equipment going through a gas lock with an upper limit (A0393).[2]

- On June 2, 1960 an employee was slightly injured and contaminated while working on an SRE fuel coffin. The incident report has not been located (A0460).[3]

- **On June 9, 1960 a core scope** from the SRE reactor core was being removed through a 6-inch gas lock when it was discovered that the valve on the gas lock had not completely closed. Immediate attempts were made to close the valve, but in the brief time it was open, gas containing mixed fission products escaped from the SRE reactor core into the high bay. Nasal smears were done and employees were found to be contaminated between 18,000 and 26,000 dpm beta-gamma. At least one employee had hair and facial contamination of 5 mrad/h. The contaminated employees were immediately removed from the high bay area and decontaminated. At least one employee was restricted from further exposure until bioassay results were obtained (A005).[4]

- On July 6, 1960 gas contaminated with mixed fission products escaped into the high bay atmosphere. An employee was measuring a moderator can through a window in the gas lock that had a plastic bag covering it and the employee's arm. As the employee removed his arm from the plastic bag, the gas escaped and set off the continuous air monitor. The plastic bag was quickly sealed and the employee was advised to leave the high bay for nasal smears. Fifteen minutes later, the employee had not reported to health physics and claims his chief operator did not deem it necessary to leave. Eventually three men were given nasal smears as a precaution. Results ranged from 0 to 3,168 dpm beta-gamma. The employee with the highest reading was decontaminated down to 22 dpm beta-gamma for the right nostril and 10

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[1] EPA/HGL, *Final HSA 6,* p. 58, citation 3:

> [3] Galperin, A., Atomics International Internal Letter, re: Radiological Safety Incident Report, SRE High Bay, 5/15/60, May 26, 1960.

[2] EPA/HGL, *Final HSA 6,* p. 58, citation 4:

> [4] Galperin, A. and Shannon, J. W., Atomics International Internal Letter, re*: Radiological Safety Incident Report, SRE High Bay, 5/25/60*, August 30, 1960.

[3] EPA/HGL, *Final HSA 6,* p. 58, citation 5:

> [5] Boeing Radiation Incident Database, 2010.

[4] EPA/HGL, *Final HSA 6,* p. 59, citation 1:

> [1] Lane, W. D., Atomics International Internal Letter, re*: Radiological Incident Report, SRE High Bay, 6/9/60*, July 20, 1960. 122119552

dpm beta-gamma for the left nostril (A0442).[1]

- On December 15, 1960 two employees became contaminated during a sandblasting operation. A sodium pump was decontaminated by sandblasting in a plastic tent fabricated for this purpose. The pump was contaminated with mixed fission products and a maximum radiation level was measured at approximately 5 rad/h. One employee was working in full protective clothing and face mast inside the tent, while the other employee was operating the sandblasting compressor outside the tent. After approximately 3 minutes, the employee in the tent realized dust was leaking into his face mask. He motioned to have the compressor shut off and stepped out of the tent where he was helped out of his protective gear. Nasal swipes of both men revealed beta-gamma contamination of 75,000 dpm (employee working in tent) and 420 dpm (employee outside tent). A survey meter check found one employee's clothing contaminated up to .2 mrad/h. The clothing was disposed and the men were decontaminated (A0305).[2]

- On May 17, 1961 an employee working in the SRE high bay discovered contamination on his shoes upon exiting for lunch. Investigation found that the rubber boots he had been wearing as required health and safety dress had developed leaks. After unsuccessful attempts to decontaminate the shoes, they were disposed as radioactive waste (A0435).[3]

- On November 4, 1961 an employee working on samples from "hot trap (heater) A" in the SRE high bay became contaminated while grinding a sample container away to expose the sample. The external surface of the sample container was less than 30 dpm beta-gamma, but the sample itself was 3 rad/h. The employee was wearing a hard hat with a face shield for grinding operations and was told that a full respirator would be required when he got close to exposing the sample. The employee stated that he had done this type of work before and had never been contaminated. Upon further observation from a health physicist, the sample had indeed been exposed by grinding operations. A smear survey was taken and indicated high internal contamination. The employee further stated that the air flow through the high bay door was enough to protect him from the exposure. The health physicist went to get a face mask for the employee, but none were available. Nasal smears indicated the employee's right nostril was contaminated to 145 dpm beta-gamma and the left nostril was contaminated to 372 dpm beta-gamma. Contamination had also filtered through the employee's cotton gloves and his hands

[1] EPA/HGL, *Final HSA 6,* p. 59, citation 2:

> [2] Galperin, A., Atomics International Internal Letter, re: Radiological Safety Incident Report, SRE High Bay, 7/7/60, August 31, 1960.

[2] EPA/HGL, *Final HSA 6,* p. 59, citations 3 & 4:

> [3] Klostermann, J. P., Atomics International Internal Letter, re: Radiological Safety Incident Report, R/A Material Storage Area – SRE, 12/15/60, December 19, 1960

[3] EPA/HGL, *Final HSA 6,* p. 59, citation 5:

> [5] DuBois, P. R., Atomics International Internal Letter, re: Radiological Safety Incident Report, SRE High Bay, May 17, 1961, May 31, 1961.

were contaminated to 2 mrad/h. The employee was decontaminated and released (A0515).[1]

- On December 23, 1961 an employee entered a red tagged area without a tagged entry permit and manipulated high contaminated core lights without protective gear or without following proper procedure for working with radioactive materials (A0472).[2]

- On February 6, 1962 an employee was observed in the Health and Safety Counting Room using counting equipment to measure radioactivity on a smear because he didn't believe the results of a health physicist's survey of the plastic cover on a storage cell. The employee failed to detect the radioactivity ($3x10^5$ dpm / 100 cm^2) observed before and after by health physics analysts. Not only did the employee delay decontamination of the object, but he violated rules by using radiation detection equipment he was not trained to use (A0534).[3]

- On April 4, 1962 two sets of air samples for radioactive particulates were taken on the roof of the SRE near the exhaust fans and filters. At least 90% of the high bay particulate activity was rubidium-88 (Rb88). One sample set was taken with the filters bypassed and the other sample set was taken with air exhausted through the filters. The reactor was at 5 MW and only the east fan was on. Air samples from the high bay were taken at the same time as samples on the roof. These results were compared to sample results on March 1, 1962 with the reactor critical.

  Additionally, a roof sample had been taken on March 3, but it could not be correlated to high bay activity because it was taken in the stack, which only exhausts the hot cell and vent system effluent. Results were as follows:

- **Air Sample Data at the SRE April 4, 1962: 90% rubidium-88 (Rb88)**

  - April 4, 1962, 9:30 a.m. filtered exhaust – 5.5×10^{-11} µCi/cm^3 beta-gamma
  - April 4, 1962, 9:30 a.m. high bay activity – 9.4×10^{-9} µCi/cm^3 beta-gamma
  - April 4, 1962, 1:30 p.m. nonfiltered exhaust – 5.9×10^{-9} µCi/cm^3 beta-gamma
  - April 4, 1962, 1:30 p.m. high bay activity – 9.9×10^{-9} µCi/cm^3 beta-gamma
  - March 3, 1962, stack sample – 2.04×10^{-11} µCi/cm^3 beta-gamma

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[1] EPA/HGL, *Final HSA 6,* p. 60, citations 1 & 2:

> [1] Yarrow, A. R., Atomics International Internal Letter, re*: Radiological Safety Incident Report, Bldg. 143 (High Bay), 11/4/61*, November 7, 1961.
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> [2] Health and Safety Department, Atomics International Internal Letter, re*: Notice of Health and Safety Rule Infraction*, November 8, 1961.

[2] EPA/HGL, *Final HSA 6,* p. 60, citation 3:

> [3] Health and Safety Department, Atomics International Internal Letter, re*: Notice of Health and Safety Rule Infraction*, January 4, 1962.

[3] EPA/HGL, *Final HSA 6,* p. 60, citation 4:

> [4] Health and Safety Department, Atomics International Internal Letter, re*: Notice of Health and Safety Rule Infraction*, February 16, 1962.

- o March 1, 1962, roof – 1.5 x 10^{-10} µCi/cm^3 beta-gamma
- o March 1, 1962, high bay – 1.1 x 10^{-10} µCi/cm^3 beta-gamma (A0015).[1]

- On June 13, 1962 an operator was engulfed in fire during the transfer of core heaters.[2]

- On July 30, 1962 an employee received an exposure exceeding the weekly limit during a source transfer operation. A 200 Ci Sb-124 source was being transferred from one storage cask to another using a bottom loading cask suspended from a crane over the cask containing the source. A cable was then used to pull the source up into the suspended cask. As the source was being drawn up, the suspended cask began to oscillate. The employee approached the cask to steady it so the source could be drawn into it and by so doing exposed himself to the unshielded source. The employee's film badge indicated a dose of 2,150 mrem gamma, but approximately 400 mrem of the film badge exposure was received prior to the incident. The employee was put on restriction not to exceed 100 mrem per week exposure for the remainder of the quarter (A0404).[3]

- On October 20, 1962 a three-man crew cutting up obsolete core heaters in the northeast corner of the SRE yard became contaminated. The eight heaters were monitored before the operation. All heaters were decontaminated to less than 150 mrad/h at the surface. The men were dressed in redline coveralls, shoe covers, and gloves for the operation. At lunch time, the men went to the hot change room to change out of their protective gear and contamination was found on their clothing and bodies. Nasal contamination ranged from 70 to 1,200 dpm, hand contamination ranged from 3 to 5 mrad/h, and radiation exposure ranged from 60 to 70 mrad. All men had scattered face and body contamination and two men had contamination on all of their clothes. The men were given continuous showers until contamination levels were brought to background. Further testing was prescribed for internal contamination. The contaminated employees reportedly contaminated most doorknobs in the lower level of the SRE building (up to 300 dpm/100 cm^2) and a large area of the floor (up to 600 dpm/100 cm^2). These areas were decontaminated to 30 dpm/100cm^2 (A0379).[4]

- On March 19, 1964 approximately 3,550 gallons of water were dumped from two new radioactive liquid waste storage tanks located on the north side of the SRE as a part of the

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[1] EPA/HGL, *Final HSA 6,* p. 60, citation 1:

[1] Badger, F. H., Atomics International Internal Letter, re*: Air-borne Activity of SRE High Bay*, April 6, 1962.

[2] EPA/HGL, *Final HSA 6,* p. 60, citation 2:

[2] Boeing Radiological Incident Database, 2010.

[3] EPA/HGL, *Final HSA 6,* p. 61, citation 3:

[3] Raper, R. R., Atomics International Internal Letter, re: Radiological Safety Incident Report, SRE West Pad, 7/30/62, September 6, 1962.

[4] EPA/HGL, *Final HSA 6,* p. 61, citations 4 & 5:

[4] Unknown Author, Atomics International Internal Letter, re: Incident Report, Contamination of Personnel Working on Disposal of Outworn Core Heaters, October 20, 1962.

[5] Sapere Consulting, Inc. and The Boeing Company, Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries, May 2005, p. G-16-17.

pre-operation testing for the PEP program. 24-hours later it was discovered that the water was contaminated with an estimated 5.8 x 10^4 µCi of irradiated corrosion products. A new radioactive liquid waste storage system was installed outside the north end of the SRE building. The system included one used tank (T-1) and two new storage tanks (T-2 and T-3). T-1 was a 150-gallon tank. T-2 was a 350-gallon tank installed alongside T-1 in the sump pit 40 feet below ground level. T-3 was a 3,200-gallon tank installed at ground level. Piping was installed to allow gravity flow of radioactive water to either T-1 or T-2. The waste waster was then pumped to ground level where it could be sampled. Activity level permitting, the waste water could then be pumped to T-3 for storage and disposal. T-1 and T-2 were vented to the existing radioactive gas compressor vent system serving the fuel wash cells.

The old liquid lines to T-1 were closed and T-2 and T-3 were filled with clean water from a nearby fire hydrant to check level indicators and pumps. The next day the water was emptied from the tanks so that the system could go through final checkout. When a health and safety representative came to monitor the circulation lines during final testing, he discovered that two lines from T-2 were radioactive, while the lines to T-1 were at what was characterized at the time as “background.” Apparently, the radioactive gas vent lines had contaminated condensate. A portion of the vent system had been drained of condensate the day before and valved off, but the remainder of the vent line was left open to T-1 and T-2. Condensation accumulated in the open vent line and entered T-2 by gravity flow contaminating the clean hydrant water in the tank. The water was later analyzed and found to have approximately 18% Co-60, 13% Co-58, 62% Cr-51, and 7% Zr-95-Nb-95.

Once the contamination was discovered the SRE area was secured and a Class 1 Emergency was proclaimed. A 150 cubic foot air sample taken in the spill area found airborne activity at 8.3 x 10^{11} µCi/cm^3 beta-gamma. Survey of personnel in the area found low-level radioactive contamination on shoes only. The maximum contamination on shoes was 2,000 dpm beta-gamma. Vehicles in the area were surveyed and smeared. The maximum contamination detected inside any vehicle was 1,800 dpm/100 cm^2 beta-gamma and the maximum contamination outside any vehicle was 4 mrad/h. Contamination was also noted at the north door of the SRE building, where 800 dpm/100 cm^2 beta-gamma was detected.

According to the incident report, the major spread of contamination, however, was to the watercourse with low-level contamination spread to no more than 500 feet from the point of dumping on the asphalt. After people and vehicles were decontaminated to less than 30 dpm/ 100 cm^2 they were released from the area. A water sample was taken from the 750,000-gallon SRE retention pond and the drain pump for the pond was secured to prevent release. The pond had not been dumped since the incident. Pond water measured 7.1x10-6 µCi/cm^3 . The asphalt area where the water was first released measured 10 mrad/h with about 3 mrad/h gamma contamination. The SRE ditch measured a maximum 60 mrad/h. The asphalt was hosed down with water and contamination levels dropped to 4mrad/h, but the maximum contamination in the ditch increased to 80 mrad/h.

Operations decided to abandon efforts to flush the asphalt and brought in a crew to clean out the ditch, and use a floor scrubber and vacuum on the asphalt to decontaminate it. The asphalt was decontaminated to a maximum of 0.7 mrad/h. Four 55-gallon drums of mud and debris from the ditch were removed, which reduced contamination from 80 mrad/h to 15 mrad/ h. Further decontamination reduced the ditch contamination to less than 2 mrad/h, except for a small area reading 10 mrad/h that was to be removed later. Any areas indicating up to 2 mrad/h were to be fixed with an additional layer of asphalt.

Rain occurred intermittently for two days during cleanup operations and runoff water filled the SRE pond to within 6 inches of the spillway leading to Brandeis Canyon and Simi Valley on March 23, 1964. **The SRE pond was drained to Rocketdyne's Area II ponds to prevent overflow.** [The Rocketdyne Area II ponds served the North American Aviation Saturn V Lunar Team, and provided water for personnel to hose down the work area following rocket engine testing. The Area II ponds were part of the Site Wide Water Reclaim System].

A sample of the SRE pond when this began indicated 1.8×10^{6} µCi/cm^3. Six hours later a sample indicated 4.1×10^{7} µCi/cm^3. Samples taken at the inlet of the first Area II pond and midpoint of the second Area II pond 9 hours into the drainage process found 1.4×10^{7} µCi/cm^3 and 6.7×10^{8} µCi/cm^3. This compares to an average of 6.8×10^{8} µCi/cm^3 for a 3-month period the previous year. Ultimately, 421,000 gallons of water from the SRE pond was drained to the Area II ponds. It was calculated that the maximum release of contamination from the incident was 5.8×10^4 µCi/cm^3, with 5.2×10^3 µCi/cm^3 released in the SRE pond.

According to the incident report, of the major isotopes involved in contamination, the most restrictive maximum permissible concentration at the time for water was 6×10^{5} µCi/cm^3. With a total release restriction of 1 Ci per year and a release of approximately 3 mCi, it appeared that the standards established by the AEC for liquid disposal were met. The incident report notes that the possibility of significant contamination offsite "appears remote." Failure to detect the release until 24 hours after it happened was attributed to failure of personnel involved to request monitoring of the water, failure of personnel to check out on the hand-and-foot counter, failure of routine surveys of the building floors to detect increased contamination levels, and lack of frequency in outside surveys (A0030).[1]

- On June 15, 1964 an employee vacuuming contamination in the fuel handling machine service pit became contaminated. Nose swipes found 90 and 450 dpm beta-gamma in his nostrils and fingers on his right hand were contaminated to 300 dpm beta-gamma. The employee was fully suited and wearing a full face mask while he was working. A few hours later, another employee wearing the same gear exhibited similar results after being in the service pit for 20 minutes. His nostrils were contaminated to 120 and 4,000 dpm beta-gamma. It was determined that the air filter equipment was not rated high enough for the contamination levels in the service pit and supplied air should have been used. The airborne radioactive contamination was mixed fission products from the MK-1 fuel handling machine (A0409).[2]

- On June 17, 1964 two employees working in the fuel handling machine service pit were found to be contaminated. One employee was contaminated to a maximum of 0.3 mrad/h on the front of his neck and had a nasal smear of 1,525 dpm beta-gamma. The other employee was contaminated to a maximum of 0.4 mrad/h on the back of his neck and had a nasal smear of 3,675 dpm beta-gamma. Both men were decontaminated, but internal contamination was still

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[1] EPA/HGL, *Final HSA 6,* p. 63, citation 1:

[1] Badger, F. H., North American Aviation Internal Letter, re*: SRE R/A Liquid Release*, April 17, 1964.

[2] EPA/HGL, *Final HSA 6,* p. 63, citation 2:

[2] Bergstrom, W. H., Atomics International Internal Letter, re*: Incident Report, Fuel Handling Machine Service Pit, June 15, 1964*, June 24, 1964.

present in sputum, spit and breath. The men were wearing full face masks with supplied air, double coveralls, hoods, two pair of plastic and one pair of canvas shoe covers, and two pair of surgeon's gloves while working. Smears of one of the masks revealed 13,000 dpm beta-gamma inside and 84,000 dpm beta-gamma outside. The incident report notes that there was extremely high surface and airborne contamination beneath the MK-1 fuel handling machine and the incident occurred during removal of Core 1 fuel. No immediate cause was found for the mechanical means of by which the employees inhaled contamination through their protective gear (A0493).[1]

- On June 21, 1964 an SRE shift supervisor having been in the MK-1 fuel handling machine service pit was checked out and found to be contaminated. He had been in the pit for inspection prior to component disassembly. A count rate meter indicated approximately 300 cpm on his left forearm and 500 cpm on his shoes. Another employee then exited and was also found to be contaminated to 300 cpm. Nasal smears for the men were 30 and 280 dpm beta-gamma. Apparently, a component from the fuel handling machine had been dropped and caused a cloud of contamination in the tented area. A check of the area indicated 1,000 to 150,000 dpm/100 cm^2 beta-gamma contamination all over the west end of the high bay. An air monitor on the east side of the plastic screen dividing the east and west high bay revealed a 200 cpm increase in airborne contamination. Spots smears of the area revealed less than 30 dpm beta-gamma. Personnel had reportedly taken off the full face mask in a portable change room set up adjacent to the service pit during a time when airborne contamination was still significant. Recommendations included providing filtered exhaust to the tented areas of work and use proper donning and doffing of protective gear, including removing face masks after outer garment (A00380).[2]

- On September 18, 1964 a crew began work in the SRE to remove Core I fuel, cladding and debris from the "Poor Man's Hot Cell." Full protective clothing was worn with the exception of full face respirators, as the plan was to set up equipment first and begin operations later in the shift. Grappling tools and a bucket were lowered into the pit. After tedious manipulation with the grappling tool, one 18-inch piece of cladding, possibly containing NaK and up to three fuel slugs, was precariously placed in the bucket. Full face respirators should have been donned at this point, but difficulty was encountered in removing the rod from the bucket and the immediate action of all three personnel was necessary to prevent the rod from falling back into the pit and starting a fire. Upon securing the rod on a ledge, work ceased and all personnel left the area. An immediate contamination survey of two crew members revealed no contamination; however nose swipes revealed nasal contamination of 1,380 and 9,000 beta-gamma. A third crew member had a nose swipe of 400 dpm beta-gamma after his shower, but the rest of his body was clean. The men were all decontaminated and placed on restriction pending bioassay analysis. The contamination was thought to result from moving the rod to

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[1] EPA/HGL, *Final HSA 6,* p. 64, citation 1:

[1] Unknown Author, Atomics International Internal Letter, re*: Incident Report, FHM Service Pit, 6-17-64*, June 24, 1964.

[2] EPA/HGL, *Final HSA 6,* p. 64, citation 2:

[2] Badger, F. H., Atomics International Internal Letter, re*: Incident Report, SRE High Bay West, June 21, 1964*, July 1, 1964.

the ledge and creating airborne contamination (A0382).[1]

- On December 1, 1964 a probe was wrapped and lowered into a control rod thimble in storage to obtain a radiation measurement. Plastic sheeting was laid on the floor and the employee conducting the survey wore shoe covers and gloves. After getting the measurement, the probe was carefully unwrapped to avoid contamination spread to the probe or the immediate area. A contamination survey of the probe revealed a significant reading on the count rate meter despite precautions. The employee received 0.3 mrad/h contamination on his hands, between 2,000 and 6,000 dpm of contamination over his face, neck, and the front of his clothing, and 1,300 dpm of contamination on a nasal smear. A smear survey of the west high bay area after operation revealed contamination levels from 1,500 to 1,800 dpm/100 cm^2 . Decontamination reduced levels to non-detect (A0545).[2]

- On December 18, 1964 size reduction of two control rods led to contamination of the surrounding area, equipment, and personnel. A tagged area entry permit was submitted for the transfer, cutting and canning of control rods in the SRE high bay. Prior to operations, the west high bay floor was covered with plastic and plastic barriers were set up around the storage cells. The work area was roped off and designated a red tagged area. Two control rod lower thimbles were transferred from the canisters in moderator storage cell 2 to the fuel handling machine. They were transferred to two fuel cans, one in storage cell 25 and the other in storage cell 74. The lower 93 inches of each thimble was cut off and remained in the storage cell. The upper 129 inches of each thimble was transferred from the fuel handling machine to the canister in moderator storage cell 2. The radiation levels encountered during the cutting and transfer operations were measured. At 3 feet from the thimble surface, activity was measured at 30 and 36 r/h (units may be incorrectly presented in the source document) for the two thimbles. At the surface of the cutting point, activity was measured at 11.5 and 12 r/h respectively.

  Personnel exposures for three employees at this time were 45, 225 and 240 mr (units may be incorrectly presented in the source document). Follow-up smear samples of the area found 3,000 dpm/100 cm^2 beta-gamma on plastic outside the work area, 800 dpm/100 cm^2 beta-gamma on a new full-face mask located south of the storage cells, 300 dpm/100 cm^2 beta gamma on an uncovered portion of the floor south of the storage cells, and 100 dpm/100 cm^2 on the floor between the hot change room and the door leading to the high bay. One worker had a nasal smear indicating 600 dpm beta-gamma.

  A cleanup of the contaminated areas began and another smear survey was conducted. Contamination remained on the hot change room floor (120 dpm/100 cm^2), floor between the hot cell stairs and high bay door (120 dpm/100 cm^2), and high bay floor just inside the hot change room doow (180 dpm/100 cm^2). Other surveys found up to 2,400 dpm/100 cm^2 beta-gamma on items in the welder's work area, which prompted immediate roping off of the area

[1] EPA/HGL, *Final HSA 6,* p. 64, citation 3:

[3] Tworek, D. D., Atomics International Internal Letter, re*: Incident Report, "Poor Man's Hot Cell," 9-18-64*, October 6, 1964.

[2] EPA/HGL, *Final HSA 6,* p. 65, citation 1:

[1] Unknown Author, Atomics International Internal Letter, re*: Incident Report, SRE High Bay, 12-1-64*, December 2, 1964.

and decontamination efforts. It was not clear at the writing of the incident report what caused the contamination of the one employee and the surrounding area. The procedure had followed established guidelines. It was recommended that the open moderator storage cell be covered with a lid or plastic between transfers and that work periodically cease to allow for health and safety monitoring in the future (A0371).[1]

- On January 14, 1965, the movement of a temperature probe caused radiation exposure in excess of guidelines for three personnel. Reevaluation of the personnel exposures suggested they were lower than reported because the film badge supplied used a linear formula to calculate exposures instead of a more accurate calibration curve. The corrected exposures showed that the three personnel involved in the incident received lifetime exposures well below the permissible level (A0296).[2]

- On February 20, 1965 an SRE core light was removed and replaced with a short plug. Personnel performed the operation manually with 0.5-inch water pressure in the core. The core light was brought up into a bag, which was tied off and cut. An extension of the core channel was removed and the plug was readied for insertion when particles of ignited sodium and contamination were released. The plug was dropped in place almost immediately, stopping the release of contamination. The spread of contamination was negligible but personnel were contaminated. Two workers had contamination on their necks (180 and 300 dpm beta-gamma) and two workers had positive nasal smears (180 and 2,400 dpm). The health physics department was not given advanced notice of the operations and was not aware that the core would be open. Personnel indicated that this activity had been performed in the past without incident. No masks were worn during the operation (A0386).[3]

- On February 27, 1965 an employee was contaminated through two pairs of coveralls as he worked to change a door seal inside a moderator cask. The employee was contaminated to about 500 cpm on his neck. Only his head and shoulders were inside the cask and he was wearing a full face mask. The employee was observed the entire time by the health and safety department and no unusual occurrences happened while performing the operation (A0416).[4]

- On April 24, 1965 an employee was injured in a non-radiological operation in the SRE high bay. The employee was drilling an electrical circuit box and the drill passed through the tip of

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[1] EPA/HGL, *Final HSA 6,* p. 66, citation 1:

> [1] Townsend, R. I., Atomics International Internal Letter, re: Radiological Safety Incident Report, High Bay Area of SRE, Building 143, Santa Susana, December 18, 1964.

[2] EPA/HGL, *Final HSA 6,* p. 66, citations 2 & 3:

> [2] Boeing Incident Database, Reviewed 2011.
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> [3] Correspondence from Remley, M. E., Atomics International, to Levy, J., U.S. Atomic Energy Commission, re*: Type B Radiation Exposures*, April 2, 1965.

[3] EPA/HGL, *Final HSA 6,* p. 66, citation 4:

> [4] Bergstrom, W. H., Atomics International Internal Letter, re*: SRE High Bay, 2-20-65*, February 24, 1965.

[4] EPA/HGL, *Final HSA 6,* p. 66, citation 5:

> [5] Owens, D. E., Atomics International Internal Letter, re*: Incident Report, SRE High Bay, 2-27-65*, March 2, 1965.

his third finger. He was taken to the West Valley Baptist Hospital for treatment and later returned to work. The incident was not radiological in nature, other than it occurred in the SRE high bay (A0444).[1]

- On March 22, 1965 an employee cut the tip of his thumb while attempting to adjust the position of a temporary ring in a sodium line prior to welding. A small area of skin on his right wrist was found to be contaminated to 60 dpm beta-gamma. This contamination was easily removed by flushing with water. All other survey results showed background activity (A0445).[2]

- On August 19, 1966 an investigation took place to identify the cause of a recent incident at the SRE Tab Exposure Facility (TEF) resulting in exposure of operating personnel to primary sodium. At the time of the incident, personnel had inserted the tabs into the line and were preparing to expose them to primary sodium at nominal operating temperatures when the primary sodium started filling the piping and gas lock used for tab insertion and removal. A freeze stem temperature alarm went off and an operating crew member found drops of sodium on the floor below the gas lock. The TEF inlet and outset valves were closed and the heaters were turned off so that the TEF was isolated from the primary sodium line. The incident occurred because the temperature alarm on the TEF was out of calibration and alarmed at a higher temperature, preventing cooling operations from being implemented to keep the freeze stem frozen. The occurrence could have been much worse during reactor operations, so standard operating procedures were changed to include adding a lead shield to access ports when the reactor was operating, helium leak testing the TEF prior to melting sodium in the piping and exposure site, and freezing adjacent piping while sodium was in the exposure site among other changes (A0041).[3]

- On December 8, 1967 radioactive water was discovered in two 8-inch pipes that penetrate the floor of the maintenance cell at the SRE. Samples indicated radioactivity of 6.10^{4} µCi/cm^3, which was principally Cs-137 with small amounts of Sr-90, Y-90, and Co-60. According to the incident report, the radioactivity found in the water samples were comparable to standards for occupational exposure and were no more than a factor of 10 greater than the 1967 standards for exposures in uncontrolled areas, with the exception of Sr-90 in both cases. However, further analysis of the liquid indicated that only about 10 to 15% of the total activity in the water was Sr-90. The total activity in the water together with the loose or removable contamination in the pipes was determined to be something less than 0.5 mCi. The incident report states that there is no potential hazard of safety problem associated with the contaminated water, but does note that the accumulation of water is an engineering concern

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[1] EPA/HGL, *Final HSA 6,* p. 66, citation 6:

> [6] Moore, J. D., Atomics International Internal Letter, re*: Incident Report, SRE High Bay, 4-24-65*, May 6, 1965.

[2] EPA/HGL, *Final HSA 6,* p. 67, citation 1:

> [1] Moore, J. D., Atomics International Internal Letter, re: Incident Report, Building 143 Primary Na Pipe Gallery, Mar. 22, 1965, May 22, 1965.

[3] EPA/HGL, *Final HSA 6,* p. 67, citation 2:

> [2] Southward, B. G., Atomics International Internal Letter, re*: Investigation of Incident at SRE Tab Exposure Facility*, August 19, 1966.

(A0321).[1]

- On October 23, 1976 radioactive gas escaped during the removal and replacement of the R-34 instrumentation probe from the core top at the SRE. A health physicist took an air sample 2 inches from inside the plug hole where the probe was located. On his way back to evaluate the sample, he discovered his shoes were contaminated. Results of the air sample were 2.0 x 10^{7} µCi/cm^3 for the immediate count and 2.0 x 10^{8} µCi/cm^3 for the delayed count. The health physicist reported the suspected contamination around the core and a possible airborne release to the operating personnel. Operating personnel were almost finished reinserting the probe so a 3-minute air sample was taken as the probe was completely replaced. Results of this air sample were 6.3 x 10^{9} µCi/cm^3 for the immediate count and 1.7 x 10^{11} µCi/cm^3 for the delayed count. The stationary air monitor 5 feet from the core face indicated no increase in radioactivity above background. Four personnel were contaminated between 400 and 500 counts above background. No contamination was found after showering. Nasal smears were below 20 dpm beta for personnel. A smear survey found maximum removable contamination at 10,000 dpm / 100 cm^2 beta. Decontamination began to remove the gross contamination as much as possible before the end of the work shift. The SRE high bay was roped off until additional smears and decontamination were completed. The cause of the rease was attributed to the core pressure being zero and not negative. Operations involving the removal of plugs from the core were to have verification of negative pressure. Three days later the SRE high bay returned to routine working status (A0289).[2]

- On August 1, 1977 the bottom of a cold trap (vapor condenser) at the SRE fell off during movement and contaminated the floor. The cold trap was lifted to a vertical position when the bottom fell off. The top portion of the cold trap was placed in a 55-gallon plastic bag. The bottom portion of the cold trap was hoisted up and placed in a plastic bag inside a 55-gallon drum. Steel baffle plates inside the cold trap had to be pulled loose and some sodium spilled onto the plastic. Contamination was noted on one of the workers' shoes. Nose smears were taken and ranged from background to 251 cpm. Surveys of personnel clothing revealed contamination ranging from 1,500 cpm to 20,000 cpm. Twenty spot smear samples were taken in the high bay area with a maximum count of 50,000 dpm. Additional smears were taken in the health physics office, change room, hallways, shop area and office area. Two smears came back over 50 dpm and those areas were cleaned (A0059).[3]

- On August 10, 1977 a water-filled storage pit used at the SRE for temporary storage of activated material removed from the reactor vessel during decontamination and disposition activities was found to be leaking. The loss of water was detected the day after explosive cutting was done in the reactor vessel near a vault penetration pit that had been welded

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[1] EPA/HGL, *Final HSA 6,* p. 67, citation 3:

> [3] Correspondence from Remley, M. E., Atomics International, to Levy, J., U.S. Atomic Energy Commission, re*: Contaminated Water at the SRE*, December 12, 1967.

[2] EPA/HGL, *Final HSA 6,* p. 68, citation 1:

> [1] Radiation and Nuclear Safety, Rockwell International Internal Letter, re*: Incident Report – Radioactive Airborne Release at SRE*, October 28, 1976.

[3] EPA/HGL, *Final HSA 6,* p. 68, citation 2:

> [2] Health and Safety, Rockwell International Internal Letter, re: Radiation Incident While Moving the Cold Trap into the Alcohol Passivation Tank at SRE, August 1, 1977.

closed. The thought was that the weld had cracked, allowing water to leak into the reactor cavity. Steps were taken to discontinue work that could aggravate existing cracks; monitor the storage pit water level frequently; and develop plans for locating the leak, storing radioactive components out of the pit, and pumping contaminated water from the pit. The water in the storage pit was contaminated to 7.2×10^{2} µCi/cm^3 gross beta activity with a mixture of Na-22, Co-60, Sr-90, Cs-137 and Pm-147.

Water samples were collected from existing wells and three additional monitoring wells were drilled. Analysis of the water samples from existing wells indicated that contamination did not spread outside of the immediate site, but could be in the surrounding soil, adjacent vaults, or to the reactor guard vessel annulus. During drilling of one of the new wells outside the east wall of the SRE, soil was found to be contaminated to 1,300 pCi/g. According to Rockwell, normal subsurface soil activity was 10 to 50 pCi/g. The water in the well was much less radioactive than the soil (39 µCi/cm^3). Preliminary water samples taken from nine well sites ranged from 2.1×10^{8} to 4.9×10^{5} µCi/cm^3 where activity was found. The highest contamination was found in the well with the highest soil activity. Thus, the leak appeared to be in the east end of the storage pit. An estimated 2,200 gallons of water was leaked from August 9, 1977 when the pit was filled to August 22, 1977. As a result of the loss of water, radiation levels in the working areas at the pit were now 20 to 50 mR/h. In October 1977, water samples were collected again and contamination ranged from 2.7×10^{8} to 9.1×10^{6} µCi/cm^3, with the highest level of contamination at the wash cell valve pit presumably a result of activities that agitated the sediment in the area. Two steel tanks were installed for containment of water in the storage pit and all water in the pit was pumped to these tanks. These tanks also served as the storage location for radioactive components (A0414).[1]

- On September 23, 1977 a release of airborne radioactivity occurred in the SRE high bay when a sodium passivation vessel was being unloaded by crane. No unusual occurrences or visible releases were noted in the operation but contamination was discovered when a health physicist checked his shoes. One employee had a nasal swipe with 66.5 cpm measured over 10 minutes (Rockwell's nasal background sample showed 20.5 cpm measured over 10 minutes) indicating an airborne release; however, an air sampler 7 feet away did not detect any rise in activity. The contaminated particles were felt by Rockwell to be so large that they fell to the floor in the immediate area and thus were tracked out of the area on shoes (A0458 and A0683).[2]

- On June 24, 1978 an employee was carrying a stainless steel tray and tripped over a piece of culvert piping that protruded 4 inches above ground. The worker suffered an injury to his leg and was taken to West Hills Hospital for treatment. The area of the incident was smear surveyed for radioactive contamination. An area of the protruding piping was found to have

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[1] EPA/HGL, *Final HSA 6,* p. 69, citations 1&2:

> [1] Correspondence from Tuttle, R. J., Rockwell International, to Jackson, C., Energy Research and Development Administration, re*: Leakage of Radioactively Contaminated Water at SRE*, August 23, 1977.
>
> [2] Correspondence from Tuttle, R. J., Rockwell International, to Jackson, C., Energy Research and Development Administration, re*: Leakage of Radioactively Contaminated Water at SRE,* October 25, 1977.

[2] EPA/HGL, *Final HSA 6,* p. 69, citation 3:

> [3] Owens, D. E., Rockwell International Internal Letter, re*: Incident Report, SRE – September 23, 1977*, Undated.

50.7 dpm of contamination. No other detectable contamination was found in the area (A0578).[1]

5.3.1.5 Previous Radiological Investigation(s) / Decontamination & Cleanup of Releases

The HSA provides a detailed chronology of all radiological investigations and decontamination / cleanup of releases associated with Building 4143.

As noted, although the 2006 Site Profile indicates that the SRE was “shut down for the last time in 1964,” the HSA references documentation showing that the SRE was shut down in 1967 following the SRE PEP program. The AEC approved a plan for the deactivation of the SRE, and its implementation resulted in a “stored in place” configuration.[2]

In October 1969, Rockwell collected a 500-cm^3 sample of groundwater for radiometric analysis from the SRE wash cell valve. Results showed a beta concentration of 7.4 x 10^{6} $\mu Ci/cm^3$. Groundwater seeped into the pit overnight and a second sample collected the next day indicated a beta concentration of 2.5 x 10^{6} $\mu Ci/cm^3$. In November, 1969 Rockwell conducted a smeaer survey and found removable contamination of between 21 and 1,326 dpm/cm^2. Rockwell concluded that the soil surrounding the wash cells was contaminated, probably as a result of the explosion that occurred in 1959 (Incident Report A00315).[3]

In October 1972, Rockwell reported that several areas of the SRE, accessible to personnel, had radiation levels in excess of 100 mR/h. These areas constituted “high radiation areas” and were required to be equipped with alarms that would be automatically actuated in the event of personnel entry, or were required to be locked with positive control on entry. Rockwell reported that extensive internal contamination was present in the fuel handling machines and moderator handling machines. Also, there was a “significant” amount of combustible material in wooden and cardboard boxes, which posed a fire hazard.[4]

Between November 1979 and September 1982, ANL conducted a series of radiological measurements and analyses of the SRE. Activities included conducting instrument and smear surveys for radioactive contamination and collecting and analyzing material samples. During the survey in the summer of 1982, 46 locations with elevated radioactivity were detected, of which 27 indicated contamination in excess of ANL’s acceptable limits. Elevated concentrations of

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[1] EPA/HGL, *Final HSA 6,* p. 69, citation 4:

> [4] Owen, R. K., Rockwell International Internal Letter, re*: Personal Injury Incident of June 24, 1978 at SRE*, July 7, 1978.

[2] EPA/HGL, *Final HSA 6,* p. 69, citation 5:

> [5] Ureda, B. and Heine, W., *Facilities Dismantling Plan for SRE*, Atomics International Report No. FDP-704-990- 003, June 24, 1975, pp. 9, 13, 17-18.

[3] EPA/HGL, *Final HSA 6,* p. 70, citation 1:

> [1] North American Rockwell Corporation Internal Letter from R. K. Owen to W. F. Heine, re: *Water Seepage Hole in the SRE Wash Cell Valve Pit*, January 15, 1970.

[4] EPA/HGL, *Final HSA 6,* p. 70, citation 2:

> [2] North American Rockwell Internal Letter from W. F.eine to R. W. Hartzler, re: *Use of SRE Facility for Storage*, October 30, 1972.

Cs-137 were detected in three samples from the storm sewer, and Sr-90, Cs-137 and U were detected in the samples from the sanitary sewer as it exited Building 4143. ANL concluded that the effluent from the outfall of the storm and sanitary sewer lines was potentially contaminated.[1]

On July 23, 1985 the DOE released the SRE complex for unrestricted use and removed it from the DOE's radiologically contaminated Surplus Facilities Program.[2] A more detailed description and chronology of the Radiological Investigations of Building 4143 is provided in the HSA.

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[1] EPA/HGL, *Final HSA 6,* p. 72, citation 1:

> [1] Argonne National Laboratory, Post Remedial Action Survey Report for the Sodium Reactor Experiment (SRE) Facility, Santa Susana Field Laboratories, Rockwell International, Ventura County, California, DOE-EV-0005-46, ANL-OHS/HP-84-101, February 1984, pp. iii-iv, 15.

[2] EPA/HGL, *Final HSA 6,* p. 72, citation 6:

> [6] Voigt, W. R., Jr., Certification for Unrestricted Use of the Sodium Reactor Experiment (SRE) Complex and the Hot Cave Facility (Building 003), U.S. Department of Energy, July 23, 1985.

Section 5.3.2

Building Number: 4041
Building Alias: 041 / T0431

Building Name: SRE Component Storage Building

Associated Buildings: Building 4687 - Loading Dock
Building 4896 - Concrete Pad

Building Function: Storage of Components & Radioactive Waste

Notes: Tritium

Radionuclides of Concern: Possible radionuclides include U-238, U-234, U-235, U- 236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-228, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn- 54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)- 140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151.

5.3.2.1 Description of Operations & Processes

Building 4041 was constructed in 1958. It was the SRE Component Storage Facility. From 1959 until 1964, the north portion of Building 4041 was used for interim storage of radioactive waste prior to shipment for disposal. The south portion was used for storage of controlled items. In May, 1962 Atomics International reported that approximately 2/3 of Building 4041 was filled with spare parts and radioactively contaminated components from the SRE that required cleaning before reuse.[1] In the early 1980's, during decommissioning of the SRE, Building 4041 was initially decontaminated. In 1985 it was released for unrestricted use, after which it was used for non-radioactive Energy Technology Engineering Center (ETEC) equipment storage. However, in 1982, ANL conducted a post-remedial-action survey. Four areas of Building 4041 were found to exceed ANL's acceptable limits of 20 dpm / 100 cm^2 for removable alpha contamination, and 200 dpm/100 cm^2 for removable beta-gamma contamination. Two areas of Pad 4678 were found to have activity above these limits. ANL surveyed the area again following Rockwell's subsequent decontamination of the areas, and found it to be below the limits specified in the draft American National Standards Institute (ANSI) Standard N13.12 and NRC guidelines dated 1982.

The preliminary MARSSIM Classification for the Building 4041 area is Class 1, primarily due to the proximity with SRE reactor Building 4143 and because radioactive waste from this reactor was stored in Building 4041.

5.2.2.2 Building 4041 Radiological Incident Reports

There HSA did not find any radiological incident reports associated with Building 4041.

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[1] EPA/HGL, *Final HSA 6,* p. 25, citation 4:

> [4] Atomics International letter from J. F. Trevillyan to J. V. Levy, U.S. AEC, re: *Sodium Components Cleaning Facility*, May 28, 1962.

Section 5.3.3

Building Number: **4686**
Building Alias: **686 / T686**

Building Name: **Temporary Hot Waste Storage Building**

Notes: **Tritium**

Radionuclides of Concern: U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151.

5.3.3.1 Description of Operations & Processes

Building 4686 was constructed in about 1957 for use as a temporary "hot" radioactive waste storage facility where solid radioactive waste, such as irradiated core components, moderator cans, and fuel elements were stored. The principal radioactive material stored in this area was plastic wrapped failed fuel elements containing induced radioactivity and mixed fission products. Aerial photographs indicate this facility was used for storage until at least 1972.

The preliminary MARSSIM Classification for the Site 4686 area is Class 1 because of the former use in the SRE complex.

5.3.3.2 Building 4686 Radiological Incident Reports

There has been one incident associated with Building 4686 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

5.3.3.3 Building 4686 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0396	6/17/1960	SRE Waste Area	MFP	Radioactive storage area was entered without approval or protective clothing.

*Isotopes are written as they are presented in the incident database. The HSA research team believes that MFP is an acronym for mixed fission products.

- On June 17, 1960, three employees entered the SRE Temporary Waste Storage Area without contacting the health physics department, despite a sign on the entrance gate requesting this action. The employees were not wearing any protective clothing. They removed a highly contaminated grapple (a type of bucket) from the area and left it unattended. One of the employees later requested a survey of his clothing and found a spot of contamination on his pants. The other employees were checked, but no contamination was found. Investigation found that the SRE Temporary Waste Storage Area gate was usually unlocked and that personnel freely moved in and out of the area without contacting the health physics department. There was also no specific information on whether a tagged area entry permit or protective clothing was required (A0396).[1]

[1] EPA/HGL, *Final HSA 6,* p. 110, citation 1:

> [1] Health Physics, Atomics International Internal Letter, re: Notice of Radiological or Industrial Safety Rule Infraction, August 12, 1960.

Section 5.3.4

Building Number: **4163**
Building Alias: **163 / T163**

Building Name: **The Box Shop[1]***
Component Equipment Repair Facility (CERF)

Building Function: **Radioactive and Chemical Materials Packaging Facility**

Notes: **Not all workers were monitored for radiation at this location.**
Tritium and Neptunium use / contamination.

Radionuclides of Concern: U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba, (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151. EPA notes no analytical method is available for Sm-151.

5.3.4.1 Description of Operations & Processes

Building 4163, known as the Component Equipment Repair Facility (CERF) and Box Shop, is referenced in the 2006 Site Description as a location that was “directly involved” with the handling of radiological materials and operations at the SRE (Sodium Reactor Experiment) area. Building 4163 was located about 50-feet east of the SRE reactor building (4143). The building was rectangular in shape and built in two sections. The west side (closest to the SRE) comprised a steel prefabricated Butler building structure approximately 40’x40’. It was separated from the east side by a floor-to-ceiling sheetrock wall.

The west side contained a change room, a 1-ton crane, sprinklers, and an exhaust system. The east side was a 3,200 square feet box shop, which contained a 5.5-foot deep SRE operations mock-up pit with concrete walls and a soil bottom.

There are indications that during the early years of facility operations, it was determined that the west side of the building would be used for the repair of radiologically contaminated equipment, while the east side (containing a pipe shop and machine shop) would be used for constructing wooden shipping containers and for non-nuclear support work. This may have resulted in a designation of the east side of Building 4163 as “non-radiological,” a designation that may not have been appropriately updated as the use and function of the building changed. It should be noted that the wall separating the two portions of the facility was reportedly removed in the mid-1970’s, which would necessitate both parts of the building being considered “radiological.”

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[1] The Box Shop is identified in the 2006 SSFL Site Description as a radiological facility. Available documentation shows use of this location for radiological processes. However, a “Crater/Packer” employed at the Box Shop received a response to a Radiation Exposure History Request from Boeing, wherein Boeing stated the worker was “never” employed at a radiological facility, never handled radioactive materials, and never exposed to radiation (and therefore, was never monitored). Boeing’s assertions about the employee’s job duties and work location conflict with the Site Profile and Employment Summary provided for the employee, who is depicted in photos alongside monitored workers in the Box Shop. The Box Shop provides an excellent example of the problematic discrepancies between the Site Profile, Boeing’s Employment Summaries, actual facility records, and actual worker records.
Case File and details provided to NIOSH / ABRWH upon request.

Tasks associated with Component Equipment Repair often required machines and equipment that were located in the Box Shop-side of the building, where the SRE operations mock-up pit and machine shop were located. Based on documented facility operations, the proximity of the building to the SRE, and incident reports involving contamination of both sides of the building, there is no reasonable explanation for photographs of employees of Building 4163 to show that some workers were monitored for radiation while others were not.

Box Shop employees built wooden boxes to ship radioactive/chemical materials. They frequently constructed these items to “spec” based around the dimensions of the containers holding materials, which needed to be shipped. It was not unusual for the containers radiological materials to be brought to the Box Shop for packaging, or for Box Shop employees to retrieve used used shipping containers (that had not yet been decontaminated) from various radiological facilities located around SSFL, so that the containers could be reused/repurposed. In 1978 Rockwell conducted a radiological survey at the east end of Building 4163 (Box Shop) to see whether contamination had migrated from the west end of the building. Rockwell did this in preparation for removing the wall between the two parts of Building 4163. The results showed contamination that was reportedly below Rockwell’s applicable limits.

The preliminary MARSSIM Classification for the Building 4163 area is Class 1 due to its documented releases and its former use as an SRE support building.

5.3.4.2 Building 4163 Radiological Incident Reports

There have been several incidents associated with Building 4163 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

5.3.4.3 Building 4163 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0424	2/13/1960	SRE Pipe Shop	ACP	Employees unwrapped contaminated pump for repair in the clean pipe shop.
A0381	8/5/1964	SRE Area		Improper handling of sodium components contaminated personnel and area.
A0542	9/15/1964	SRE Bldg. 163	MFP	Drum containing primary piping from SRE was found smoking in CERF bldg.
A0461	12/7/1964	SRE CERF	ACP	Arc cutting plugged filters causing high airborne activity.
A0385	12/21/1964	T163		Work in the contaminated equipment repair facility contaminated 3 employees.
A0600	11/11966	CERF T163 Bldg.	MFP	Primary sodium valve cleaning resulted in explosion and contamination spread.

*Isotopes are written as they are presented in the Incident Database. The EPA research team believed that "MFP" is an acronym for mixed fission products and "ACP" is an acronym for activation products.

- On February 13, 1960 an employee removed a contaminated pump impeller (126 dpm/100 cm^2 beta-gamma) from its protective wrapping in a clean area of the SRE Pipe Shop. A health physicist questioned why this was done and the employee noted there was no other area available to perform the repair operation on the part. The health physicist noted that if the health physics department had been notified arrangements would have been made for a controlled work area. The impeller was rewrapped until it could be decontaminated. The incident report notes that the supervisor involved showed poor management and the employee has constantly shown a lack of respect for established radiological safety practices (A0424).[1]

- On August 5, 1964, personnel and equipment were contaminated in the Sodium Component Cleaning Area. An employee discovered his hands and feet were contaminated on a routine checkout survey. Smears of the forklift he had been driving showed 200 to 300 dpm/100 cm^2 beta gamma. Two bags of radioactive waste on the forklift were 700 dpm/100 cm^2 beta-gamma on the outside surface. Other members of the crew were alerted to the contamination and brought in for monitoring. Contamination of the efour men involved ranged from 7 to 18 mrad/h on the shoes, 2 to 6 mrad/h on the hands, and nasal smears ranging from 30 to 2,100 dpm beta-gamma. The rest of their bodies showed nothing above background levels. The men were decontaminated and released, although two men were placed on restriction until bioassay results were received.

  An extensive smear survey was then conducted in all areas and building where the men had been working as well as all equipment that had been used by the men. Areas found to have contamination levels exceeding "permissible limits" included: door handles between the SRE lobby and hallway (370 dpm beta-gamma), door handles in the CERF room (1,200 dpm beta-gamma), the ground in front of the CERF door (120 dpm beta-gamma), and the cherry picker seat/steering wheel (300 dpm beta-gamma), and running board (110 dpm beta-gamma).

  Additional smear surveys found maximum levels of contamination as follows: crane hook on steam pad (3.4×10^4 dpm beta-gamma), and floor of building containing oil-bath tank (3.6×10^3 dpm beta-gamma). Both concrete pads and most of the items on the pads were contaminated to some level, but none to the levels described above. Smears of the asphalt between the two pads were below 30 dpm beta-gamma.

  The incident appears to have resulted from handling of a contaminated pipe during various stages of the component cleaning operation. Nasal contamination may have resulted from the initial unwrapping of the pipe where airborne release may have occurred, or from personnel touching their noses with contaminated hands. The incident report suggests temporarily suspending operations until the exact cause of contamination is found and corrective

[1] EPA/HGL, *Final HSA 6,* p. 84, citation 1:

> [1] Health Physics Department, Atomics International Internal Letter, re*: Health Physics Notice of Rule Infraction*, February 13, 1960.

measures can be implemented (A0381).[1]

- On September 15, 1964 an employee noticed smoke coming from under the lid of a 55-gallon waste disposal drum at the CERF. The drum was approximately half full of pipes containing sodium contaminated with fission products. The fire department was called and they arrived in full protective gear. They opened the drum and poured a bag of calcium carbonate in to cover all of the sodium. The drum was closed. No contamination to personnel or equipment resulted from the incident (A0542).[2]

- On December 7, 1964 an arc welder cutting through a contaminated steel and sodium component had to stop because the smoke inside the glove box he was working in obscured his vision. Smoke then started coming out of various openings in the glove box so the operation was shut down and personnel were requested to leave the area. A high volume air sampler that was started at the beginning of the cutting operation was shut off after a 10-minute period and indicated activity of 1.76×10^{8} µCi/cm^3. Two employees had nasal smears that revealed contamination of 72 and 150 dpm and a fireman responding to the incident had a nasal smear of 18 dpm. The men were restricted from radioactive areas until bioassay results were reviewed. The incident report notes that the health physics department should be given a copy of any written procedure for work involving radioactive material with sufficient time prior to the start of the job to fully evaluate hazards involved (A0461).[3]

- On December 21, 1964 a tagged entry permit was approved for cleanup of the CERF Building 4163. The area had been used for the disposition of the SRE main intermediate heat exchange (MIHE). When a health physicist entered the work area to provide assistance, he noticed that an operation was being performed that was not approved in the permit. An employee was using a skill saw [located in the Box Shop] to cut wood used as cribbing for the SRE MIHE. The wood cribbing was saturated with cutting oil and material from within the heat exchanger. The air in the CERF was filled with sawdust and no one was wearing respirators. The employee was told to stop sawing, but he stated he was almost finished and that the health physicist could swipe his nose if he wanted. A nasal smear indicated background activity, but it was suspected the employee blew his nose prior to the swipe.

  A 10-minute air sample indicated airborne activity at 1.83×10^{9} µCi/cm3. Later, the whole work crew was surveyed for contamination and results were negative on all but three people. Nasal smears ranged from 120 dpm to 300 dpm beta-gamma. No clothing or skin contamination was detected as proper protective clothing was worn. A second 10-minute air sample taken after the dust settled showed a reduction in activity to 7.1×10^{11} µCi/cm^3. The incident occurred due to haste and lack of foresight in the cutting operation (A0385).

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[1] EPA/HGL, *Final HSA 6,* p. 85, citation 1:

> [1] Townsend, R. E., and C. L. Young, Atomics International Internal Letter, re*: Radiological Safety Incident Report*, August 23, 1964.

[2] EPA/HGL, *Final HSA 6,* p. 85, citation 2:

> [2] Young, C. L., Atomics International Internal Letter, re*: Incident Report, Building 163 (CERF), 9-15-64*, September 17, 1964.

[3] EPA/HGL, *Final HSA 6,* p. 86, citation 1:

> [1] Galperin, A., Atomics International Internal Letter, re*: Incident Report, CERF, 12-7-64*, January 7, 1965.

- On November 1, 1966 a sodium explosion occurred in the CERF (Building 4163). The incident occurred during cleaning of a valve used in the SRE primary sodium service system. Although the valve had been soaking in Dowanol solvent for approximately 6 weeks prior to the cleaning operation, some unreacted sodium remained in the valve and reacted violently with the cleaning agent. Smear surveys of the area following the explosion indicated contamination levels from 726 to 57,762 dpm/100 cm^2 beta-gamma. A high volume air sample obtained in the CERF change room indicated airborne concentrations of $2x10^{9}$ µCi/cm^3. A recount of the air sample 24 hours later indicated a concentration of $1.2x10^{9}$ µCi/cm^3. Filter paper from the air sample was analyzed for isotope identification. Results showed the presence of Cs-137, Na-22, Sr-90, and Y-90. The CERF room was decontaminated and SRE employees were reminded of the hazards involved in using solvents to react sodium (A0600).[1]

[1] EPA/HGL, *Final HSA 6,* p. 86, citation 3:

[3] Unknown Author, Atomics International, re: Radiation Safety Progress for November 1966, December 9, 1966.

Section 5.3.5

Building Number: **4695**
Building Alias: **695 / T695**

Building Name: **Cold Trap Vault**

Notes: **Tritium**

Radionuclides of Concern: U-238, U-234, U- 235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151

5.3.5.1 Description of Operations & Processes

Building 4695 was constructed in about 1957 as the cold trap (vapor condenser vault). It was a below-ground vault for the SRE that contained a cold trap (vapor condenser) and two hot traps (heaters).[1] Building 4695 was demolished in 1978. All below-grade structures were removed and the area was backfilled and paved. There were no radiological use authorizations for this facility, however, the DOE released the area for unrestricted use on July 23, 1985.

The preliminary MARSSIM classification for Building 4695 is Class 1 due to its former use as an SRE support building.

5.3.5.2 Building 4695 Radiological Incident Reports

During the course of reactor operations, several primary sodium leaks and fires occurred within the vault. No additional information has been found about these incidents.[2]

The HSA provides a detailed chronology of previous radiological investigations and decontamination/cleanup of releases at this location. The DOE released this location for unrestricted use July 23, 1985.

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[1] EPA/HGL, *Final HSA 6,* p. 115, citation 2:

> [2] Owen, R. K., Radiological Survey Plan, Support of D & D Program Operations at T-143 (SRE), Rockwell International Report No. N704TP990008, September 15, 1981, p. 3.

[2] EPA/HGL, *Final HSA 6,* p. 115, citation 4:

> [4] Owen, R. K., Radiological Survey Plan, Support of D & D Program Operations at T-143 (SRE), Rockwell International Report No. N704TP990008, September 15, 1981, p. 3.

Section 5.3.6

Building Number: **4653**
Building Alias: **653 / T653**

Building Name: **Interim Radioactive Waste Vault / Liquid Radioactive Waste Vault**

Notes: **Tritium**

Radionuclides of Concern: The main source of radioactivity was from mixed fission products, and activation products. Possible radionuclides include U-238, U-234, U-235, U- 236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe- 59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb- 95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151.

5.3.6.1 Description of Operations & Processes

Building 4653 was constructed in about 1957 as the Interim Radioactive Waste Vault.[1] Building 4653, located on the hillside above Building 4143 (SRE), consisted of several vaults one of which contained 10 50-gallon tanks and interconnected piping. A compressor vault contained compressors, controls and piping. A suction tank was buried behind and above Building 4653. Six decay tanks, four for gas and two for liquid, were buried in front of and below Building 4563. Building 4653 was connected to the SRE by piping.[2]

Liquid wastes generated in the SRE were directed to one of the two 5,000-gallon liquid holdup tanks before disposal. Liquids were pumped from floor drains in the hot cell area, hot sinks in the controlled areas, and the fuel element wash station located in the high bay area of the reactor room. Most of the radioactivity was from mixed fission products. There were two gas storage systems; a low volume system for the core cover gas, and a larger volume system for all other areas of the SRE. Gas was pumped to one of four gas holdup tanks where short-lived radioactivity decayed. Activation products were the primary isotopes detected in the gas holdup system.[3]

The preliminary MARSSIM classification for Building 4653 is Class 1 due to its former use as an SRE support building.

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[1] EPA/HGL, *Final HSA 6,* p. 102, citation 1:

> [1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.

[2] EPA/HGL, *Final HSA 6,* p. 102, citations 2 & 3:

> [2] Gallegos, A. N., *Disposal of Radioactive Waste Systems at Bldg 653 and Bldg 143*, Rockwell International Report No. N704-DWP-990-054, April 7, 1977, pp. 3, 9-10.
>
> [3] Owens, D. E., Radiological Survey Results – Release to Unrestricted Use, SRE Region V (Gas Storage Vault), Rockwell International Report No. N704TI990031, November 2, 1978, pp. 3-9.

[3] EPA/HGL, *Final HSA 6,* p. 102, citation 3:

> [3] Owens, D. E., Radiological Survey Results – Release to Unrestricted Use, SRE Region V (Gas Storage Vault), Rockwell International Report No. N704TI990031, November 2, 1978, pp. 3-9.

5.3.6.2 Building 4653 Radiological Incident Reports

There has been one incident report located in association with Building 4653 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

5.3.6.3 Building 4653 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0062	11/14/1977	North of High Bay	MFP	Overfilled liquid transfer tank spilled radioactive liquid outside.

*Isotopes are written as they are presented in the incident database. The HSA research team believes that MFP is an acronym for mixed fission products.

- On November 14, 1977 the 500-gallon radioactive liquid transfer tank, one of two on the hillside, was overfilled while performing a backflush of the SRE Culligan filter. An estimated 25 gallons of water overflowed around the tank and to the surrounding asphalt. Activity was estimated at 0.12 µCi/cm^3 for a total of 11 mCi. Principal isotopes were Cs-137, Sr-90, and Co-60. Absorbent material was placed on the spill and efforts were made to cover the areas with plastic and plywood to prevent further spreading of contamination in the high wind conditions at the time. The incident occurred because the operator was not continuously watching the tank sight gage and the back-flush operations proved difficult. Contaminated soil did not appear to have been removed at the time the HSA was conducted. (A0062).[1]

The HSA provides a detailed chronology of previous radiological investigations and decontamination/cleanup of releases at this location. The DOE released this location for unrestricted use July 23, 1985.

[1] EPA/HGL, *Final HSA 6,* p. 103, citation 1:

[1] Brengle, R.G., Rockwell International Internal Letter, re: Spill of Radioactively Contaminated Water During SRE Backflush Operations, November 15, 1977.

Section 5.3.7

Building Number: **4654**
Building Alias: **654 / T654**

Building Name: **Interim Storage Facility (ISF)**
Waste Storage for SRE, OMRE, SNAP

Radionuclides of Concern: Uranium and mixed fission and activation products.

5.3.7.1 Description of Operations & Processes

Building 4654 was constructed in 1958 to support the SRE. It was originally used to store dummy and spent fuel elements, shipping and storage casks, and hot waste generated at the SRE. After the SRE stopped operating, Building 4654 was also used to store waste from the Organic Moderated Reactor Experiment (OMRE) and the Systems for Nuclear Auxiliary Power (SNAP). Building 4654 was taken out of service and did not support an active program from 1964 through 1984.

Building 4654 consisted of a concrete structure in the ground that anchored the topes of eight storage tubes. The tubes extended into large holes drilled in the bedrock, and were embedded with drilling mud. A paved pad was adjacent to the inground structure and provided a fenced storage area.

Because low-level radiation was released from the storage of containers at this facility it was kept in surveillance and maintenance mode to contain the contamination until decommissioning began in 1984.[1] It is worth noting that Building 4654 was open to the environment providing the potential for surface water to seep into the storage tubes and possibly corrode the steel pipes. This building design increased the potential for contaminated water to leak into the subsurface below the storage tubes.

A 1964 inspection tour of SSFL fuel storage areas notes that one of the SRE Core I fuel elements removed from the Building 4654 storage pits contained in an unwelded tube, which separated just as it was being fitted into the RMHF storage thimble. It was recommended that the tube be weld-sealed for contamination control. The inspection report notes that the building 4654 storage area was also temporarily being used to store classified scrap materials.[2]

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[1] EPA/HGL, *Final HSA 7-3,* p. 184, citations 7 & 8:

> [7] Johnson, R.P. and Speed, D.L., Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507, Rockwell International, Rocketdyne Division, March 15, 1985, p. 1.
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> [8] Shah, Satish, N., Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364, The Boeing Company, May 20, 1999, p. 12.

[2] EPA/HGL, *Final HSA 7-3,* p. 184, citations 7 & 8:

> [7] Johnson, R.P. and Speed, D.L., Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507, Rockwell International, Rocketdyne Division, March 15, 1985, p. 1.
>
> [8] Shah, Satish, N., Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364, The Boeing Company, May 20, 1999, p. 12.

The preliminary MARSSIM classification for Building 4654 is Class 1 due to the building design, its former use, radiological incidents, and previous investigations

5.3.7.2 Building 4654 Radiological Incident Reports

There has been one incident report located in association with Building 4653 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

5.3.7.3 Building 4654 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0014	1/23/1962	T654 R/A Storage	MFP	Loss of containment of R/A equipment stored outside.
A0079	7/5/1979	654 R/A Yard	MFP	Contamination found on pavement and outside storage yard fence.

*Isotopes are written as they are presented in the incident database. The HSA research team believes that MFP is an acronym for mixed fission products.

- On January 23, 1962 a radiation survey of Building 4654 was conducted and revealed contamination had spread from the inside fenced area to the asphalt outside the fence. At that time, the contamination level outside the fenced area of Building 4654 was between 2 and 3 millirads per hour (mrad/hr). The contamination on exposed equipment surfaces inside the fence was as high as 17 rads per hour (rad/hr). This information was written in the SRE operations logbook. The incident report indicated that no action was taken to decontaminate the area or prevent further spread of contamination. On February 13, 1962 a similar survey was conducted and indicated an increased spread of contamination due to rain. The contamination on the pavement was between 2 and 17 mrad/hr outside the enclosure. Exposed equipment surfaces inside the enclosure showed loss or displacement of 5 rad/hr of contamination as the maximum detectable level was 12 rad/hr. Four soil samples were taken along drainage pathways. Soil contamination ranged from 20 to 43 “uuc/gm” (presumably µCi/g). Additional information regarding any cleanup of the area, or whether contamination continued to spread, was not provided in the incident summary (A0014).[1]

- During a preliminary survey of the storage yard on July 5, 1979, contaminated shipping casks stored in the area were found to be emitting high levels of radiation. These high levels were noted in the northeast corner of the fenced area. An area of asphalt measured greater than 50,000 dpm with PUG-1 used.[2] A smear of a 3-gallon shipping cask found radioactive

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[1] EPA/HGL, *Final HSA 7-3,* p. 186, citation 1:

[1] Badger, F.H., Atomics International Internal Letter, *Re: Spread of Contamination in Area # 654*, February 18, 1962.

[2] EPA/HGL, *Final HSA 7-3,* p. 186, citation 2:

[2] A PUG is a radiation survey instrument made by Technical Associates, which has been developing radiation detection equipment since 1946.

contamination of 12,000 dpm and an instrument survey indicated 35 mrad/hr at the cask. Some of the other casks surveyed indicated radioactive intensities of 40 mrad/hr. A preliminary survey of the soil outside the fenced area indicated possible soil contamination along the northeast fence line along the ease side ranging from 200 to 400 cpm. The incident report did not include information to indicate any cleanup operations of the area (A0079).[1]

- Seals and packing on some casks and equipment stored at the ISF deteriorated from exposure to the elements to such an extent that low-level contamination was released. This release contaminated the asphalt surface near the casks and soil just outside the ISF fence. The casks and other sources of potential contamination were sent to an offsite disposal facility. Radioactive core components placed in the storage tubes contaminated the internal storage cells.[2] The exact location where the casks and equipment were stored inside the ISF fenced storage area is unknown.

- During decontamination and decommissioning (D&D) excavation activities, the hydraulic hammer mounted on the end of the backhoe punctured storage tube #7. The area was surveyed for contamination, but none was found.[3]

The HSA provides a detailed chronology of previous radiological investigations and decontamination/cleanup of releases at this location. The DOE released this location for unrestricted use February 1, 2005.

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[1] EPA/HGL, *Final HSA 7-3,* p. 186, citation 3:

> [3] Owen, R.K., Handwritten Note Re: SRE Interim Storage Yard, July 5, 1979.

[2] EPA/HGL, *Final HSA 7-3,* p. 186, citation 4:

> [4] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, p. 1.

[3] EPA/HGL, *Final HSA 7-3,* p. 186, citation 5:

> [5] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, pgs. 9, 13.

Section 5.3.8

Building Number: **4689**
Building Alias: **689 / T689**

Building Name: **Intermediate Contaminated Storage Area**

Note: **Possible Tritium**

Radionuclides of Concern: U-238, U-234, U-235, U-236, Pu- 239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co- 60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru- 103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151.

5.3.8.1 Description of Operations & Processes

Building 4689 was constructed in about 1959 as an intermediate storage area for contaminated items from the SRE. This is assumed to be an area where intermediate-level radioactive waste was stored. Aerial photographs indicate that this facility was used for storage until at least 1965. Building 4689 was removed prior to 1967.

The preliminary MARSSIM classification of Building 4689 is Class 1 due to its former use as an SRE support building.

5.3.8.2 Building 4689 Radiological Incident Reports

The HSA research team did not located any radiological incident reports associated with this location.

5.3.8.3 Radiological Investigations and Decontamination/Cleanup of Releases

The HSA provides a detailed chronology of radiological investigations and cleanup activities at this location. However, this area appears to have become contaminated from the radioactive waste stored there. In 1978, Rockwell conducted a radiological survey of this location (then designated as “SRE Region V”). Survey results indicated a maximum reading of 0.08 ± 0.05 mrad/h for surface gamma radiation, and soil samples were found to have less than 50 pCi/g of gross detectable beta activity. All survey results were below Rockwell’s applicable limits for release for unrestricted use.[1]

In September 1982 ANL completed a verification survey of the SRE complex and found that it had been decontaminated to below limits specified in the Draft ANSI Standard No. N13.12 and NRC 1982 guidelines.

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[1] EPA/HGL, *Final HSA 6,* p. 112, citation 3:

> [3] Owens, D. E., *Radiological Survey Results – Release to Unrestricted Use, SRE Region V*, Rockwell International Report No. N704TI990031, May 26, 1978, pp. 3-9.

5.4 SRE: ADDITIONAL LOCATIONS / OPERATIONS

Several buildings and facilities associated with Sodium Graphite Reactor operations (SRE) were excluded from the 2006 Site Profile. This section provides a partial list and description of important facilities that should be included in the Site Profile.

The majority of the following locations are classified as MARSSIM Class 1 status as a result of their use and proximity to other radiological buildings. Some have documented radiological processes, and/or documented reports of releases contained in the Incident Database. In some cases, support buildings were designated as “non-radiological” facilities despite their location in Area IV, documented use of radiological materials, incidents, and/or proximity to known sources of radiation exposure. Tritium has been listed among the radionuclides of concern at several locations.

>> Interesting Fact: The SRE area drained directly to a ditch that transported run-off, spills, industrial effluent, and reactor blowdown to the R-2A Pond, located in Area II. As part of the Site-Wide Water Reclaim System, the ditch was constructed by AEC and Atomics International during the 1950’s - 60’s to keep Area IV from flooding by directing water into a system that drained to ponds located throughout Areas I, II and III. These ponds provided Rocketdyne personnel with water to fill fire extinguishers, hose down work areas, and conduct rocket engine testing. Each rocket engine test required, on average, up to 640,000 gallons of water. Over 30,000 rocket engine tests were conducted at SSFL.

On March 19, 1964 approximately 419,000 gallons of radioactively contaminated water from the SRE Sodium Pond was released to the Area II R-2A pond (Incident Report #A0030),[1] where the Saturn V Lunar Team conducted rocket engine tests for the Apollo missions. For a full summary of this incident, please see Section 5.3.1.4 Radiological Incident Report Summary for the SRE.

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[1] EPA/HGL, *Final HSA 6,* p. 63, citation 1:

[1] Badger, F. H., North American Aviation Internal Letter, re*: SRE R/A Liquid Release*, April 17, 1964.

Section 5.4.1

Building Number: **4153**
Building Alias: **153/T153**

Building Name/Function: **SRE Service Building / Sodium Service Vault**

Notes: Tritium

Radionuclides of Concern: Building 4153 was part of the SRE reactor complex and was located on the north side of Building 4143. Possible radionuclides include U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151.

5.4.1.1 Description of Operations & Processes

Building 4153 was constructed in approximately 1957 as a service building for the SRE.[1] There have been several radiological incident reports associated with Building 4153, which contained an underground vault, a 2,620-gallon secondary fill tank, a diffusion cold trap (vapor condensor) attached to the bottom of the secondary fill tank, an 80-gallon transfer tank, a sodium melt station, piping, valves, a freeze trap, a vapor trap, electrical controls, and switch gear.[2]

The preliminary MARSSIM classification for the Building 4153 area is Class 1 due to its former use as a service building for the SRE reactor.

5.4.1.2 Building 4153 Radiological Incident Reports

There have been several incidents associated with Building 4153 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

5.4.1.3 Building 4153 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0340	3/12/1960	NA SERVICE VAULT		Sodium service vault spill cleanup resulted in fire in sodium container.

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[1] EPA/HGL, *Final HSA 6,* p. 77, citation 1:

> [1] *Ureda, B. and Heine, W, Facilities Dismantling Plan for SRE, Atomics International Report No. FDP-704-990- 003, June 26, 1975, pp. 76-77.*

[2] EPA/HGL, *Final HSA 6,* p. 77, citation 2:

> [2] *Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.*

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0426	4/4/1960	NA SERVICE VAULT	ACP	SRE sodium service vault modification ignited tetralin during welding.
A0010	4/10/1961	NA SERVICE VAULT	MFP	Sodium fire in sodium service vault.
A0532	1/29/1962	SRE NA Vault		Employee reported injured and contaminated leg on the next day.
A0013	1/30/1962	SRE NA Vault	MFP	Employee moved contaminated item into clean area without HP approval.
A0533	3/6/1962	NA SERVICE VAULT	MFP	Worker in sodium service vault without required permit or controls.

*Isotopes are written as they are presented in the incident database. The HSA research team believed that “MFP” is an acronym for mixed fission products and “ACP” is an acronym for activation products.

- On March 12, 1960 a crew of men was going to work on a filter and cold trap (vapor condenser) in the Sodium Service Vault when one of the men noticed sodium leaking from a valve. The sodium had leaked over some of the piping and onto the floor of the vault. The fire department was notified and the sodium was removed from the vault by putting it in a 55-gallon drum filled with calcium carbonate. The sodium was measured at 1,300 dpm/g and the radiation field the men were working in was 400 mrad/h. At approximately 10:45 a.m., a fire started in one of the 55-gallon drums, but it was quickly put out with an argon purge. A few minutes later, a fire was noticed in the sodium service vault. The vault workers donned contained breathing apparatus and some assisted the firemen in trying to put out the fire. Eventually, the vault had to be sealed and purged with argon to put the fire out. During the fire, a high volume air sample was taken and measured 1.64×10^{10} $\mu Ci/cm^3$. All personnel and equipment in the immediate area were smeared and found free of contamination (A0340).[1]

- On April 4, 1960 a fire started in the Sodium Service Vault when welding sparks ignited tetralin on the floor of the vault. Approximately 2 quarts of residual tetralin was on the floor when tetralin lines had been removed for modification. The area and personnel involved were monitored and no contamination was found. A high volume air sample was also taken and revealed no radioactive airborne contamination (A0426).[2]

- On April 10, 1961 a contaminated sodium fire erupted in the Sodium Service Vault area. Sodium that had leaked onto the floor of the vault was being removed by being placed in 35-gallon drums with calcium carbonate. Once all the sodium from the floor was drummed, sodium-covered insulation from the cold trap flange was placed in the drum. An explosion occurred and an employee nearby started pouring calcium carbonate on the contents of the drum. Another explosion occurred, accompanied by flames, and the drum was capped with a

[1] EPA/HGL, *Final HSA 6,* p. 78, citation 1:

> [1] Hetzler, D.K., Atomics International Internal Letter, re*: Radiological Safety Incident Report, SRE Sodium Service Vault, 3/12/60*, March 30, 1960.

[2] EPA/HGL, *Final HSA 6,* p. 78, citation 2:

> [2] Marcotte, E.J., Atomics International Internal Letter, re*: Radiological Safety Incident Report, Sodium Service Vault SRE, 4/4/60*, April 19, 1960.

lid. At this time, an employee in full face mask carried the drum out of the area so fire fighting could be effectively employed. After the smoking drum was removed another bag of calcium carbonate was emptied into the drum and an argon purge was started under the lid of the drum. Calcium carbonate was banked along the bottom of the drum to prevent any sodium from leaking out. The drum started to cool off and it was placed in a 55-gallon drum as secondary containment with additional calcium carbonate. Personnel involved received nose smears, but all were negative. A high volume air sample taken in the Sodium Service Vault showed airborne activity at 6.3×10^{10} µCi/cm^3, and smears taken in the surrounding area were all less than 30 dpm. The cause of the fire appeared to be the use of damp calcium carbonate (A0010).[1]

- On January 29, 1962 an employee scratched his leg while working in the Sodium Service Vault. He did not report the injury or have it checked out at the time. The following day he became contaminated again. The front portion of the employee's leg was contaminated to 1.3 mrad/h. The wound itself was free from detectable contamination. The Sodium Service Vault was noted as a red tagged area. The employee had been handling waste from this area with a radiation field of 250 mrad/h before the contamination was detected (A0532).[2]

- On January 30, 1962 a tagged area entry permit for work in the Sodium Service Vault was approved for the first shift of workers. The permit was specified to expire at 4:00 p.m. A tour of the SRE facility at 6:30 p.m. revealed that four men were working in the area. Two men were in the vault welding the hot trap (heater) and two men were packaging waste. All four men had initialed the entry permit after it expired. One of the employees requested the health physicist to monitor some radioactive waste. The waste was found to be 230 mrad/h, an abnormally high reading for waste from the Sodium Service Vault. A check of personnel was immediately conducted. One employee was found to have contamination on his hands (1.2 mrad/h), leg (1.3 mrad/h), shoe (1.2 mrad/h), socks (0.7 mrad/h), and nose (nasal smear 374 dpm). Another employee had 0.5 mrad/hr contamination on his hand because he did not have rubber gloves on under his canvas work gloves. Both men were successfully decontaminated. In an effort to pinpoint the cause of the contamination, an employee brought a flashlight into the Health and Safety Office, an untagged area, for a smear survey. The flashlight was found to be contaminated to 120 dpm beta-gamma. Eventually, a new tagged area entry permit was requested to complete the work in the Sodium Service Vault. Numerous radiological safety rules and practices were violated in this incident and rule infraction notices were issued (A0013).[3]

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[1] EPA/HGL, *Final HSA 6,* p. 79, citation 1:

> [1] Lane, W.D., Atomics International Internal Letter, re*: Radiological Safety Incident Report, SRE Sodium Service Vault, 4/10/61*, April 28, 1961.

[2] EPA/HGL, *Final HSA 6,* p. 79, citation 2:

> *[2] Health and Safety Department, Atomics International Letter, re: Notice of Health and Safety Rule Infraction, February 7, 1962.*

[3] EPA/HGL, *Final HSA 6,* p. 79, citation 3:

> *[3] Denham, R.S., Atomics International Internal Letter, re: Unusual Incident – SRE – January 30, 1962, February 5, 1962*

- On March 6, 1962 an employee removed tape over a weld in the SETF high bay and NaK ran out onto his hand and leg. He “flipped” the NaK off his hands but his coveralls started to burn. He took the coveralls off and headed for the shower. The Fire Department cleaned up the NaK. Health and Safety monitored the area and found no detectable beta-gamma contamination. The employee was found free of contamination. He did not realize there was NaK in the system and was not dressed in proper protective gear (A0533).[1]

[1] EPA/HGL, *Final HSA 6,* p. 80, citation 1:

> [1] Sessions, S.D., Atomics International Internal Letter, re*: Radiological Safety Incident Report, SETF High Bay, Bldg 24, 3/6/62*, March 21, 1962.

Section 5.4.2

Building Number: **4723**
Building Alias: **723/T723**

Building Name/Function: **SRE Steam Cleaning Pad**

Notes: **Tritium**
Drainage to Area II R-2 Ponds.

Radionuclides of Concern: U-238, U-234, U-235, U-236, Pu- 239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, **H-3**, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co- 60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151

5.4.2.1 Description of Operations & Processes:

Building 4723 was used as a steam cleaning pad for equipment and materials in the SRE. Prior to an incident in March, 1960 the pad was used to clean low-level radioactivity from items of equipment. After the incident, Atomics International decided not to use the pad for radioactive decontamination.[1]

In 1959, a 6-foot diameter overflow pipe and a pumped sump were installed at the confluence of two main drainage channels upstream of the pond. Water was then pumped through a 4-inch diameter overland pipe to a channel connecting to the Area II ponds that serviced the Coca rocket engine test stand area used by Saturn V S-II employees. The overflow from these ponds is into Bell Canyon and thence to the Los Angeles River.[2]

The preliminary MARSSIM classification for the Site 4723 area is Class 1 because of its former use within the SRE complex.

5.4.2.2 Building 4723 Radiological Incident Reports

There has been one incident associated with Building 4723 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

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[1] EPA/HGL, *Final HSA 6,* p. 123, citation 4:

> [4] *Inter-office letter from J. Borg and E. J. Marcotte to W. L. Fisher, re: Steam Clean Pad Incident, June 2, 1960.*

[2] EPA/HGL, *Final HSA 6,* p. 125, citation 5:

> [5] Stelle, A. M., *SRE Activity Requirement No. 27, D & D of Building 143 Retention Pond and Sanitary Sewer*, Rockwell International Report No. N704ACR990024, September 14, 1981, p. 6.

5.4.2.3 Building 4723 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0004	3/19/1960	SRE Steam Pad	MFP	Steam cleaned radioactive sodium pipe at clean pad, contaminating area.

*Isotopes are written as they are presented in the incident database. The HSA research team believes that "MFP" is an acronym for Mixed Fission Product.

• On March 19, 1960 employees were decontaminating a 2-inch valve containing radioactively contaminated sodium at the SRE steam cleaning pad. The valve was placed in an oil bath and then removed for steam cleaning. The residual sodium was blasted from the valve and spread over the greater portion of the concrete pad. The employees were not wearing protective clothing and their shoes were contaminated as a result. The pad was hosed down, washing contaminated sodium and water onto the soil.

Two of the men had contamination on their shoes that ranged from 1.5 to 2.0 mrad/h beta-gamma activity. Surveys from the south, east and west edges of the pad to the center ranged from 0.5 to 30 mrad/h; however, the north edge of the pad to the center ranged from 30 to 100 mrad/h. Ten representative soil samples were collected from the north edge of the pad down the hillside to the retention pond. Beta-gamma activity in soil ranged from 2.7 x 10^{7} to 1.5 x 10^{2} µCi/g. According to Rockwell, water samples from the retention pond revealed nothing in excess of normal groundwater activity.

Decontamination efforts included chipping the pad surface and removing soil on the hillside. Sixteen barrels of concrete and 46 barrels of contaminated soil were collected for disposal. Follow-up soil samples found beta-gamma contamination ranging from 5.3 x 10-6 to 4.8 to 10-5 µCi/g. Smears taken of the concrete pad showed beta-gamma activity ranging from 4 to 20 dpm / 100 cm2, with the exception of one sample that was 40 dpm/100 cm2. A survey of the pad found readings between 0.08 and .15 mrad/h which were deemed by Rockwell as low enough to resurface the pad (A004).[1]

The HSA provides a detailed chronology of previous radiological investigations and decontamination/cleanup of releases. DOE released this location for unrestricted use July 23, 1985.

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[1] EPA/HGL, *Final HSA 6,* p. 124, citation 1:

> *[1] Borg, J. and E.J. Marcotte, Atomics International Internal Letter, re: Steam Clean Pad Incident, June 2, 1960.*

Section 5.4.3

Building Number: **4733**
Building Alias: **733/T733**

Building Name/Function: **SRE Sodium Cleaning Pad**

Notes: **Tritium**

Radionuclides of Concern: U-238, U-234, U-235, U-236, Pu- 239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, H-3, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co- 60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151

5.4.3.1 Description of Operations & Processes:

Building 4733 was constructed in about 1957 and used as a sodium cleaning pad.[1] It was demolished in the 1970's.

The preliminary MARSSIM classification for the Site 4733 area is Class 1 because of its former use within the SRE complex.

5.4.3.2 Building 4733 Radiological Incident Reports

There has been one incident associated with Building 4733 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

5.4.3.3 Building 4733 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0282	5/12/1961	SRE North Pad	MFP	Steam cleaning operation contaminated a concrete pad, equipment and shoes.

*Isotopes are written as they are presented in the incident database. The HSA research team believes that "MFP" is an acronym for Mixed Fission Product.

• On May 12, 1961 parts were being steam cleaned near an open SRE high bay door. A smear survey of the area outside the open door indicated contamination levels as high as 1,200 dpm beta-gamma. The area was roped off and a meter survey of personnel was made. Contamination was found on the bottom of two employees' shoes and the shoes had to be discarded. Additionally, 60 packages that were wrapped for storage outside the high bay doors were contaminated. A smear survey of the control room floor indicated 50 dpm beta-gamma.

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[1] EPA/HGL, *Final HSA 6,* p. 129, citation 1:

> [1] *Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.*

The control room and areas outside the high bay door were decontaminated (A0282).[1]

The HSA provides a detailed chronology of previous radiological investigations and decontamination/cleanup of releases. DOE released this location for unrestricted use in 1985.

[1] EPA/HGL, *Final HSA 6,* p. 129, citation 2:

> [2] *Galperin, A. Atomics International Internal Letter, re: Radiological Safety Incident Report, SRE, 5-12-1961, May 19, 1961.*

Section 5.4.4

Building Number: **4773**
Building Alias: **773/T773**

Building Name/Function: **SRE Sodium Pond / Waste Disposal Site**

Notes: **Tritium**
Area II Drainage

Possible Radionuclides of Concern: U-238, U-234, U-235, U-236, Pu- 239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, H-3, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co- 60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151

5.4.4.1 Description of Operations & Processes:

Site Area 4773 was constructed in about 1956 as a retention pond and dam for the SRE.[1] It received wastewater from the SRE complex and drained directly to Area II ponds that provided water for the Site-Wide Water Reclaim System, used by rocket-engine test stand personnel to hose down work areas and during rocket engine testing. The pond, the septic sewer system, and the industrial waste system were all disposal locations for waste water, and radioactive contamination was found in the pond.[2]

It was an 800,000-gallon capacity retention pond with a compacted native earth dam. The dam was damaged by storm flow in 1958 and the repairs included the installation of a 1.5-foot diameter valved outlet pipe. A year later, as a result of complaints from downstream property owners, additional repairs included the installation of a 6-foot diameter overflow pipe and a pumped sump located at the confluence of the two main drain channels upstream of the pond. The sump collected all stormwater from the SRE. The pump, acting on an automatic level switch in the sump, pumped the water at 350 gpm through a 4-inch diameter overland pipe to a channel connecting to the Area II ponds serving rocketry personnel.

When the sump filled with silt, it was abandoned in place and the pump suction inlet was changed to a raft floating on the SRE retention pond. In 1977, the pond was at about 1/8 capacity (100,000 gallons); it was weed infested and algae laden. An unknown quantity of silt from the SRE had been deposited on the bottom. The last known cleanup was in 1958 as part

[1] EPA/HGL, *Final HSA 6,* p. 138, citation 1:

> [1] *Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.*

[2] EPA/HGL, *Final HSA 6,* p. 141, citation 1:

> [1] *Letter from B. D. Sujata, The Boeing Company, to J. Evans, County of Ventura, re: Information Regarding Permit – Septic Tank and Leach Field, October 23, 2001.*

of the dam repair project. The 800,000-gallon capacity pond was below the 16-million gallon requirement for regulation and licensing by the California Department of Dam Safety.[1]

The preliminary MARSSIM classification for the Site 4773 area is Class 1 because of its former use as the retention pond and drainage control dam for the SRE reactor.

5.4.4.2 Building 4773 Radiological Incident Reports

There were no official incident reports compiled for this site. However, a chronology of radiological incidents cited in Rockwell International reports is as follows:

- During operations, the liquid waste storage tanks overflowed near Building 4653, the Intermediate Radioactive Waste Vault. The event resulted in contamination of soil in the run-off area. The spill was cleaned up shortly afterward.[2]

- In 1964, the draining of test water from the new liquid radioactive waste tanks T2 and T3 sent radioactive solutions to the SRE pond and subsequently to the Area II ponds. Reportedly, the total release did not exceed 60 µCi. The concentration of radioactivity in the SRE retention pond was reportedly less than 2 pCi/cm^3, and in the Area II ponds was 0.1 pCi/cm^3 . C0-60 was found to contribute about 5% of the radioactivity.[3]

  The HSA provides a detailed chronology of previous radiological investigations and decontamination/cleanup of releases. In brief, in 1979 Rockwell drained the SRE pond and allowed it to dry out. According to Rockwell, all areas of the pond bottom that exceeded 100 pCi/g gross detectable beta activity were removed and disposed of as radioactive waste. AFter this decontamination process, Rockwell collected soil samples from the pond bottom and the pond was subsequently returned to service. Soil sampling resulted indicated that all samples were below 100 pCi/g, with a mean value of 29 pCi/g. All survey results were below Rockwell's applicable limits for release for unrestricted use.[4] In March, 1983 Rockwell recommended the

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[1] EPA/HGL, *Final HSA 6,* p. 138, citation 2:

> [2] Stelle, A. M., *SRE Activity Requirement No. 27, D & D of Building 143 Retention Pond and Sanitary Sewer*, Rockwell International Report No. N704ACR990024, September 14, 1981, pp. 6-7.

[2] EPA/HGL, *Final HSA 6,* p. 139, citation 3:

> [3] Stelle, A. M., *SRE Activity Requirement No. 27, D & D of Building 143 Retention Pond and Sanitary Sewer*, Rockwell International Report No. N704ACR990024, September 14, 1981, pp. 6-7.

[3] EPA/HGL, *Final HSA 6,* p. 139, citation 1:

> [1] Groundwater Resources Consultants, Inc., *Assessment of Pond Sediments in R2, SRE and Perimeter Ponds at the Rockwell International Corporation Rocketdyne Division, Santa Susana Field Laboratory, Ventura County, California*, Report No. 8640M-101, July 26, 1990, pp. 4-5.

[4] EPA/HGL, *Final HSA 6,* p. 139, citation 4:

> [4] Wallace, J. H., *Radiological Survey results – Release to Unrestricted use, SRE Region VII*, Rockwell International Report No. N704TI990033, May 13, 1983, pp. 7-9.

water being held in the SRE pond be pumped to the Rockwell Site-Wide Water Reclaim System, and the bottom gate valve be opened to allow for natural run-off.[1]

[1] EPA/HGL, *Final HSA 6,* p. 140, citation 2:

> *[2] Rockwell International internal letter from P. L. Kleinsmith to K. Johns, re: Deactivation of SRE Retention Pond, March 28, 1983.*

5.5 SNAP REACTORS (DOE-NASA)

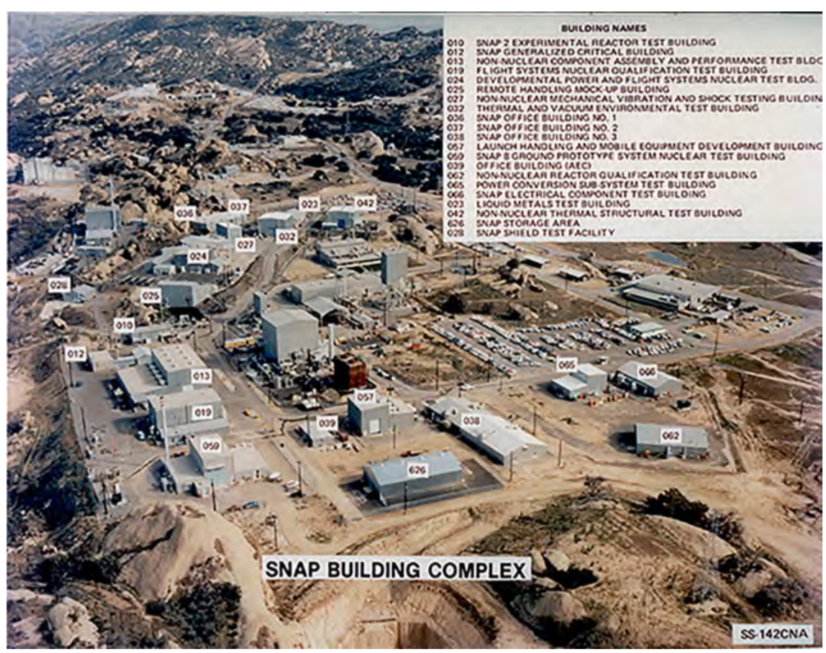
The 2006 Site Profile provides an incomplete list of buildings, processes, and incidents associated with the SNAP (Systems for Nuclear Auxiliary Power) Complex. Additional SNAP facilities and a description of operations and incidents are provided in Section 6.2.

SNAP was a DOE-NASA project.[1] Research and development of SNAP reactors was intended to perfect nuclear space propulsion. SNAP involved North American Aviation Atomics International and Rocketdyne Space & Information Division personnel, some of whom were associated with Area I, II or III "Time Clock Locations." In addition, some DOE Facilities that operated to support SNAP were located outside Area IV, and will be addressed in a subsequent report.

The SNAP Program operated from 1956 to 1971. SNAP reactors were uranium-zirconium hydride reactors that used fully enriched 93% uranium dispersed in fuel rods containing zirconium hydride. SNAP reactors that were developed and tested at SSFL: SNAP 2 SER - Experimental Reactor, SNAP 8 S8ER - Experimental Reactor, SNAP 2 S2DR - Developmental Reactor, SNAP 8 S8DR - Developmental Reactor, SNAP 10-A Flight Reactors - FS1, FS2, FS3.

5.5.1 Rockwell International Adopts Its Own "ACCEPTABLE LIMITS" for SNAP

It should be noted that Rockwell International adopted its own "acceptable limits" for the radiological investigation of all buildings and facilities associated with the SNAP program, based on enriched uranium that was used for SNAP. According to Rockwell International, the ambient gamma exposure *inside a SNAP Criticality Facility* was actually lower than outdoor natural background; and elevated rates were persistently attributed to "primordial isotopes in building material," thus requiring no further investigation according to Rockwell International.



[1] Atomics International News Release, "NASA Contract to Study SNAP Reactors," May 20, 1963. HDMSP001802805.pdf

5.5.2 Perspective: Below, an Atomics International press release announces the SNAP AEC-NASA contract.[1]

Atomics International Inter-Office Letters

To: All Supervision
From: Public Relations

Subject: News Release **Date: May 20, 1963**

A news announcement on a NASA contract to study applications of SNAP reactor systems for use on the moon will be released to the press tomorrow. Essence of the story follows.

Compact nuclear power sources for supplying electricity for men and equipment on the moon will be studied for the National Aeronautics and Space Administration (NASA) by Atomics International, a division of North American Aviation, Inc., according to a contract announced today.

The contract, which is directed by NASA's Lewis Research Center, Cleveland, Ohio, for the Office of Advanced Research and Technology, calls for a nine-month study to determine design modifications required to adapt SNAP reactor systems for possible lunar missions. SNAP, for Systems for Nuclear Auxiliary Power, is the Atomic Energy Commission program to develop compact, light-weight, nuclear electric power systems for space applications.

Some uses for SNAP reactor systems on the moon might include: power for communication stations that would operate unattended for long periods; power for a manned experimental laboratory or astronomical observatory, and a power source for charging the batteries of roving electrical vehicles.

Richard E. Jespersen
Public Relations

[1] Atomics International News Release, "NASA Contract to Study SNAP Reactors," May 20, 1963. HDMSP001802805.pdf

5.5.3

Building Number: **4010**
Building Alias: **010 / T010**

Building Name: **SNAP Experimental Reactor (SER)**
SNAP 2 Experimental Reactor (S2ER)
SNAP 8 Experimental Reactor (S8ER)

Building Function: **Power & Endurance Tests for SNAP Reactors**

Associated Buildings: **4807 / 4808 - Electrical Equipment Pads**
4809 - Air Blast Heat Exchanger Pad

Notes: **SNAP: DOE-NASA**
Known source of Tritium contamination to groundwater well.

Radionuclides of Concern: Sb-125, Am-241, Cs-134, Cs-137, Co-60, Eu-152, Eu-154, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, **H-3**, U-234, U-235, U-238. Be-10 is a potential radionuclide of concern at Building 4010 because beryllium reflectors were used in the SNAP reactor.

5.5.3.1 Description of Operations & Processes

SNAP reactors were uranium-zirconium hydride reactors that used fully enriched uranium dispersed in fuel rods containing zirconium hydride.

Building 4010 was constructed in 1959 as the SNAP Experimental Reactor (SER).[1] It was used for power demonstration and endurance tests of the SER and the SNAP 2 Experimental Reactor (S2DR). The SER/S2ER operated in Building 4010 from September 1959 to December 1960 at a power level of 50 kWth. After completion of the SER/S2ER operations, the reactor and associated test equipment were removed from the building and sent offsite for disposal.

In 1961, improvements and modifications were made to Building 4010 to allow for testing of the higher power level SNAP 8 Experimental Reactor (S8ER), a prototype for the SNAP 8 reactors. The S8ER operated in Building 4010 from May 1963 to April 1965 at a power level of 600 kWth. At the conclusion of the S8ER experiment in 1965, the reactor, primary and secondary sodium loops, and control panels were removed from Building 4010. The primary vault, which still contained surface contamination, and the reactor containment vessel, which still contained induced radioactive materials, were covered with shielding blocks to restrict access and shield the remaining radiation.

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[1] EPA/HGL, *Final HSA 5-B,* p. 13, citations 1 & 2:

[1] Stelle, A.M., *S8ER Facilities Decommissioning Final Report, ESG-DOE-13237*, Rockwell International, Atomics International Division, Energy Systems Group, February 28, 1979, p. 17.

[2] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.

An Atomics International internal letter (September 27, 1965)[1] authorizes Building 4010 personnel to receive 600 MREM of exposure during the removal of the S8ER core vessel and disassembly.

Plans for facility reuse did not materialize and Building 4010 remained unused for nine years until being declared surplus in 1974. D&D occurred through the winter of 1977 and 1978.[2]

In the late 1980's, a large structure consisting of four cooling towers (Sodium Components Test Installation, or "SCTI" Power Pak Cooling Tower Building 4710) was constructed in the approximate location of former Building 4010. It was operated until the mid-1990's. The cooling towers were removed in 2003.[3]

The HSA provides a detailed chronology and description of Building 4010's features, equipment and schematics. In addition, EPA included numerous employee interview excerpts related to operations at Building 4010. In addition, the HSA provides a chronology of radiological investigations concerning Building 4010, and details about its D&D.

1978 Rockwell International radiological investigations of Building 4010 indicated that contamination levels were below cleanup guide limits. However, in 1979, Argonne National Laboratory (ANL) conducted a radiological survey for post remedial assessment of Building 4010 to ensure that it met unrestricted release criteria. A walkover survey indicated some elevated readings on the asphalt, ranging from 15 to 30 µR/hr with a natural background ranging from 9 to 15 µR/hr. Further investigation suggested these readings were a result of radioactive materials stored on the hill east of the Radioactive Materials Handling Facility (RMHF). The Building 4010 area was eventually released for unrestricted use by DOE in 1982.

Radiological Use Authorization No. 18 pertained to radiography in Building 4010. Radiological Use Authorization No. 111 pertained to the D&D of Building 4010. The HSA research team did not find any other Use Authorizations pertaining to this location.

The preliminary MARSSIM classification for Building 4010 is Class 1 because of its former use.

5.5.3.2 Building 4010 SER / S2ER / S8ER Radiological Incident Reports

There have been several incidents associated with Building 4010 that could have resulted in a release to the environment and worker exposure. The following table provides information

[1] Atomics International, Internal Letter to M.L. Dina from R.M. Hill, Re: Approval for More Than 600 MREM Exposure During S8ER Core Vessel Removal & Disassembly," September 27, 1965. File: HDMSp01640465.pdf

[2] EPA/HGL, *Final HSA 5-B,* p. 15, citation 4:

> [4] Stelle, A.M., *S8ER Facilities Decommissioning Final Report, ESG-DOE-13237*, Rockwell International, Atomics International Division, Energy Systems Group, February 28, 1979, pgs. 15, 27.

[3] EPA/HGL, *Final HSA 5-B,* p. 15, citations 5 & 6:

> [5] Montgomery Watson Harza, DOE Leach Fields (Area IV AOC) RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Draft, October 2003, pgs. 2-2–2-3.
>
> [6] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962-November 1992.

presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

5.5.3.4 Building 4010 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0598	4/30/1961	SER BLDG 10		Refers to samples from April incident at SER.
A0277	1/1/1964	SNAP-8 CORE	MFP	Fission product release from cladding failure of SNAP 8 Reactor Fuel
A0349	10/19/1965	High Bay	ACP	Saw cutting of control rods resulted in contamination of building.

*Isotopes are written as they are presented in the Incident Database. The EPA research team believed that "MFP" is an acronym for mixed fission products and "ACP" is an acronym for activation products.

- On April 30, 1961 an unknown incident occurred in Building 4010. Incident Report A0598 referenced the April incident when it indicated that the processing of samples from the incident would be delayed. The report states that three of the five samples resulting from the recent SER incident will be delayed due to a backlog of analyses for the gamma spectrometer. The three samples for which analysis was delayed were the "coolie hat smear; the smear of the upper grid plate, and the metallic fragments scraped from the core." Analysis of two samples following the incident was completed. The first sample was composed of dust removed from the constant air monitor filter. The air monitor had been operating inside the reactor at the time of the incident. The second sample consisted of smears taken of the interior sides of the reactor below the core. The following radioisotopes were found in both samples: Cs-137, Sb-124, Co-60, Sc-46, Mn-54, Sr-90, and Y-90. The air filter dust sample had a total activity of 2.20 x 10 [1] uC/g and the smears below the core had a total activity of 1.23 x 10 [1] uC (no units of weight were included, since this was considered a surface sample). (A0598).[1]

- On January 1, 1964 mixed fission product was released to the cover gas and sodium potassium (NaK) coolant as a result of cladding failure of SNAP 8 reactor fuel. A "substantial release of fission products due to cladding failure occur[red] in about 80% of the fuel rods during the reactor's extended endurance run."[2] The uranium-zirconium fuel swelled, stretching the cladding beyond its ductility limit. This caused cracks in the cladding that allowed fission products to diffuse into the NaK. There was no melting of the fuel or cladding and all fission products were, reportedly, completely contained within the reactor system. However, the Atomics International task force that was created to analyze the behavior of SNAP 8 fuel noted

[1] EPA/HGL, *Final HSA 5-B,* p. 18, citation 1:

[1] Internal Correspondence from Copeland, A.A. to Carpenter G.D., Atomics International, Re: Status Report on Analysis of Samples Resulting from the Incident at SER in April, 1961, June 27, 1961.

[2] EPA/HGL, *Final HSA 5-B,* p. 18, citation 3:

[3] Zwetzig, G.B., Survey of Fission- and Corrosion-Product Activity in Sodium- or NaK-Cooled Reactors, AI-AEC- MEMO-12790, Atomics International, a Division of North American Rockwell Corporation, February 28, 1969, p. 10.

that cracked cladding contained broken fuel in several of the elements.[1] (A0277).[2]

- A 2008 RFI report lists a July 5, 1961 and June 11, 1964 incident related to Building 4010. The details of these incidents were unclear to the EPA HSA research team. The documents referenced for the information in the RFI were reviewed by the research team, and did not suggest that radiological incidents had occurred on these two dates. A review of Boeing's Radiological Incident Database does not include incident reports for these two dates. It is unclear if the statements in the RFI were accurate. EPA's research team specified that additional information regarding possible incidents will be updated, if more is obtained.[3]

- In addition to the incident reports, two leaks in cooling lines are known to have occurred. One leak occurred in the shield cooling water lines under the vault floor and another leak was identified in the reactor containment vessel cooling lines in the earth near the concrete shield. Both leaks were repaired, and no extensive decontamination was found to be required or performed. However, these leaks may have promoted the release of tritium. Building 4010 has been identified as the source of tritium in a neighboring groundwater well.[4]

- On May 18, 1965 a NaK fire occurred in the reactor pit in Building 4010. The fire was extinguished by placing the cover on the reactor pit and flooding it with argon. No personnal injury or property damage was reported to be sustained.[5]

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[1] EPA/HGL, *Final HSA 5-B,* p. 18, citations 4 & 5:

> [4] Oldenkamp, R.D. and Mills, J.C., Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective, N001ER000017, Rockwell International, December 20, 1989, p. 86.
>
> [5] S8ER Fuel Failures, Unknown Author, October 5 1999, HDMSp01708835.

[2] EPA/HGL, *Final HSA 5-B,* p. 18, citation 2:

> [2] Sapere Consulting, Inc. and The Boeing Company, Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries, May 2005, p. L-2.

[3] EPA/HGL, *Final HSA 5-B,* p. 18, citation 6:

> [6] Group 5 – Central Portion of Areas III and IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume VIII – RFI Site Reports, Appendix P, United States Department of Energy Leach Fields 2, CH2M Hill, Draft in Progress November 2008, p. Table P.2-1.

[4] EPA/HGL, *Final HSA 5-B,* p. 19, citation 3:

> [3] The Boeing Company, Rocketdyne Environmental Affairs, *Building 4010 – SNAP-8 Experimental Reactor*, February 10, 2000, pgs. 1-2.

[5] EPA/HGL, *Final HSA 5-B,* p. 19, citation 7:

> [7] Internal Correspondence from Wilmes, R. to Lang, J., Atomics International, a Division of North American Aviation, Inc., *Reference: Monthly Progress Report for Industrial Hygiene and Safety, Santa Susana, Period Ended May 29, 1965*, dated June 2, 1965, p. 3.

Section 5.5.4

Building Number: **4024**
Building Alias: **024 / T024**

Building Name / Function: **SNAP 2 Development Reactor (S2DR)**
SNAP 10-A Flight Simulation Reactor (S10FS1)
SNAP 10-A Flight Simulation Reactor (S10FS3)
SNAP 10-A Flight Simulation Reactor (S10FS5) Storage
SNAP Transient Reactor (SNAPTRANS-1)
Liquid Metal Fast Breeder Reactor (LMFBR) Support
Clinch River Mock-up Reactor Operations
Storage, D&D of Hot Lab (Bldg. 4020) Equipment

Notes: **DOE/NASA**
Tritium

Radionuclides of Concern: The primary radiological constituents of concern have been identified as Co-60 and Eu-152 as a result of activation in the concrete and piping of the subterranean test vaults. Secondary radiological constituents of concern at Building 4024 include Cs-137 and Sr-90 (fission products); **H-3**, Eu-154, Fe-55, Ni-59, Ni-63, Mn-54, potassium-40 (K-40), and sodium-22 (Na-22) (neutron activation products); Th-232, U-234, U-235, and U-238 (nuclear fuel material); and Am-241, Pu-238, Pu-239, Pu-240, Pu-241, and Pu-242 (transuranic elements).[1]

5.5.4.1 Description of Operations & Processes

Building 4024 was constructed in 1959 and used for testing SNAP reactors in a simulated space environment. The sub-grade test cell complex comprising Building 4024 consisted of three parallel cells (two power-test cells and a center transfer cell), a partial rear corridor that interconnected the cells, and the operating gallery. A detailed description of Building 4024's features and measurements is provided in the EPA-HSA.

The SNAP 2 Developmental Reactor (S2DR) prototype was tested at a nominal power level of 65 kWt without any power conversion system equipment. It was tested in Vault No. 1 of Building 4024. The SNAP 10-A Flight System 3 (S10FS3) reactor was tested in a different vault. The SNAP Transient (SNAPTRAN-1) reactor criticality tests occurred at Building 4024, as well as tasks related to the Liquid Metal Fast Breeder Reactor (LMFBR) and Clinch River Mock-Up reactor. During later years of site operations, Building 4024 was used for the storage and decontamination tasks associated with Building 4020 Hot Laboratory.

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[1] EPA/HGL, *Final HSA 5-A,* p. 42, citations 167-169:

[167] The Boeing Company, "Building 4024 Decontamination and Decommissioning Engineering Evaluation/ Cost Analysis," May 1, 2007.

[168] Tuttle, R.J., Listing of Locations in SSFL Area IV Associated With Radioactive Materials," September 1989.

[169] The Boeing Company, Engineering Evaluation & Cost Analysis (EE/CA) Community Meeting Microsoft PowerPoint® Presentation, February 21, 2007.

Building 4024 was modified in 1962. An additional control room was added, along with a new room ("Vault Number 2"), which contained vacuum pumps and other heavy equipment associated with the SNAP 10-A Space Nuclear Reactor (S10FS-1 / S10FS-3). The vacuum chamber allowed for a simulation of the operational environment in outer space.[1]

Power Test Vault Number 1 housed a SNAP-2 Demonstration (a.k.a. "Developmental") Reactor (S2DR) that operated for 5,000 hours at 30 and 50 thermal kilowatts (kWt) between April 1961 - December 1962. The S2DR generated 13 MWd of power and contained 390 x 10^3 Ci of radioactivity at the end of operation. The Hot Lab (Building 4020) was used to examine the fuel and components from the reactor following the operation. The EPA research team could not find additional historical information regarding the operation of the S2DR in Building 4024.

According to a 1962 document, Power Test Vault Number 2 was scheduled to provide shielding and containment for the SNAP 10-A Flight System (S10A-FS-1) in a vacuum chamber located within the test vault. The vacuum chamber was designed to simulate the space environment, and the reactor was put through various tests, including shock and vibration testing, that simulated space-launch. The reactor system test was scheduled to begin in late 1962 and would be completed and removed some time in 1963. The EPA research team did not find documentation indicating that the S10A-FS-1 was tested in Building 4024, but the EPA research team did locate documentation that the S10A-FS-3 was tested there.[2]

CORE Advocacy located an Atomics International document[3] that cautioned against exceeding specifications limits due to the rate of temperature rise. The document cautioned that the results of the intended testing were not exactly known and emphasized that the rate of the heat rise would be the governing factor of a successful test, rather than the ultimate temperature (provided that the specification limits were not exceeded). Part of the testing involved exposing the reactor to thermal shock and extreme temperature fluctuations, but Atomics International stressed that the effect on the device could not be accurately predicted; according to Atomics International, the thermal shock was greatest during the first few seconds of energizing at room

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[1] EPA/HGL, *Final HSA 5-A,* p. 25, citation 84:

> [84] Atomics International, Document NAA-SR-7300 Special, *"Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities,"* May 25, 1962.

[2] EPA/HGL, *Final HSA 5-A,* p. 26, citations 89-93:

> [89] Rockwell International, Document N001ER000017, Rev. C.,*Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, May 30, 1991.
>
> *[90] Sapere Consulting, Inc. and The Boeing Company, Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries, May 2005*
>
> *[91] Clark, R., and Potter, G., SEC Petition Evaluation Report Summary: SEC-00093, Santa Susana Field Laboratory- Area IV, April 28, 2009.*
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> *[92] Atomics International Document, N704FDP990006 Rev. A., "Building T024 (SETF) Facilities Dismantling Plan," July 31, 1981.*
>
> *[93] Atomics International, Document NAA-SR-7300 Special, "Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities," May 25, 1962.*

[3] J. Susnir / I. Rowe, Atomics International Interoffice Letter, *"Duty Cycle SNAP 10-A Actuators, Room Ambient Conditions,"* May 20, 1963. HDMSP001906220.pdf

temperature conditions when full voltage to the reactor was applied. The heat (watts) generated was almost three times the amount that it was designed for (at 800˚ F).

Atomics International warned that continuous duty for approximately one minute, just once, may or may not produce deleterious effects but the repetition of this would probably have a harmful effect, and the degree was uncertain. The author of the letter (I. Rowe, Supervisor of the Electro-Magnetic Devices Component Development Group in the Reactor Development Department), stated:

> *“I hesitate to give consent to any unregulated operations for an extended time and recommend constant current control for these operations. However, if this is impossible, then I would reluctantly and with great reservation consent to not more than any one minute of unregulated energizing and more important, limit this to three times during the life of the actuator. Even so, the effects on the unit are indeterminate. A failure later on due to stresses caused is entirely feasible.”*

The prototype SNAP 10-A Flight System (S10FS-3) reactor operated for 10,000 hours at about 40 kWt between January 1965 and March 1966 and set the record for the longest continuous operation of a nuclear reactor system with 10,000 hours of uninterrupted operation.

On April 27, 1966 a preliminary draft radiation engineering analysis report by the Radiation Safety Unit of Atomics International presented information on the removal of the S10FS-3 reactor core, coolant pump and associated piping from the building. The materials were to be transported to the Hot Laboratory, Building 4020. At the time of removal, the reactor was to have been shut down for a period of 45 days. The EPA HSA provides a detailed account of the sequential removal of the items but the EPA research team was unable to locate documentation indicating the route that may have been followed during the transfer to Building 4020, which may have put workers at other locations at risk of exposure.[1]

On July 14, 1966, an internal letter reported that the building 4024 cells were being decontaminated following the conclusions of the SNAP10FS-3 ground tests. At the time of the letter there was no immediate work planned for the cells, and the letter therefore requested the maximum permissible contamination levels the cells could be left in, on standby status.[2] Such maximum permissible contamination levels should be taken into consideration when estimating worker dose at Building 4024, because the building remained functional and in use between 1966 and 1976.

A November 1976 document outlined the working procedures to be used to remove the vacuum vessel from the west cell of Building 4024. The document, in advance of a general radiological

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[1] EPA/HGL, *Final HSA 5-A,* p. 27, citations 94-95:

> [94] Heine, W.F., Atomics International, *Preliminary Draft Radiation Engineering Analysis: Radiation Safety Analysis*, April 27, 1966. HDMSP001852876.
>
> [95] Lords, R.E., Westinghouse Idaho Nuclear Company, Inc., *SNAP and AI Fuel Summary Report*, Report WINCO- 1222, August 1994.

[2] EPA/HGL, *Final HSA 5-A,* p. 27, citation 96:

> . [96] Wilson R.F., Atomics International Letter Re: Building 024 – FS-3 Vault and Transfer Cell Contamination Levels, July 14, 1966.

survey of the cells, indicated that the vacuum vessel was slightly activated. While the document outlined the dismantling procedure, it did not indicate the date of final removal.[1]

SNAP Critical Assembly 4B operated in the east cell for a short time at low power. SNAP Transient Test (SNAPTRAN-1) support reactor, also critical, operated in the east cell for a short time. Typically SNAPTRAN-1 was operated at low power, except for some pulsed operation. This reactor last operated in 1971, and it was the last reactor to be tested in Building 4024.[2]

According to an undated Rocketdyne Environmental Affairs document, following termination of each project, all equipment and fuel was removed from the facility. The document does not indicate where all the equipment and fuel were taken upon removal; however, an August 1994 SNAP and Atomics International Fuel Summary Report states that within a few months of shutdown, reactors were disassembled and select elements were examined in extensive post-irradiation studies at Building 4020 (Hot Laboratory). Following examination, the fuels were sent to the Idaho Chemical Processing Plant (ICPP). As of 1994, the fuels remained in underwater storage at the ICPP. EPA's HSA research team could not locate additional historical information for the termination of each project.[3]

On January 30, 1973 permission was granted in an internal letter for the storage of Building 4019's SNAP 10A FS-5 system in Building 4024.[4] A document drafted December 13, 1972 outlined the procedures for the transfer of the reactor from Building 4019 to Building 4024. According to the document, the SNAP 10A FS-5 was a complete power system that was loaded with fuel and NaK, and acceptance tested. The fuel was identified as 93% enriched U-235 with a total mass of 5 kilograms of material, 4.75 kilograms compromising U-235.

The system had been stored in Building 4019, and was to be removed and transferred to Building 4024 for permanent storage in 1973, via the south end of Building 4019 to the east roll-up door of the high bay of Building 4024.[5] The permission letter reported that a nuclear safety analysis (NSA) should be prepared for handling the elements outside the reactor and should be

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[1] EPA/HGL, *Final HSA 5-A,* p. 28, citation 97:

[97] Rockwell International Document, N704DWP990024, "Dismantling and Removal of 10FS3 (SNAP) Vacuum Vessel from Building T024, Detailed Working Procedure," November 16, 1976.

[2] EPA/HGL, *Final HSA 5-A,* p. 28, citation 98:

[98] Atomics International Document, N704FDP990006 Rev. A., "Building T024 (SETF) Facilities Dismantling Plan," July 31, 1981.

[3] EPA/HGL, *Final HSA 5-A,* p. 28, citations 99 & 100:

[99] Rocketdyne Environmental Affairs, *Building 4024 – SNAP Environmental Test Facility*, Undated.

[100] Lords, R.E., Westinghouse Idaho Nuclear Company, Inc., *SNAP and AI Fuel Summary Report*, Report WINCO- 1222, August 1994.

[4] EPA/HGL, *Final HSA 5-A,* p. 28, citation 101:

[101] Ketzlach, N., Internal Letter Re: New MBA for SNAP 10FS-5 Storage, January 30, 1973. HDMSP001840067.

[5] EPA/HGL, *Final HSA 5-A,* p. 28, citation 102:

[102] Heneveld, W.H., NSA-652-160-001 *Transfer of SNAP 10A FS-5 from Bldg 019 to Bldg 024*, December 13, 1972, HDMSP001856104.

reviewed by the Fuels Committee. However, information regarding the final transfer of the system to, and the removal of the system from, Building 4024 could not be located.[1]

According to a December 1976 radiological survey plan for Building 4024, the Building 4024 test vaults became radioactively contaminated during the dismantling of the reactors upon completion of operations. The plan stated that the test vaults were lined with aluminum and were decontaminated by site personnel to safe limits of less than 50 dpm.

It is interesting to note that the DOE-ETEC site closure web site[2] provides a photograph and detailed explanation of the use of aluminum vault lining for Building 4024. According to DOE, even with the use of the aluminum vault lining, severe activation of the concrete walls occurred and was detectable 15" into the concrete during later radiological surveys. However, the web site does not reference any aluminum lining for the test vault located at Building 4059, although aluminum vault lining was specifically recommended due to the unshielded, extreme testing that SNAP reactor systems required. A serious incident occurred during the S8DR tests at Building 4059, and there is no indication that aluminum lining was present to contain mixed fission releases. DOE's web site neither references the incident, nor the lack of aluminum shielding at Building 4059. More details about the S8DR Building 4059 incident are provided in the Building 4059 section, below.

Radiation surveys performed after decontamination of the test vaults indicated activation of the vault walls and equipment within the vaults, including TV camera traverse rails, vault light fixtures, and the environmental test vacuum vessel for S10FS3. In addition, beryllium metal contamination was also detected to be present during the SNAPTRAN reactor operations. According to the plan, the beryllium contamination resulted from the use of bare (not anodized) beryllium metal plates as neutron reflectors for the SNAPTRAN. The plan stated the beryllium contamination was cleaned up to less than 0.1 µg/100 cm^2 following SNAPTRAN operations.[3]

According to the 1976 plan, no significant radioactive contamination was ever detected in the radioactive liquid waste retention tanks; radioactive gaseous waste retention tanks contained atmosphere from the test vaults. Rockwell International stated in the plan that analysis of the gas within the tanks identified only argon-41, which has a decay half-life of 1.83 hours. Rockwell International indicated that no other long-lived isotopes were reported to have been detected during reactor operations.[4] However, it bears noting that several of the assertions made by Rockwell International contradict the standardized regulations of the time. (For instance, according to a report authored by Rockwell International, a reading of 7,500 dpm / 100 cpm^2

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[1] EPA/HGL, *Final HSA 5-A,* p. 28, citation 103:
[103] Ketzlach, N., Internal Letter Re: New MBA for SNAP 10FS-5 Storage, January 30, 1973. HDMSP001840067.

[2] http://www.etec.energy.gov/Operations/Major_Operations/SNAP.html

[3] EPA/HGL, *Final HSA 5-A,* p. 28, citation 104:
[104] Rockwell International Document, N704TP99009, "Radiological Survey Plan, Support of D&D Program Operations – T-024 (SNAP 2 and 10), December 9, 1976.

[4] EPA/HGL, *Final HSA 5-A,* p. 29, citation 105:
[105] Rockwell International Document, N704TP99009, "Radiological Survey Plan, Support of D&D Program Operations – T-024 (SNAP 2 and 10), December 9, 1976.

was considered "acceptable" for surface contamination of beta and gamma emitters. This report is discussed in detail, below).

Following the termination of the SNAP program, Building 4024 was used intermittently on different Liquid Metal Fast Breeder Reactor (LMFBR) tasks. In 1987, the most recent program to utilize the building was the testing of a mockup of the Clinch River fuel handling systems.[1] SSFL worker records indicate that Rocketdyne employees previously thought to be confined within SSFL Areas I, II and III routinely performed Clinch River-related job tasks at Building 4024.[2]

5.5.4.2 Radiation Surveys & Surveillance - Building 4024

Progress reports for maintenance and surveillance of facilities in 1987 show that monthly maintenance and surveillance activities included radiation surveys and groundwater sampling. In April 1987, it was reported in the progress report that no significant removable activity was found during the monthly radiation survey, and that sampling of water showed to radioactivity above background. However, in January 1987 samples of water from the pipe chase room at Building 4024 showed low levels of Co-60. It is important to note the monthly report did not provide information to indicate what other radionuclides were included in the sampling program, how frequently samples were taken, or what the reportable levels were.[3] In 1989, DOE's Office of Environmental Audit indicated insufficient monitoring and sampling practices at SSFL.[4]

Weekly surveillance and maintenance activities were conducted in 1988 and 1989.[5] According to a 1989 factual perspective of the SSFL facilities, Building 4024 contained approximately 15 mCi of confined activation radioactivity in concrete. Because of the design of the facility, the cost of D&D of the facility was determined to be expensive. According to the report, "the confined radioactivity is decaying and will meet release criteria when the SSFL is released for unrestricted use." Accordingly, the report stated Rockwell would continue surveillance of the facility in the interim.

According to Boeing, between 1997-1999 Building 4024 was used as a staging and decontamination area for the Hot Lab (Building 4020) concrete blocks. Weekly monitoring measured airborne releases to the environment. Monitoring included, but was not limited to, the following radionuclides that were determined to possibly be present in the process of decontaminating the blocks: Sr-90, Cs-137, Th-230, U-234, U-235, U- 238, Pu-238, Pu-239, Pu-240, and Am-241.

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[1] EPA/HGL, *Final HSA 5-A,* p. 29, citation 108:

[108] ETEC, Site Consolidation Assessment, April 16, 1987. p. 41.

[2] Worker Records provided upon request, redacted unless authorized to review.

[3] EPA/HGL, *Final HSA 5-A,* p. 30, citations 110 & 111:

[110] Wieseneck, H.C., ETEC Monthly Progress Report-April 1987, May 20, 1987.

[111] Wieseneck, H.C., ETEC Monthly Progress Report-January 1987, February 20, 1987.

[4] U.S. DOE Office of Environmental Audit, *"Environmental Survey Preliminary Report, U.S. DOE Activities at SSFL,"* 1989.

[5] EPA/HGL, *Final HSA 5-A,* p. 30, citation 112:

[112] Gaylord, G.G., *SFMP Weekly Reports*, 1988 through 1989.

As of 2011, D&D of Building 4024 was incomplete. A chronology of radiological investigations at Building 4024 follows:

• A radiation survey was carried out in test cell 2 of Building 4024 on April 1, 1966, to establish the dose rates surrounding the S10FS-3 reactor core. The purpose of the survey was to provide measured dose rate data for comparison with calculated dose rate data prior to the removal of the test cell shield blocks. At the time of the survey, the reactor had been shut down for a period of 15 days. The data were obtained by taking measurements in 1-foot increments by lowering the detection instrument into the #3 reactor instrument thimble. The radiation dose rates various from 24.0 R/hr 8 feet lowered from the high bay floor, to 87.0 R/hr at the midline of the reactor core 15 feet lowered from the high bay floor, to 36.0 R/hr 21 feet lowered from the high bay floor, at the floor level of reactor test cell 2.[1]

- A remote radiation survey of the transverse corridor of test cell 2 was performed on April 30, 1966. The purpose of the survey was to evaluate the radiation levels at the entrance to the transverse corridor with door B-104 open. The levels at three additional points were also evaluated. At the four points where measurements were taken, the radiation intensity varied from .055 R/hr to 22.5 R/hr. The survey concluded that operations personnel could enter the transfer lock with door B-104 open, if necessary.[2]

- On May 3, 1966, an Atomics International internal letter provided the results of a second radiation survey of SNAP 10FS-3, located in test cell 2 of building 4024. The survey, performed on April 30, 1966, measured radiation of the reactor after the reactor had been shut down for a period of 45 days. The data were obtained by lowering a Victoreen Radacon Model 510 detector into the #3 reactor instrument thimble, approximately 8 feet from the axis of the reactor core. The results measured that, if the reactor core is assumed to be the point source, the maximum dose rate 1 foot from the core was approximated to be 3.07×10^3 R/hr. If the source geometry was assumed to be a 1 foot line source when the detector is located at the midline of the core, the dose rate was approximated to be 2.6×10^3 R/hr at 1 foot from the core.[3] The letter did not provide information to indicate the purpose of the survey; however, it should be noted that the tests on the reactor ceased in March 1966 and decontamination of the cells had begun by July 14, 1966.[4] It should also be reiterated that maximum permissible

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[1] EPA/HGL, *Final HSA 5-A,* p. 33, citation 128:

. [128] Owen, R.K. Atomics International Letter Re: Radiation Survey of SNAP 10FS-3 Reactor in Test Cell 2, Building 024, April 12, 1966.

[2] EPA/HGL, *Final HSA 5-A,* p. 33, citation 129:

. [129] Owen, R.K., Atomics International Letter Re: Remote Radiation Survey of Transverse Corridor of Test Cell 2, Building 024, May 3, 1966.

[3] EPA/HGL, *Final HSA 5-A,* p. 33, citation 130:

. [130] Owen, R.K., Atomics International Letter, Re: Radiation Survey #2, SNAP 10FS-3 Reactor in Test Cell 2, Building 024, May 4, 1966.

[4] EPA/HGL, *Final HSA 5-A,* p. 33, citation 131:

. [131] Wilson R.F., Atomics International Letter Re: Building 024 – FS-3 Vault and Transfer Cell Contamination Levels, July 14, 1966.

contamination levels were sought, in order to leave the cells in "standby" status.[1]

- A February 11, 1977 internal letter from R.K. Owen to W.F. Heine of Rockwell International provided preliminary survey results of Building 4024, noting that the "complete radiological survey of building 024 appears to require more extensive effort than originally expected." According to the letter, test vault 1 (S2DR and SNAPTRAN-1), test vault 2 (SNAP10FS-3), the vacuum equipment room, and radioactive liquid waste system were marked with a 1-meter square grid for a detailed smear and instrument survey. The letter did not indicate the type of instrument used. In test vault 1, the floor showed 55 dpm/100 cm^2 in one location, while the remainder of the survey grids showed less than 20 dpm. The letter does not indicate whether the contamination was fixed or removable. A light fixture that was surveyed on the south wall measured 4 mR/hr. According to the letter, "one storage hold lid was lifted. The liner appears to be floating, suggesting that the lower part of the hole is filled with water, but this could not be checked at the time."

  The EPA HSA research team did not find any additional information on the "storage hold lid" or its location. As a result, EPA could not (at the time the HSA was written) determine if it was in contact with groundwater.[2] In addition, the floor of test vault 2 was randomly smear-checked following removal of the vacuum vessel. The letter does not provide information to indicate the number of smears performed; but the smears found no contamination about 20 dpm. Radiation levels in the vacuum equipment room were reported to be at the 1977 background levels. The letter did not provide 1977 background levels. The radioactive liquid waste system measurements comprised the "low level waste tank water," the "suspect tank water," and the "sump water." The letter did not provide information to indicate the location of these liquid wastes. The results as reported in the letter are presented as follows:[3]

  - Low level waste tank water

    o alpha – 1.2×10^{-9} µCi/mL

    o beta – 1.7×10^{8} µCi/mL

  - Suspect tank water

    o alpha – 2.1×10^{-9} µCi/mL

    o beta – 1.4×10^{-8} µCi/mL

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[1] EPA/HGL, *Final HSA 5-A,* p. 27, citation 96:

. [96] Wilson R.F., Atomics International Letter Re: Building 024 – FS-3 Vault and Transfer Cell Contamination Levels, July 14, 1966.

[2] EPA/HGL, *Final HSA 5-A,* p. 33, citation 132:

[132] Owen, R.K., Rockwell International, Re: Preliminary Survey Results – Building 024, February 11, 1977.

[3] EPA/HGL, *Final HSA 5-A,* p. 33, citations 133 & 134:

[133] Owen, R.K., Rockwell International, Re: Preliminary Survey Results – Building 024, February 11, 1977.

[134] The alpha and beta measurements are those reported in the letter; however, their values are very low. It is important to note that the micro were hand written on the document, which may have been a result of the original document having been drafted on a type writer, or may have been added in error.

- Sump water

  o alpha – 8.8 x 10^{-10} µCi/mL o beta – 2.5 x 10^{-8} µCi/mL

- According to an undated report titled, "Long-Range Plan for Decommissioning Surplus Facilities at the SSFL," a partial decontamination project of Building 4024 was performed in 1978. The source document does not indicate how the items were decontaminated or where the decontamination took place. **The acceptable limits for residual radioactivity for surface contamination were reported by Rockwell International to be 7,500 dpm/100 cm^2 maximum beta-gamma emitters and 300 dpm/100 cm^2 maximum alpha emitters.** Accessible surfaces within the cell and support areas were cleaned to acceptable removable contamination limits of 100 dpm/100 cm^2 beta-gamma and 20 dpm/100 cm^2 alpha.[1]

- A November 1978 radiological survey report presents the findings of a September 1978 survey to ensure that the facility met unrestricted release criteria. The survey included 800 smears from the walls, floors, and remaining piping and equipment. No beta contamination in excess of 50 dpm/100 cm^2 was reported; no alpha activity was reported for any areas of Building 4024 including the test vaults, transfer cell, operating gallery, high bay, and equipment rooms and support area. **The acceptable limits for residual radioactivity for surface contamination were reported by Rockwell International to be 7,500 dpm/100 cm^2 maximum beta-gamma emitters and 300 dpm/100 cm^2 maximum alpha emitters.**

  According to the report, smears were counted for alpha and beta activity on a Nuclear Measurements Corporation automatic counting system with an average background of 25 cpm for beta and a counting efficiency factor of 2.35 dpm/cpm for beta. The report stated that alpha contamination was not suspected; however, had there been alpha contamination it would have been detected by the Nuclear Measurements Corporation system, and during the course of the survey of removable contamination no alpha activity was detected.

  Rockwell International also performed a survey of surface radiation. This survey was conducted throughout the building and surrounding area using a beta-gamma ion chamber. Beta-gamma surface dose rate limits were 0.1 mrad/hr (average) and 0.5 mrad/hr (maximum). The maximum beta-gamma surface contamination detected outside of the power vaults was 0.07 mrad/hr with an average background of 0.05 mrad/hr. Inside the power vaults, beta-gamma surface contamination was found to range from 0.5 mrad/hr to 2.5 mrad/hr. Inside the corridor to the power vaults, beta-gamma surface contamination ranged from 0.02 mrad/hr to 1.8 mrad/hr. According to the report, the center floor drain in the lower level operating gallery was found to be contaminated during decommissioning and disposal operations. Following an acid cleaning, water and smear samples indicated 0.08 mrad/hr using the ion chamber and 200 cpm using a Technical Associates Model Pug-1. The report summarized that contamination was "probably located in the threads at the bottom of the vertical pipe."

  Soil samples were also collected in the yard during and following the removal of the liquid and gas holdup tanks. According to the report, all samples were less than 30 pico curies per gram (pCi/g). The soil samples were counted on a Nuclear Chicago automatic counting system with

[1] EPA/HGL, *Final HSA 5-A,* p. 35, citation 136:
Rockwell International Document N001T1000200, Long-Range Plans for Decommissioning Surplus Facilities at the Santa Susana Field Laboratories, Date Unknown.

a KCI standard, with an average background of 30 cpm and a counting efficiency factor of 3.29 dpm/cpm. The report approximated the natural activity of uncontaminated soil in this area to be 20 to 30 pCi/g; however, the report did not identify or provide a reference to how these natural activity values were determined.

Concrete cores drilled in the power vault walls and corridors were found to have a maximum specific activity of 818 pCi/g. The average specific activity was 103 pCi/g. Rockwell International analyzed fourteen cores at 1-inch increments to a depth of between 10 and 11 inches, for a total of 144 samples. The average specific activity was 103 pCi/g.

Rockwell International collected water samples from the drain pipe in the operating gallery, hot waste storage vaults, cooling system water waste holdup tanks, groundwater during the removal of the waste tanks, and the vacuum cleaning line in Power Vault 2. The report indicated all the samples were below the limit for Sr-90. However, some water was found to be contaminated above the limit during decommissioning and disposal work, and it was transferred to the RMHF for disposal. The report did not indicate the volume of water that was found to be contaminated above the limit during decommissioning and disposal.[1]

- On March 26, 1981, additional concrete sampling in the power vaults began to determine the amount of concrete needed to be removed to meet 1981 unrestricted release criteria. Potential radiological hazards were identified as being limited to the high bay area (including cell complex), electrical/mechanical support, and yard areas. Two general areas of concern in the high bay were the cells and the S10FS-3 reactor support equipment room. Additionally, the electrical/mechanical support area contained other equipment and systems that were potentially contaminated.

  As a result of exposure to neutrons escaping from the two operating reactors, the walls, ceiling, floor and remote handling equipment of the test cells were activated. The survey indicated that 12 to 22 inches of concrete would need to be removed for surface radiation to meet the acceptable dose rate of 0.1 mR/hr. Only two radionuclides, Co-60 and Eu-152, were identified as the principal contaminants found to contribute significantly to radiation greater than background. The report identified the following activation products as contributing to contamination at Building 4024: Fe-55, Mn-54, and Eu-154.[2]

- According to a December 1992 safety review report regarding tritium production and release at SSFL, production of tritium by the operation of the S2DR, and later the S10FS3, occurred

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[1] EPA/HGL, *Final HSA 5-A,* p. 36, citations 137 & 138:

. [137] Rockwell International Document N001T1000200, *Long-Range Plans for Decommissioning Surplus Facilities at the Santa Susana Field Laboratories*, Date Unknown.

[138] Rockwell International Document, N704TI990044, “Radiological Survey Results – Release to Unrestricted Use, Building 024, SSFL,” November 28, 1978.

[2] EPA/HGL, *Final HSA 5-A,* p. 36, citations 139 & 140:

. [139] Atomics International Document, N704FDP990006 Rev. A., “Building T024 (SETF) Facilities Dismantling Plan,” July 31, 1981. (This document was referenced in the May 2005 HSA but has not yet been obtained.)

[140] Rockwell International Document N001T1000200, *Long-Range Plans for Decommissioning Surplus Facilities at the Santa Susana Field Laboratories*, Date Unknown.

by the following ways[1]:

o Neutron absorption by lithium-6 present in the concrete biological shield – The concrete used for the inner 2 feet of the shield differed from the concrete usually used at SSFL in that limestone aggregate was substituted for the normally used granitic gravel. The natural lithium content of this concrete was measured in 1992 to be 6.2 ppm. Using this concentration and an average flux of 1.2 x 108 n/cm2/sec at 37 kWt for the first 112 cm of concrete (and considering that this flux was uniform over all the walls, floor, and ceiling in the vault) the activity of tritium produced in the concrete of Vault 1 by operation of S2DR is estimated to be 0.16 Ci at shutdown in December 1962. In a similar manner, adjusting for power level and operating time, the tritium activity produced by operation of S10FS3 in Vault 2 is estimated to be 0.20 Ci at March 1966.

o Neutron absorption by lithium-6 present in soil surrounding the biological shield – The thick concrete biological shield with the added boron content absorbed nearly all the neutron that escaped from the reactor (less than 1 neutron per million produced by the reactor reached the soil), and so the production of tritium in the soil was negligible.

o Ternary fission – This was calculated to produce 0.21 Ci in the fuel of the S2DR by December 1962, and 0.26 Ci in S10FS3 by March 1966.

o Neutron absorption by lithium-6 present as an impurity in NaK coolant – Tritium produced in this manner was negligible for both reactors.

o Neutron absorption by lithium-6 in the lithium hydride shield – This activity was estimated from the calculation for S8DR at Building 4059, adjusting for power and time, for the S10FS3 operation. The natural isotopic fraction of 7.42 atom percent was used to estimate a production of 2,200 Ci in the S10FS3 shield.

- In September 1995, ORISE conducted an independent verification survey at Building 4024. Surface scans were performed over 50 to 100% of accessible floors and lower walls (up to 2 meters) for alpha, beta and gamma activity. In the fan room, elevated direct beta radiation was identified. While, in all other areas, alpha, beta and gamma radiation was within the 1995 range of ambient site background. Acceptable contamination limits and gamma exposure rates for releasing a facility for unrestricted use are prescribed in the U.S. Department of Energy (DOE), the U.S. Nuclear Regulatory Commission (NRC), and the State of California guidelines. The lowest, most conservative limits were chosen from these guidelines and incorporated into the final survey criteria for Building 4024. The surface contamination limits for alpha and beta were excerpted from DOE Order 5400.5 and NRC Regulatory Guide 1.86 (see Table below). The ambient gamma exposure rate limits at 1 meter were excerpted from an NRC Dismantling Order because at 5 microroentgens per hour (μR/hr) it was more

[1] EPA/HGL, *Final HSA 5-A,* p. 36, citation 141:

. [141] Tuttle, R.J., Rockwell International Report RI/RD92-186, *Tritium Production and Release to Groundwater at SSFL*, December 1, 1992.

conservative than the DOE value of 20 μR/hr, and more consistent with as low as reasonably achievable principles.[1]

5.5.4.3

Surface Contamination Guidelines from DOE Order 5400.5 (1990) and NRC Regulatory Guide 1.86 (1974)

Allowable Total Residual Surface Contamination (dpm/100 cm²)

Radionuclides	Average	Maximum	Removable
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, and I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, and I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000β-γ	15,000β-γ	1,000β-γ

External Gamma Radiation: The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/hr. *Source: U.S. Atomic Energy Commission (now NRC) Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors, June 1974, p. 1.86-5 U.S. Department of Energy Order 5400.5, Radiation Protection of the Public and the Environment, February 8, 1990, p. IV-6.*

Surface activity measurements were conducted at 76 floor and wall locations. Excluding the power vaults, surface activity levels were less than 55 dpm/100 cm² for alpha and ranged from less than 1,400 to 33,000 dpm/100 cm² for beta. Removable alpha measured less than 12 dpm/100 cm², and removable beta measured less than 16 dpm/100 cm². The maximum beta-gamma total surface activity guidelines (15,000 dpm/100 cm²) as exceeded in the hot gas compression room of Building 4024. Exposure rate measurements were made at four locations in Building 4024, but none were made in the power vaults. Excluding the power vaults, exposure rates ranged from 11 to 13 micro roentgen per hour (μR/hr). Background was 8 μR/hr. Interior exposure rates satisfy DOE and NRC exposure rate guidelines. ORISE determined that existing documentation for Building 4024 was inadequate to support the determination that DOE guidelines for unrestricted release were met. Deficiencies noted included inadequate final status survey methods, no discussion of specific contaminants, inconsistent specification of all applicable guidelines and presentation of data that may be compared to the guidelines, absence of quantitative laboratory data, and absence of adequate figures documenting remediated areas and measurement and sampling locations.[2]

The EPA-HSA contains more details about subsequent, chronological radiological investigations of Building 4024 and recommendations for the final D&D activities.

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[1] EPA/HGL, *Final HSA 5-A,* p. 36, citation 142:

[142] ORISE Report, 96/C-5, "Verification Survey of Buildings T019 and T024, Santa Susana Field Laboratory, Rockwell International, Ventura County, California," February 1996.

[2] EPA/HGL, *Final HSA 5-A,* p. 38, citation 143:

[143] ORISE Report, 96/C-5, "Verification Survey of Buildings T019 and T024, Santa Susana Field Laboratory, Rockwell International, Ventura County, California," February 1996.

5.5.4.4 Building 4024 Radiological Use Authorizations

A review of a database documenting the use authorizations related to SSFL, the EPA research team identified two use authorizations relating to Building 4020 (Hot Lab). Authorization No. 46 relates to the use of Cs-137 and Pu-Be sources in Building 4024, and Authorization No. 112 relates to the "surveillance of Building 4024."

Authorization No. 46 was issued to Atomics International August 5, 1971 and expired on September 5, 1971. As referenced above, the authorization was for the use of a Cs-137 source and a Pu-Be neutron source in the high bay section of Building 4024. The authorized materials included 4.5 Ci of sealed source Cs-137, 5 Ci or sealed Pu-Be source identified as Pu-239, and an additional 10 mCi of sealed source Cs-137.[1] According to the user application dated August 3, 1971, the purpose of the test was to observe the effect of gamma rays and neutrons on an infrared sensor. The application noted that there would be no contaminated materials since the sources were encapsulated.

Authorization No. 112 relates to the surveillance of Building 4024 under the Surplus Facilities Management Program. The first available use authorization was issued on January 16, 1978 and expired January 16, 1979. The authorization operation was listed as "decontamination and disposition of Building 024." the authorized materials were listed as being, "activation product radioactivity" of an unknown quantity in the building's structure and concrete.[2] The authorization was renewed yearly; and in March 1992, the authorization was modified to include the following operations; surveillance and maintenance activities for contaminated areas, future decontamination and decommissioning activities (however not scheduled for the duration of the 1992 annual authorization), and storage of empty radioactive materials containers. By 1994, Authorization No. 112F included required environmental monitoring at Building 4024. This monitoring included quarterly radiation surveys and quarterly contamination surveys.[3]

Subsequent use authorizations after Boeing took over site operations (1996) added the storage and survey of contaminated waste materials from Building 4020 Hot Lab decontamination and decommissioning operations. The requirement was that a running inventory of Building 4020 materials stored in Building 4024 would be maintained, but no additional controls for these operations were identified in the authorizations. In 1997, added operations included the decontamination of Building 4020 materials.

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[1] EPA/HGL, *Final HSA 5-A,* p. 40, citation 153:

[153] Baumesh, L., and Heine, W., Authorization No. 46., August 5, 1971.

[2] EPA/HGL, *Final HSA 5-A,* p. 40, citation 155:

[155] Tuttle, R., Authorization No. 112, January 16, 1978.

[3] EPA/HGL, *Final HSA 5-A,* p. 41, citations 156-161:

[156] Barnes, J.G., and Rutherford, P.D., Authorization No. 112D, March 18, 1992.

[157] Barnes, J.G., and Rutherford, P.D., Authorization No. 112F, April 20, 1994.

[158] Barnes, J.G., and Rutherford, P.D., Authorization No. 112H, January 30, 1996.

[159] Barnes, J.G., and Rutherford, P.D., Authorization No. 112I, January 14, 1997.

[160] Barnes, J.G., and Rutherford, P.D., Authorization No. 112I, January 14, 1997.

[161] Barnes, J.G., and Rutherford, P.D., Authorization No. 112L, March 15, 1999.

While active decontamination of Building 4020 materials occurred in Building 4024, personnel were to perform weekly routine surveys of radiation and contamination levels. During periods when decontamination activities did not occur, personnel were instructed to perform monthly surveys. By 1999, use authorizations expanded to include the storage of radioactive sources pending transfer to a third party recycling or disposal vendor, and the authorization continued to list the storage and survey of contaminated waste material from Building 4020 as an "operation." However, the decontamination of building blocks was expanded to include "L-85 lay down area," but did not provide additional detail to describe what was meant by, "L-85 lay down area."

5.5.4.5 Building 4024 Open Storage Areas

Aerial photographs over the years show open storage areas between 1967-1972, container leakage and open storage areas in 1980, 1983, and potentially 1985. The preliminary MARSSIM Classification for the building 4024 area is Class 1, due to its site operations, results of previous radiological investigations, and current building status. EPA's research team emphasized that there were radiological incidents evidence of radiological releases; significant information is lacking regarding excavation activities. Additionally, EPA emphasized that past characterization studies for Building 4024 were focused on delineating the extent of contamination to standards that were applicable at the time, and EPA made additional recommendations for appropriate characterization of the Building 4024 area.

5.5.4.6 Building 4024 Radiological Incident Reports

There have been several incidents associated with Building 4024 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

5.5.4.7 Building 4024 Radiological Incident Report Summary: Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0535	3/6/1962	SETF High Bay	Active Corrosion Products	Welder burned with NaK in High Bay
A0634	2/19/1970	Building 4024 General Mills	None Identified	Maintenance Workers Unknowingly Worked on Contaminated General Mills
A0686	4/28/1998	Building 4024 Yard	None Identified	Non-Contaminated Skin Rash

- On March 6, 1962 a welder began grinding on the upper weld of the "PCS" in the high bay. The welder stopped, removed the tape over the lower weld and NaK ran out onto his hands and left leg. The welder "flipped" the NaK off his hands and his coveralls started to burn. The welder removed the coveralls and entered the shower. The Fire Department cleaned up the approximately 1/4 cup of NaK. According to the incident report, health and safety personnel found no detectable beta and gamma contamination in the high bay or on the welder

(A0535).[1]

- On February 19, 1970, maintenance workers unknowingly worked on contaminated general mills (A0634). [2]

- On April 28, 1998, an employee working at Building 4024 developed a skin rash on left thigh and both ankles. The employee believed the rash to be "beta burns" caused by beta radiation. A thorough investigation of the worker and the area found no radiation or contamination. The employee was diagnosed with poison oak at the West Hills Medical Center (A0686).[3]

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[1] EPA/HGL, *Final HSA 5-A,* p.32, citation 122:

[122] Sessions, S.D., "Radiological Safety Incident Report A0533, SETF High Bay, Building 24," March 21, 1962.

[2] EPA/HGL, *Final HSA 5-A,* p.32, citation 123:

[123] The research team has not yet received the incident report for this incident. The incident was documented in Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California*, *Volume 2 – Area IV Site Summaries,* May 2005, p. V-3.

[3] EPA/HGL, *Final HSA 5-A,* p.32, citation 124:

124 Liddy, Patricia, "Incident Report File A0686, Worker Concern Over Skin Rash," May 1, 1998.

Section 5.5.5

Building Number: **4028**
Building Alias: **028 / T028**

Building Name: **Shield Test & Irradiation Reactor (STR / STIR)**
Liquid Metal Fast Breeder Reactor (LMFBR)

Building Function: **Experimental Shield Test Facility**

Notes: **DOE-NASA**
Tritium
N16 (Neptunium) found in reactor coolant

Radionuclides of Concern: The primary contaminant within Building 4028 is natural and depleted uranium (U-234, U-235, and U-238).[1] A 1 Ci plutonium beryllium (Pu-Be) source was used with initial criticality and low power experiments and **N-16** was found in the reactor coolant. Radioactive polonium-210 (Po-210) would also be present in the coolant if a break should occur in the aluminum plate covering the bismuth window separating the thermal column from the reactor core.[2] Other radionuclides of concern include isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241), americium-241 (Am-241), Cs-137, cobalt-60 (Co-60), europium isotopes (Eu-152, Eu-154), **tritium (H-3)**, and Sr-90.[3]

5.5.5.1 Description of Operations & Processes

Building 4028 was a DOE-owned facility constructed in 1960 as the **experimental** facility for the Shield Test Reactor (STR), also referred to as the Systems for Nuclear Auxiliary Power (SNAP) Shield Test Experiment (STE) and the Shield Test Facility (STF).[4] It was designed to perform tests on space reactor shields in order to obtain physical parameters necessary to prove the

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 223, citation 6:

> [6] Vitkus, T.J., *Verification Survey of the Old Conservation Yard, Building T064 Side Yard, and Building T028, Santa Susana Field Laboratory, Rockwell International, Ventura County, California,* Oak Ridge Institute for Science and Education, October 1993, p. 6

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 223, citation 7:

> [7] Randen, et al., *Hazards Summary Report The Shield Test and Irradiation Reactor Modifications for One Megawatt Operation, NAA-SR-9129,* Atomics International, December 15, 1963, pgs. 29, 70, 93.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 223, citation 8:

> [8] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 1 – Methodology*, May 2005, p. 2-9.

[4] EPA/HGL, *Final HSA 7-3-NBZ,* p. 195, citations 1-3:

> [1] Santa Susana Area IV, *Atomics International/Energy Systems Group Planning Maps*, March 1962-November 1992.
>
> [2] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries,* May 2005, p. K-1.
>
> [3] Department of Energy, *Real Property and Site Development Planning FY 1988-FY 1992*, January 1988.

safety of the reactor system. The original reactor was the Shield Test Reactor (STR); research and experimentation began in 1961 and ended in 1964.

Experiments consisted of exposing slabs of shielding materials to be used in the SNAP 2, 8, and 10-A programs to the fission spectrum from the fission plate, and measuring their attenuation characteristics for various energies of neutrons. The parameters studied included the energy and angular neutron distraction as a function of shield thickness. The decision was made to make modifications to increase the power from 50 kilowatts to 1 megawatt.

The STR was modified to become the Shield Test and Irradiation Reactor (STIR); research and experimentation began in 1964 and continued to 1972. The STIR was used for reactor physics experiments, studies in radiation damage to electronic and instrumentation components, and neutron radiography. The STIR program was used to study neutron radiography of electronic explosive devices for the Saturn & Apollo space programs, including Apollo 7 - Apollo 17.

A North American Rockwell letter (1970) describes a Reactors Committee Chairman's visit to the STIR facility to view a "dry-run" in preparation for neutron radiography, which was anticipated to introduce "many curies of radioactivity into the facility, with attendant possibilities of direct radiation exposure and fission product release." The Chairman cautioned that review of criticality considerations had not yet been requested by the Operating Staff and, based on his reading of the rough-draft outlining the procedure, he could not recommend the approval of the experiment. "The missing ingredient is a safety analysis."[1] (See Building 4059 below for a detailed description of the major incident that led to this proposed "dry run").

In March, 1976, STIR was decommissioned and removed from Building 4028. From 1977-1981, Building 4028 was used to conduct research on the behavior of molten uranium, which caused the building to again become contaminated.

Operations were terminated in 1984, and the building remained inactive until 1988 when clean out and decontamination began. Decommissioning and Demolition (D&D) began in 1988.

The filters were to be routinely monitored and would also be changed if the dose rate at the filter surface approached 100 mrem/hr. According to the 1961 manual, under normal operation the gaseous or particulate airborne radioactive effluent released at the stack would not exceed the maximum permissible levels indicated by the Chicago Operations Office Atomic Energy Commission Manual at that time. The 1961 manual does not state what the maximum permissible level was at the time.[2]

There are several conflicts in facility records and manuals regarding Building 4028. While 1961 Atomics International manuals note no major radioactive waste system was associated with the STE, provisions were made for handling low-level liquid wastes. A 1968 STIR manual notes that the sink and shower in the change-room were connected to the sanitary sewer system, thus prohibiting discharge of radioactive materials into either. An undated facility information

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[1] North American Rockwell Internal Letter, R.O. Williams, R.E. Durand, Re: *Neutron Radiography of S8DR Fuel Elements in the STIR Facility,"* May 4, 1970

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 198, citation 4:

> [4] Johnson, R.P. et al., *SNAP Shield Test Experiment Preliminary Operations Manual, NAA-SR-5897*, Atomics International, May 8, 1961, pgs. 6-9.

document notes that there was no radioactive liquid holdup tanks at Building 4028, but a 1965 document on changes that needed to be made in the STIR operations manual states that the radioactive waste sink in the laboratory fume hood drained to a 20-gallon holdup tank.[1]

A 1966 reactor safety survey report states that radioactive wastes generated at the STIR consisted of solid wastes only. According to the report, ice cream cartons containing low-level waste were picked up by the Radioactive Materials Handling Facility (RMHF) approximately once a week. Radioactive wastes of larger sizes and/or higher radiation levels were put in 55-gallon drums, but the report notes that this material averages no more than one drum every 6 to 9 months.[2] In 1977, Building 4028 was used for uranium oxide experiments under the Liquid Metal Fast Breeder Reactor (LMFBR) Fuel Safety Building, or Arc Melt Facility, to investigate the behavior of molten uranium oxide relative to simulated reactor accidents. These tests continued until 1981. The former shield test vault, known as the basement or Room B101 during this time, housed experimental equipment such as the arc-melting vacuum furnace and associated appurtenances.

5.5.5.2 Bldg. 4028 Radiological Use Authorizations

During the course of building operations from 1960 through 1975, the use of radioactive materials in Building 4028 was exempt from California licensing requirements as a U.S. Energy Research and Development Administration (ERDA)-owned facility. After 1975, decontamination and disposition of the STIR, which involved low-level contamination, were authorized. In 1977, Use Authorization 108 was initially issued for the use and storage of UO_2 for melting operations in Building 4028. In 1989, the retirement of Use Authorization 108 was requested as all uranium

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 199, citations 4-7:

> [4] Johnson, R.P. et al., *SNAP Shield Test Experiment Preliminary Operations Manual, NAA-SR-5897*, Atomics International, May 8, 1961, p. 41.
>
> [5] Golliher, K.G., *Shield Text and Irradiation Reactor Operations Manual, NAA-SR-MEMO-12606*, Atomics International, September 1, 1968, p. 6-12.
>
> [6] Unknown Author, *Facility Information, Building # 028*, Unknown Date, BNA01247350.
>
> [7] Unknown Author, *Changes in STIR Operations Manual*, October 15, 1965, BNA 02011149.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 199, citation 8:

[8] Health and Safety Division, Chicago Operations Office, *Reactor Safety Survey Report, Shield Test and Irradiation Reactor (STIR), Atomics International*, February 16-17, 1966, p. 8.

was removed from Building 4028 and the facility had been demolished, with the exception of the vault area.[1]

The preliminary MARSSIM classification for Building 4028 is Class 1, due to its former use as a nuclear reactor, radiological incidents, and previous investigations.

5.5.5.3 Building 4028 Radiological Incident Reports

There have been several incidents associated with Building 4028 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

5.5.5.4 Building 4028 Radiological Incident Report Summary, Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
AO278	3/5/65	Irradiation Tub		High Airborne Activity During Sample Removal After In-Core Irradiation
A0280	5/8/65	Irradiation Tub		High Airborne Activity During Sample Removal After In-core Irradiation
A0279	6/17/65	Irradiation Tub		Extremity Exposure From Handling Irradiated Bag Sealed With Green Tape
A0437	8/6/65	STIR Office	U235	Unmarked Irradiated Fission Foil Moved in Private Car to Clean Office
A0055	6/2/75	RMDF & Adjacent	Mixed Fission	Nine Spills Have Been Identified @ RMDF Complex
A0065	1/10/78	Furnace Area	U	A Small Uranium Fire In An Arc Melting Furnace
A0077/ A0232	1/17/79 / 1/30/79	Floc Tower Area / Pond	Mixed Fission	R/A Water From Flocculation Tower Contaminated Drainage Ditch and Pond / Contaminated Crucible Stored Outside Exposed to Element[s]

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 223, citations 1-5:

[1] *Radioactive Material Authorizations*, Rockwell International, BNA02647573.

[2] Internal Correspondence from Burgess, D.D. to Isotope Committee Chairman, Rockwell International, *Re: Application for Renewal of Authorization for Use of Radioactive Materials No. 108C*, June 8, 1981.

[3] Nagel, W.E., Authorization for Use of Radioactive Materials or Radiation Producing Devices, Authorization Nos. 108D, 108E, 108F, 108H, 108K, Rockwell International, June 22, 1981 through June 22, 1988.

[4] Internal Correspondence from Schmidt, F.G. to Moore, J.D., Rockwell International, *Re: Retirement of User Authorization No. 108 – Uranium Melt Facility T028*, September 20, 1989.

[5] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0087	7/24/1981	Yard	U	Contaminated Crucible Stored Outside, Exposed to Elements.
A0096	1/20/82	Pond		Stuck Float Switch Pumped Pond Dry Increasing Background to Cause Alarm

- On March 5, 1965 the constant air monitor located in the reactor room alarmed during the removal of an irradiated sample from the north irradiation facility tube referred to as a "glory hole." The removal operation consisted of "hand hauling" a length of plastic coated electronic hoop-up wire, from which the sample was suspended, to a position where the sampled would be allowed to "cool." Following the alarm, all personnel in the area were evacuated to the reactor control room and office. High volume air samples and smear surveys were taken from the reactor room and the reactor control room. The operations personnel were requested to seal the "glory hole" opening with plastic to prevent further airborne contamination to leak into the area. Based on available data contained within the incident report, the "glory hole" was sealed approximately an hour and a half after the alarm sounded.

  The incident report summarized that surveys of personnel involved in the incident and indicated no contamination in excess of the background of the instrument, or 30 disintegrations per minute (dpm) beta and gamma. There were four 10-minute high volume air samples taken in the reactor room, including a sample taken at the "glory hole" (Sample No. 3). The measurements ranged from 1.0x10-7 microcuries per cubic centimeter (µC/cc) at the "glory hole" to 5.8 x 10-10 µC/cc, which was approximately 30 minutes after the "glory hole" had been sealed with plastic. A high volume air sample taken in the reactor control room approximately 30 minutes after the incident indicated a gross beta-gamma activity of 1.7x10-9 µC/cc upon immediate analysis.

  The results of the smear surveys obtained from the reactor room and other areas traversed by personnel did not indicate any contamination in excess of 30 dpm gross beta-gamma, with the exception of the reactor room, which ranged from 40 to 402 dpm gross beta-gamma activity.

  The incident report summarized that "as indicated by the high volume air sample obtained in the reactor control room, the building environmental air flow patterns permit the penetration of radioactive airborne contamination into areas from which it should be prohibited." It was recommended that a precise air flow pattern of Building 4028 be examined to correct any deficiencies within the building (A0278).[1]

- On April 8, 1965 a special bioassay request was made for an employee as a result of the "emission of radioactive particulates from the irradiation thimble ("glory hole") during removal of sample from thimble." The incident report did not indicate how the emission of radioactive particulates occurred, but indicated that the "radioelements" involved in the bioassay included possible "hydrocarbons plus other activation products." According to the document, nasal

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 209, citation 1:

[1] Owen, R.K., Rough Draft Internal Letter Re: High Level Radioactive Airborne Concentrations Incident at Building-028 (STIR), March 5, 1965, Undated.

swipes of the employee indicated a gross beta-gamma activity of 1 x 10^3 dpm. An air sample was reported to have measured 5.5x10^{9} μC/cc. No additional information regarding this incident or the employee was included in the referenced document (A0280).[1]

- On August 6, 1965 an unmarked fission foil containing less than .05 grams of U-235 was left on a desk in the office area of Building 4028 after being hand-carried from Building 4009 to Building 4028 in his car. The outside of the container was contaminated to a maximum of 12,000 dpm per 100 square centimeters (dpm/100 cm^2). The U-235 foil had ben previously irradiated at Building 4028 in April 1965. The gasket under the top did not provide a seal for the can because the threads of some of the screws holding the top on were stripped. The can was placed in safe storage and the desk was decontaminated to less than 30 dpm/100 cm^2 beta gamma. The employee who transferred the can in his car was surveyed, and his car was surveyed, and no significant contamination was found (A0437).[2]

- An October 17, 1975 internal letter discusses nine significant radioactive spill areas and numerous “spot areas” at the RMHF complex. The activity associated with the spills ranged from 0.5 to 3,500 millirads per hour (mrad/hr). The spills were assumed to have occurred between 1972-1975 and to have followed the course of water. The letter noted that the rainy season was approaching and a spill area on the bank above Building 4028 would “assuredly spread and create considerably more radioactive waste.” The figure [indicated in the report] appears to show this area to have had an activity of 210 mrad/hr adjacent to the stairway northwest of Building 4028 and 35 mrad/hr adjacent to the stairway at the northeast corner of Building 4028. Two more suspect areas, presumably around Building 4028, were to be surveyed as they became accessible; however, the available documents do not provide information on these areas (A0055).[3]

- A November 18, 1975 Rockwell letter follows up on the October 17, 1975 letter discussed above and describes the current status of the RMHF complex. It describes a contaminated area extending along the fence west of the RMHF complex between Building 4028 and the RMHF perimeter fence. This area of contamination appears to be the same area described above in the October 17, 1975 letter. Contamination of dirt and asphalt was thought to be the result of contaminated barrels stored at the west end of the RMHF complex. The barrels may or may not have contained contaminated material. They may have become contaminated due to drainage from an upstream source. Presumably, one or more of the contaminated barrels filled with rain water and tipped over, or by some other means, possibly corrosion, spread

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 209, citation 2:

> [2] Owen, R.K., Atomics International Internal Correspondence, *Subject: Special Bioassay Request*, April 9, 1965.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 210, citation 3:

> [3] Tschaeche, A.N., Atomics International Internal Correspondence, *Re: Incident Report, Santa Susana Bldg. 028, August 6, 1965*, August 30, 1965.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 210, citation 4:

> [4] Badger, F.H., Rockwell International Internal Letter, *Re: Radioactive Spills in RMDF*, October 17, 1975.

contamination down the hill to the south for approximately 100 feet by several feet wide.[1] This report, in its entirety, precluded the RMHF Section of the Proposed 2016 SSFL Site Description.

- On January 10, 1978 there was a small uranium fire at Building 4028. According to the incident report, the health physicist entered the test area to take a low volume air sample and take several spot smears on the floor and high ledges to determine if airborne activity had been present. The incident report states that, "when both the air sample and smear were attempted to be counted, several problems were encountered with the counting system in the area." The report did not elaborate on the problems encountered, but indicated that alpha contamination of 4 to 7 counts per minute (cpm) appeared to be located on the "planchette slide holder." The EPA research team has been unable to determine exactly what this "planchette slide holder" is, or where it was located.

  Subsequent investigation found contamination of approximately 60 dpm/100 cm2 alpha on the lip edge of the arc-melt furnace. This area was decontaminated by personnel assigned to the building. The incident report stated that the constant air-monitor in the area was not operating at the time of the incident, but did not provide detailed information on the actual incident, including the duration and extent of the fire (A0065).[2]

  A 1978 letter report provides some additional information on the fire. According to the report, before the pyrophoric nature of UO_2 was known, "a small amount of UO_2 fell out on the plastic covering on the floor while opening the door." Presumably, this means the UO_2 fell out of the furnace door and onto the floor of the former shield test vault room. The door was closed and the fire was extinguished by argon flow from a hose. No spread of contamination resulted. To prevent reoccurrence, metal trays were installed under the doors and the trays were covered with calcium carbonate to catch the UO_2 and slow down the oxidation process.[3]

- On January 30, 1979 a water sample from the Building 4028 retention pond located to the west of the building showed an unusual increase in the concentration of radioactivity within the pond. The Building 4028 retention pond is also known as the RMHF 4614 Holdup Pond. Accordingly, this incident is addressed by EPA in detail, in the EPA Final HSA, 7-3 NBZ provided in its entirety with this document.

- A July 24, 1981 handwritten report indicates that radioactive material was being stored on the pad northwest of Building 4028. According to the report, a copper crucible for melting depleted uranium was stored in a wooden box, but the box lid had been removed. A survey of the upper sides of the crucible indicated contamination of less than 50,000 dpm. The report indicated

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 211, citation 1:

> [1] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 211, citation 2:

> [2] Owens, D.E., Rockwell International Internal Letter, *Subject: Emergency Response-Uranium Fire at T028*, March 28, 1978.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 211, citation 3:

> [3] Gunderjahn, C.A. and Campbell, D.C., Operation of the Arc Furnace in Building 028, Santa Susana, Rockwell International, September 7, 1978.

that the box, and a similar adjoining box, was badly weathered with the plastic wrap on the crucible “all but gone.”

The report stated that drainage from the storage area and building 4028 was directly to Simi Valley. The document indicated there to be violations of existing regulations and policies and the author requested immediate attention. The document did not provide additional information on the duration of these storage activities, and additional information regarding the fate of the crucible and wooden box could not be located by EPA in the documents reviewed during the HSA (A0087).[1]

- On January 20, 1982 the water monitor in the Building 4028 Pond alarmed during heavy rain. The Building 4028 retention pond was also known as the RMHF 4614 Holdup Pond. Accordingly, this incident is also discussed at length in the EPA-HSA, 7-3 NBZ, which is provided in its entirety with this document.

The EPA HSA provides a detailed chronology of all radiological investigations and decontamination details associated with Building 4028. EPA specified that it did not agree with the background or maximum acceptable contamination limits that were provided in Rockwell International’s Final Decontamination and Radiological Survey (1991), which also appears to conflict with the ORISE Verification Survey conducted in 1992.[2] However, according to the ORISE report, Building 4028 met the release requirements for unrestricted use.

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 212, citation 1:

[1] Author Illegible, Handwritten Correspondence, *Subject: Storage Area Northwest of T028*, July 24, 1981.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 218.

Section 5.5.6

Building Number: **4059**
Building Alias: **059 / T059**

Building Name: **SNAP 2 Developmental Reactor (S8DR)**
Large Leak Test Rig (LLTR)
Ground Prototype Test Facility

Building Function: **Unshielded SNAP 8 DR Prototype Endurance Testing**

Notes: **MAJOR INCIDENT**
DOE-NASA
Verified Tritium Groundwater Contamination

Radionuclides of Concern: The S8DR contained 211 fuel/moderator elements of zirconium-uranium hydride ($(Zr\text{-}U)H_x$) with beryllium reflector agents. Some parts of Building 4059 became activated by neutrons produced by the reactors. Tritium was produced and was detected in groundwater. Potential radioactive contaminants include U-238, U-234, U-235, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Cs-137, Sr-90, H-3, Fe-55, Co-58, Co-60, Ni-63, Ba- 133, Eu-152, Eu-154, Eu-155, Pm-147, and Ta-182.

5.5.6.1 Description of Operations & Processes

The Systems for Nuclear Auxiliary Power (SNAP) 8 Developmental Reactor (S8DR) was intended to power space missions. Building 4059 was constructed in 1961 and modified in 1964 in order to create a simulated space environment for ground-testing the S8DR prototype. The S8DR was unshielded, and due to its design objectives, it would require extensive testing and experimentation to prove its longevity and resilience in orbital spaceflight. One of the requirements was a 12,000-hour test run.

According to the 2006 SSFL Site Profile, “No incidents of any consequence” occurred involving the S8DR, other than cracked cladding that proved to be a minor issue, and all fission products were contained in the reactor system. However, the S8DR was an unshielded, experimental reactor that was operated for a year, despite signs of failing fuel.[1] EPA describes the event at Building 4059 as one of the worst nuclear incidents at SSFL, second or third in comparison only to the SRE event in 1959. This incident is described in detail below.

Building 4059 contained a below-ground test vault, a pipe chase room, vacuum equipment room, cement vault walls (which contained activation products), and a contaminated liquid holdup system. There is no indication that Building 4059 used the recommended aluminum vault lining that was implemented in the construction of Building 4024’s test vaults. The pipe chase room (adjacent to the vault) was sand-filled and contained the vessel shield cooling pipes and a line from the vacuum chamber to the vacuum equipment room. In 1964, a French drain was added around three external sides below the foundations, to collect and remove any

[1] Atomics International, “*Findings of the SNAP 8 Developmental Reactor (S8DR) Post-Test Examination,”* June 30, 1971 by A.H. Lillie and V.L. Rooney, Jr.

infiltrating groundwater.[1] Gas produced from the reactor was pumped to gas holdup tanks and after a delay for the needed decay of radioactive argon and zenon, discharged to the atmosphere through the facility stack. The HSA provides a detailed description of Building 4059's features, equipment, and schematics.

5.5.6.2 Building 4059 S8DR Serious Incident

In August 1964, Bechtel was contracted to provide the AEC with a conceptual report, detailing the types of modifications Building 4059 would need to be capable of handling 10,000+ hour endurance tests of an unshielded, experimental reactor in a simulated space environment. The S8DR would need to endure extreme operating conditions associated with orbital spaceflight, and to provide a 600 kwt power output, 1300˚F NaK coolant outlet temperature, and 12,000 hours of continuous operation with high reliability. Bechtel's report provided specific recommendations that would be required to modify Building 4059, and to improve both the capability and quality of reactor testing, while ensuring worker safety.[2]

Bechtel acknowledged the risks of such a degree of experimentation with an unshielded reactor. The containment of mixed fission products in the event of an accident was a primary concern. Bechtel's answer was to ensure that the facility itself was properly shielded, and recommended the use of a special aluminum alloy to line the walls of the test vault. Bechtel reasoned that the <u>use of special aluminum alloy lining on the walls of the test vault</u> would limit the activation of cement vault walls; ensure containment of mixed fission products in the event of an accidental release; facilitate ease of decontamination between tests; and permit personnel to safely reenter the vault 45 days after a 10,000+ hour test run. Bechtel calculated that a worker's expected exposure under such tightly controlled conditions and flawless operations would be approximately 2.5 mrem/h, 45 days after the reactor was shut down and removed from the test vault.

> *"The facility will be shielded to reduce the total neutron and gamma ray dose rate to a level that will permit occupancy of areas adjacent to those containing radiation sources. Occupancy will be based on shifts of 8 hours per day, 5 days per week. Special materials will be used in the test vault to reduce activation of the test vault walls, thus permitting safe re-entry (2.5 mrem/h) into the test vault 45 days after shutdown and removal of the reactor."*[3]

The EPA HSA research team provided a detailed description of Building 4059's construction materials. There were no references to the presence or use of aluminum alloy lining the walls of the test vault. EPA indicated that the cement vault walls were highly activated with mixed fission products. Review of construction details and documentation related to Building 4059 suggest

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[1] EPA/HGL, *Final HSA 5C* p. 15, citation 1:

> [1] Vitkus, T. J. and Morton, J. R., Radiological Survey of the Building 059 Reactor Vault, Santa Susana Field Laboratory, Rockwell International, Ventura County, California, Final Report, Oak Ridge Institute for Science and Education ORISE 95/G-18, June 1995, pp. 1-2, 8-9.

[2] Bechtel Corporation for the U.S. AEC, "Title 1 Report: Preliminary Services for SNAP 8 Flight Prototype Test Facility, Building 056 [sic], Santa Susana, California," August 1964. File: 4609929.pdf

[3] Ibid. 122119551

that Bechtel's recommended modifications, which included the addition of aluminum vault lining to improve safe reactor operations, where never implemented.

The DOE-ETEC site closure web site[1] describes the use of aluminum vault lining for Building 4024, and a photograph is provided to illustrate the vault walls lined with aluminum alloy. However, no such information is provided for Building 4059 and there is no photograph of the vault. At this point in time, CORE Advocacy has found no references to the documented use of aluminum alloy lining of the Building 4059 reactor vault, to ensure safer operations of the unshielded, experimental S8DR during its 12,000 hour endurance test, the majority of which was conducted with clear indications of fuel failure.

In addition, while the Bechtel modification guide specifies a waiting period of 45-days before employees should enter the vault following a reactor test, incident reports and other documents associated with Building 4059 and S8DR operations indicate that personnel were allowed to enter the test vault immediately following reactor tests. There is no indication that workers were required to wait for a specified time period, before entering the vault.

A 12,000-hour endurance test of the S8DR began in January, 1969. According to Atomics International's "post-mortem" examination of S8DR fuel, soon after the test began there were clear indications of fuel element cladding ruptures.[2] However, despite the indications of problems, the reactor continued to operate and by July, the report indicates that it had become apparent that a number of the fuel elements had ruptured inside the reactor. The coolant temperature was reduced by 100˚F and the test continued. The endurance test was terminated after 7,000 hours in December, 1969.

It is currently unclear what date the S8DR was removed from Building 4059. However, according to a May 4, 1970 Atomics International internal memo,[3] the S8DR had been removed from Building 4059 and set-up to function at the STIR Facility (Building 4028) by April 30, 1970. It was prepared for a "dry run" in preparation for neutron radiography of 211 S8DR fuel elements. The Chairman of the Reactor Committee, R.E. Durand, specified that the "dry run" of the S8DR "would introduce many curies of radioactivity into the facility, with attendant possibilities of direct radiation exposure and fission product release." In addition, the process of radiography posed its own risk, with employees present during the operation. Mr. Durand refused to approve the dry-run of the S8DR because of the clear risks involved, and because the process had not been adequately evaluated for safety.

It is currently unclear what date the S8DR was removed from the STIR Facility (Building 4028) and transported to the Hot Laboratory (Building 4020), where the cause of the fuel element cladding ruptures would be determined. However, once at the Hot Lab, Atomics International determined that 72 fuel elements in the core had cracked cladding tubes typical of stress caused by temperatures in excess of the reactor's design capability. In addition, it was

[1] http://www.etec.energy.gov/Operations/Major_Operations/SNAP.html

[2] Atomics International, "*Findings of the SNAP 8 Developmental Reactor Post-Test Examination,"* by A.H. Lillie and V.L. Rooney, Jr. June, 1971 for the AEC, Contract AT(04-3)-701

[3] Atomics International, Internal Letter, "Neutron Radiography of S8DR Fuel Elements in STIR Facility," R.E. Durand to R.O. Williams, May 4, 1970. File: HDMSP01715643.pdf

determined that the damage had been incurred "relatively early in life," from element-to-element loadings that resulted from bowing and clustering of the fuel elements.[1]

It is unlikely that mixed fission products would have been contained in the S8DR during fuel failure, given the lack of shielding of the reactor, and the lack of aluminum alloy shielding at the facility (which had been recommended by Bechtel). S8DR's operation for 7,000 with failing fuel and inadequate reactor or building shielding should be considered when evaluating environmental data for SSFL workers, and when assuming probable worker exposure as a result of Building 4059 operations.

5.5.6.3 Building 4059 Tritium Contamination

In 1983, during a routine facility inspection, Rockwell discovered groundwater leaking into the south test cell of the reactor vault and becoming contaminated. Radioactivity measurements in the water were less than maximum concentration permissible (MCP) limits in effect at that time. Countermeasures were established to pump out the water and prevent leaching of radioactivity.[2] Rockwell's 1987 inspection found more water on the north test cell floor of the reactor vault floor. Two radionuclides (Eu-152 and Na-22) were found to be above their MCP limits. This discovery prompted Rockwell to begin a decontamination and decommissioning program to remove the remaining radioactivity.[3]

In July 1989, EPA sampling identified tritium in water from the French drain around the west end of the basement of Building 4059. Tritium was found at a level far above what could be described as a background, but orders of magnitude below the maximum contaminant level at the time. It was recommended that further testing be conducted to determine the origin and spread of tritium at the site.[4]

EPA indicated that there were two findings of interest on the samples taken at Building 4059's French drain. First, that Co-60 or other gamma emitters were not detected, and second, that tritium was. According to EPA, tritium was found in a level suggested it came from the facility; **Rocketdyne previously did not test water for tritium activity.** According to EPA, SSFL personnel were apparently unaware of the presence of tritium at Building 4059.

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[1] Atomics International, "*Findings of the SNAP 8 Developmental Reactor Post-Test Examination,"* by A.H. Lillie and V.L. Rooney, Jr. June, 1971 for the AEC, Contract AT(04-3)-701

[2] EPA/HGL, *Final HSA 5C* p. 22, citation 4:

> [4] Liddy, P., *Building 4059 Final Status Survey Report (Phase 1)*, Boeing Report No. RS-00008, September 11, 1999, p. 4.

[3] EPA/HGL, *Final HSA 5C* p. 22, citation 4:

> [4] Liddy, P., *Building 4059 Final Status Survey Report (Phase 1)*, Boeing Report No. RS-00008, September 11, 1999, p. 4.

[4] EPA/HGL, *Final HSA 5C* p. 22, citation 2:

> [2] Dempsey, Gregg, *Report on Environmental Samples Collected at the Rocketdyne Santa Susana Field Laboratory*, Environmental Protection Agency, Office of Radiation Programs, Las Vegas Facility, July 1989, pgs. 5-6.

5.5.6.4 Building 4059 Additional Information

Building 4059 housed the SNAP 8 prototype reactor, S8DR, Large Leak Test Rig and Ground Prototype Test Facility. By January 1969, the unshielded SNAP 8 prototype reactor was operating at 600 kW in the north cell. It continued operating until December 1969 at 600 kW with a short period at 1MW. In 1970, the reactor and associated equipment were removed and the facility became inactive. In 1973, the Liquid Metal Engineering Center (LMEC) occupied the building, removed the shielding and remote handling equipment, and erected the Large Leak Test Rig (LLTR) in the test vault and high bay areas.[1] In 2004, the building shell and concrete cells and foundations were removed after which the large excavation area was backfilled with soils that had been removed from the excavation.

Building 4059 was inactive between 1970 and 1973. In 1973, Rockwell dismantled and removed all control consoles and reactor instrumentation, and all contaminated items were removed from the test vault. What remained in place were extensive below-grade, radiologically activated structures, including steel containment vessels and vacuum lines, concrete biological shielding, and sand fill.[2]

In 1978, Rockwell removed the radioactive liquid and gas holdup tanks. The reactor core and Sodium-Potassium (NaK) systems were removed.[3] Residual contamination remained in place. Rockwell conducted a survey for the building, soil, and water. **The reactor vault was excluded from the survey.** Beta gamma contamination was measured above the 1978 acceptable limit of 1,000 dpm/100 cm^2. Decontamination was conducted.[4]

The HSA provides a detailed chronology of radiological investigations and decontamination/ cleanup of release(s) associated with Building 4059. The preliminary MARSSIM Classification for Building 4059 is Class 1 due to its use as a reactor building.

5.5.6.5 Building 4059 Radiological Incident Reports

There has been one major incident associated with Building 4059, and several incidents that could have resulted in a release to the environment and worker exposure. The following table

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[1] EPA/HGL, *Final HSA 5C* p. 15, citation 4:

[4] SNAP 8 Ground Prototype Test Facility – Building 059, fragment, circa 1980, p.1.

[2] EPA/HGL, *Final HSA 5C* p. 21, citation 6:

[6] Graves, A. W., *Decontamination and Disposition Facilities Program Plan,* Atomics International Report No. PP- 704-990-002, January 23, 1975, p. 11.

[3] EPA/HGL, *Final HSA 5C* p. 21, citation 7:

[7] Sturtevant, W.C. et al., Building 059 Remediation Program, Phase II Reactor Test Cell Remediation, EID-04422, June 25, 1999, pp. 24-25.

[4] EPA/HGL, *Final HSA 5C* p. 22, citation 1:

[1] Rockwell International, Radiological Survey Results – Interim Status, Building 059, Santa Susana Field Laboratory, N704TI990043, November 28, 1978.

provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

5.5.6.6 Building 4059 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
None	10/29/1969	S8DR Reactor	H_2	Fuel elements leaking hydrogen and mixed fission products during operation.
A0633 Incident Report Missing	02/12/1970	T059 Test Vault		Absolute filter on vacuum cleaner ruptured contaminating area
A0576	02/29/2970	Pipe Chase B59		Cutting a NaK line in Pipe Chase Room caused NaK fire.
None	11/04/1981	Building 59		Fire broke out, burning arms and hand of one worker.
A0183	01/27/1988	Vacuum Duct Room	Co-60	Photographer sent into controlled area without proper training or protection.
A0187	08/12/1988	Pipe Chase Room	Co-60, Eu-152, Eu-154	Torch cutting in pipe chase resulted in contamination of operators.
A0189	08/19/1988	Pipe Chase Room	Co/Eu	Breathing airline became disconnected in airborne area.
A0194	01/31/1989	Pipe Chase Room	Co/Eu	Employee entered radiation area without film badge on chest, with dosimeter.
A0197	04/06/1989	Filter Bank	Co-60	Improper procedure on filter change caused high airborne contamination.
A0204	04/12/1990	Test Vault Area		Employee entered controlled area w/o prescribed monitoring/protective equipment.
A0206	05/08/1990	Vacuum Equipment Room	Co-60	Exit survey revealed contamination on pant leg.
A0212	01/17/1991	Electrical Room	K/Co	clean area floor sweeping found to contain radioactive material
A0214	02/25/1991	Test Cell	Co-60	Torching operation generated high airborne activity in adjoining high bay.
A0216	09/20/1991	Test Cell		Employee entered controlled area without a film badge.
A0219	09/02/1992	Test Cell		Torching slag violated protecting clothing contaminating shoe
A0307	12/03/1992	Test Cell 1		Employee’s dosimeter went off-scale during D&D operations

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0579	07/29/1993	Test Cell 1		Exit survey indicated contamination on Tee-Shirt
A0692	12/22/1998	T059 HiBay		Contamination of Fork Truck / Gloves was due to naturally occurring radon daughters.
A0691	01/05/1999	SSFL		Naturally occurring radon daughters plated on hard hat and gloves.

*Isotopes are written as they are presented in the Incident Database. The HSA research team believes that "MFP" is an acronym for "mixed fission products."

- **MAJOR INCIDENT:** In 1969 Atomics International found fuel elements leaking hydrogen and fission products. A group of experts was gathered to analyze the leak and find its cause. At the time, the zirconium hydride reactor was being considered for numerous space missions.[1] This was the second or third most serious accident at SSFL. The reactor operated for a year with failing fuel. Detailed description above.

- On February 13, 1970 an absolute filter on a vacuum cleaner ruptured contaminating the Building 4059 test vault. The incident report has not been located (A0633).[2]

- On February 19, 1970 a sodium/potassium (NaK) fire broke out in the Pipe Chase Room while an employee was cutting a pipe during demolition activities. Approximately one teacup of NaK spilled into a drip pan on the floor and began to smolder. The fire was extinguished by shoveling calcium carbonate onto the pan. When a dense cloud of white smoke filled the vault, personnel evacuated, bolting the access door in place. A subsequent inspection of the exhaust duct filter revealed no increase in airborne radioactivity (A0576).[3]

- On November 4, 1981 a fire broke out at Building 4059. The cause and region of the fire are unclear from the report. A worker received burns to his right hand and arms and is taken to the "nurse." The local fire service extinguished the blaze using three hoses.[4]

- On January 27, 1988 a photographer was sent to the Vacuum Duct Room without proper safety precautions. He entered a "High Radiation Area" without protective clothing, a film badge, or a pocket dosimeter. Upon exiting the room, one pant leg was found to be contaminated. Radiation levels in the area were in excess of 100 mR/h). Loose contamination

[1] EPA/HGL, *Final HSA 5C* p. 18, citation 1:

[1] U.S. Atomic Energy Commission, Letter from M. Klein, AEC, to J. J. Flaherty, Atomics International, dated October 29, 1969.

[2] EPA/HGL, *Final HSA 5C* p. 18, citation 2:

[2] The Boeing Company Radiation Incident Database, 2010.

[3] EPA/HGL, *Final HSA 5C* p. 18, citation 3:

[3] Bresson, J. F., Rockwell Internal Letter to W. F. Heine, re: *Fire in Building T059 Vault*, February 26, 1970.

[4] EPA/HGL, *Final HSA 5C* p. 18, citation 4:

[4] Incident Report, dated November 4, 1981 (BNA05615738-744).

consisted primarily of Co-60 in sand. The contamination was removed successfuly at the RMHF (A0183).[1]

- On August 12, 1988 two employees were contaminated as a result of cutting in the Pipe Chase Room during demolition activities. Contamination was measured at 17,500 dpm of beta-gamma contamination per 100 square centimeters (17,000 dpm / cm^2). These employees were subsequently decontaminated (A0187).[2]

- On August 19, 1988 an employee working in the Pipe Chase Room in an air-line respirator felt his filter cartridge pod disconnect from his face mask. He picked it up and had his co-worker try to reconnect it. His coworker thought the coupling was broken so they evacuated the room within two minutes. Nasal and facial smears and the inside of the face mask indicated no detectable activity. Analysis of the work area air sample indicated 1.5 x 10-11 µCi/mL, below the maximum permissible concentration of 9 x 10^{9} µCi/mL. A warning letter was issued alerting respirator users to the risk of uncoupling (A0189).[3]

- On January 31, 1989 a radiation worker entered a radiation area for work without a personally issued film badge although he wore the required pocket dosimeter, two TLD LiF chips finger rings (one on each hand), a visitor film badge on his foot, and a TLD-CAF. A review of the pocket dosimeter and the TLD indicated an accumulated exposure of 74 mrem. Greater caution to observe safe work practices was recommended (A0194).[4]

- On April 6, 1989 an employee dropped an open box of used filters (approximately 10 feet) while changing the exhaust system filters during torching operations on the upper level of Building 4059. A cloud of dust arose from the filters when they landed on the floor and a "lot of dust" settled on the floor. Higher counts were recorded by the radiation detector. The employee's hands (4,350 dpm) and shoes (5,800 dpm) were subsequently decontaminated. no other activity was detected on his body or clothing. The filters were to be disposed of as radioactive waste and the area was to be vacuumed (A0197).[5]

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[1] EPA/HGL, *Final HSA 5C* p. 19, citation 1:

> [1] Tuttle, R. J., Rockwell Internal Letter to J. A. Chapman, re: *Radiological Safety Incident Report, T059 Vacuum Duct Room*, January 27, 1988.

[2] EPA/HGL, *Final HSA 5C* p. 19, citation 2:

> [2] Wallace, J. H., Rockwell Internal Letter to Radiation and Nuclear Safety Group, re: *Radiological Safety Incident Report, T059 Pipe Chase Room*, August 12, 1988.

[3] EPA/HGL, *Final HSA 5C* p. 19, citation 3:

> [3] Wallace, J. H., Rockwell Internal Letter to Radiation and Nuclear Safety Group, re: *Radiological Safety Incident Report, T059*, August 19, 1988.

[4] EPA/HGL, *Final HSA 5C* p. 19, citation 4:

> [4] Saba, V. B., Rockwell Internal Letter to Radiation and Nuclear Safety Group, re: *Radiological Safety Incident Report, SSFL Building 059, Reactor Vault*, January 31, 1989.

[5] EPA/HGL, *Final HSA 5C* p. 19, citation 5:

> [5] Begley, F. E, Rockwell Internal Letter to Radiation and Nuclear Safety Group, re: *Radiological Safety Incident Report, Lower Level of T059*, April 6, 1989. Ref. 122119552

- On April 12, 1990 an employee entered the test vault area on the lower level of Building 4059 without approval, without plastic shoe covers, and without a personally issued film badge or pocket dosimeter. When discovered and reprimanded, the employee left the area approximately three minutes after entering the vault (A0204).[1]

- On May 8, 1990 at the end of his shift, an employee surveyed himself and found a hot spot on his pant leg. Fixed contamination was localized to the 1-inch by 1-inch area on the pant leg reading 300 cpm. The employee had been decontaminating the vacuum equipment room shield blocks wearing a red-line lab coat. After several unsuccessful decontamination attempts, the pants were disposed of as radioactive waste. It was recommended that future work with shield blocks would require red-line coveralls (A0206).[2]

- On January 17, 1991 floor sweepings in the electrical room were found to contain Co-60 (0.85 pCi/g). The sweepings were disposed of as radioactive waste (A0212).[3]

- On February 25, 1991 open-tent torching operations generated high airborne Co-60 radioactivity in the adjoining high bay during demolition activities. Nasal smears revealed that three of seven workers had collected detectable activity. All seven employees submitted 1-day and 5-day samples for bioassay. Operations ceased until the Co-60 radioactivity in the air dropped to a safe level (A0214).[4]

- On September 20, 1991 an employee noticed that his film badge was missing while working on a plastic containment shroud above the test cell tent in the reactor vault. He left the area and notified the facility health physicist. A search for the film badge was conducted, but the film badge was not found. A new film badge was issued to the employee (A0216).[5]

- On September 2, 1991 an employee performing torching operations had hot slag penetrate two pairs of plastic booties and lodge in the bottom of his shoe. The shoe was decontaminated by napping the leather and using duct tape to remove the slag. After

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[1] EPA/HGL, *Final HSA 5C* p. 20, citation 1:

> [1] Saba, V. B., Rockwell Internal Letter to Radiation and Nuclear Safety Group, re: *Radiological Safety Report, SSFL Building 059*, April 12, 1990.

[2] EPA/HGL, *Final HSA 5C* p. 20, citation 2:

> [2] Wallace, J., Rockwell Internal Letter to Radiation and Nuclear Safety Energy Systems Group, re: *Radiological Safety Incident Report, T059 Vacuum Equipment*, May 8, 1990

[3] EPA/HGL, *Final HSA 5C* p. 20, citation 3:

> [3] McGinnis, E. R., Rockwell Internal Letter to Radiation Protection and Health Physics Services, re: *Radiological Safety Report, T059 Electrical Room*, January 17, 1991.

[4] EPA/HGL, *Final HSA 5C* p. 20, citation 4:

> [4] McGinnis, E. R., Rockwell Internal Letter to Radiation Protection and Health Physics Services, re: *Radiological Safety Report, T059 Restricted Area*, February 25, 1991.

[5] EPA/HGL, *Final HSA 5C* p. 20, citation 5:

> [5] McGinnis, E. R., Rockwell Internal Letter to Radiation Protection and Health Physics Service, re: *Radiological Safety Report, T059 Vault*, September 20, 1991.

decontamination no beta-gamma activity was detected on the shoe (A0219).[1]

- On December 3, 1992 an employee's dosimeter showed an off-scale reading after exiting Test Cell 1 during decontamination and decommissioning activities. The employee's film badge was sent to the vendor to be read, and his dosimeter was sent to the instrument laboratory for an "as found" test. The film badge was processed the next day and read 170 mR for the quarter, within acceptable limits. Rockwell concluded that the increased dose rate could have been due to exposure of activated steel behind the portion of wall being removed (A0307).[2]

- On July 29, 1993 an employee upon exiting a pit was found to have 150 cpm beta gamma contamination on the rear shoulder of his personal tee shirt. He removed the tee shirt and no contamination was detected on his skin. The employee was wearing the tee shirt because of a previous contamination event in Building 4020 (Hot Laboratory) (A0579).[3]

- On December 22, 1998 a fork lift truck was surveyed for radioactive contamination in the Building 4059 high bay. Naturally occurring radon daughters were found to have been plated on a hard hat and gloves. Rockwell concluded that this was a natural phenomenon (A0692).[4]

- On January 5, 1999 an employee was found to have a hard hat and leather gloves contaminated with an alpha emitter. Based on isotopic analysis, the material was determined to be naturally occurring radon daughters. Rockwell concluded that this was a natural phenomenon (A0691).[5]

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[1] EPA/HGL, *Final HSA 5C* p. 20, citation 6:

> [6] McGinnis, E. R., Rockwell Internal Letter to P. D. Rutherford, re: *Radiological Safety Report, T059 Test Cell 1*, September 2, 1992.

[2] EPA/HGL, *Final HSA 5C* p. 21, citation 1:

> [1] McGinnis, E. R., Rockwell Internal Letter to P. D. Rutherford, re: *Radiological Safety Report, T059 Test Cell 1*, December 3, 1992.

[3] EPA/HGL, *Final HSA 5C* p. 21, citation 2:

> [2] Wallace, J. H., Rockwell Internal Letter to P. D. Rutherford, re: *Radiological Safety report, T059 RPT Pit*, July 29, 1993.

[4] EPA/HGL, *Final HSA 5C* p. 21, citation 3:

> [3] Redacted, Rockwell Incident Report, re: *Contaminated Fork Truck/Gloves*, December 22, 1998.

[5] EPA/HGL, *Final HSA 5C* p. 21, citation 4:

> [4] Redacted, Rockwell Incident Report, re: *Contaminated Hard Hat and Gloves*, January 5, 1999.

6.0 CRITICAL TEST FACILITIES

Several program used critical test facilities (i.e. low-power reactors) in Area IV. Use of these low-power reactors began in 1954 and continued until 1974. Some of the Critical Test Facilities at SSFL were used for the production of electricity, and others were used to develop energy resources for the United States Space Program under DOE-NASA contracts (like the SNAP).

6.1 SNAP DEVELOPMENT TEST FACILITIES

Test facilities in Area IV for the SNAP Program included Buildings 4373, 4012, 4019 and 4024.

CORE Advocacy identified several locations associated with SNAP operations and support that should have been included in the 2006 Site Description, but were not. Some were non-radiological facilities that are documented as having engaged in radiological processes. They are described in detail, in Section 6.2.

Section 6.1.1

Building Number: **4373**
Building Alias: **373 / T373**

Building Name: **SNAP Critical Facility**

Building Function: **Built to store and test highly explosive solid rocket fuel**
First SNAP Critical Facility

Notes: **DOE-NASA Program**
Tritium

Prior to 1957, this location was used for rocketry purposes and operated by Rocketdyne, verifying (again) worker rotation and cross-facility operations.

Radionuclides of Concern: Uranium, plutonium, and their decay and daughter products: U-235, U-238, and Th-232 decay chains include Th-234, Th-228, Ac-228, Ra-226, Pb-214, Bi-214, Pb-212, Bi212, and Tl-208. In addition, **H-3**, Sr-90, Cs-137, Na-24, Co-57, Co-60, Eu-152, and Am-243 would have been formed. Also gadolinium (Gd-64) and samarium (Sm-153).

6.1.1.1 Description of Operations & Processes

The 2006 Site Description provides confusing and inaccurate information about Building 4373, indicating that it ceased operations in 1963 and was "replaced by Building 4012." However, numerous criticality tests are documented at Building 4373 after 1965; it was referred to as a "Critical Cell and Development Test Building" on industrial maps as late as 1975; as of 1987 it was reported to be unoccupied and abandoned.[1] As of 1989, it still had not been cleared of old equipment, and was determined to be a "mess."[2] In 1995, Rockwell International devised a procedure to demolish the rubidium loop that remained in the building, which had been installed in the 1960's. In addition, during the pre-demolition survey, three radioactive pre-filters from the ventilation system were found on the roof of Building 4373, thought to have been in continuous use from 1957 to 1962; they were not replaced or removed since building operations ceased and had apparently remained on the roof in excess of 30 years. Radioactivity of each pre-filter indicated11,250 dpm/100 cm^2 of beta activity. Gamma spectroscopy determined that the activity was predominantly Cs-137. As a result, the incident report summarized that the high levels of Cs-137 were the result of building operations, as well as from atmospheric weapons testing (Incident Report A0664).[3]

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[1] EPA/HGL, *Final HSA 5D* p. 109, citations 6&7:

[6] Schrag, F.C., Internal Letter Re: Building 373, SSFL, June 19, 1987.

[7] Schrag, F.C., Job Improvement Request, May 22, 1987.

[2] EPA/HGL, *Final HSA 5D* p. 109, citation 9:

[9] Robinson, K.S., Rockwell International Internal Letter Re: Alkali Metal Waste in Area IV, January 22, 1989.

[3] EPA/HGL, *Final HSA 5D* p. 111, citation 1:

[1] Harcombe, Richard, Internal Letter Re: Radiological Incident Report A0664, August 25, 1995.

According to the HSA, Building 4373 was constructed in 1956. It was originally intended for use as a testing and handling facility for high explosive solid rocket fuels. Use of this location for rocketry-related purposes further supports the lack of separation between DOE nuclear operations and NASA rocketry endeavors, at SSFL and illustrates that North American Aviation Rocketdyne employees likely associated with the Space and Information operations in Areas I, II and III also had access to certain Area IV facilities associated with rocketry research, and space nuclear propulsion. This information supports the inclusion of Area I-III workers to EEOICPA.

A 1957 and 1958 progress report indicated that the building was first modified to provide field test facilities for the performance of the "ANN" program.[1] One test call was modified for critical assembly research supporting SNAP in 1957. Test areas were separated from the administrative and general operating areas by a concrete shield wall. Part of the building was used for miscellaneous non-nuclear tests that appear to have changed throughout the operation of the building.[2]

The test cells were originally designed as explosion blow-out rooms and were provided with 12-inch thick concrete inside walls. An additional 2 feet of magnetite concrete was added to the reactor test cell wall adjacent to the administrative area, and 2 feet of ordinary concrete on the wall separating the reactor test cell and adjacent test cell. The roof consisted of metal joists and cemesto panels with built-up roofing material; it did not include any shielding. According to a February 1962 summary hazards report and operations manual for the SNAP 8 critical experiments to be conducted in the building, the location of the critical machine within the test cell had been changed at some time not documented in the report. According to the report, the structures of the previous "critical machines" had been removed from the cell. The document does not provide information to indicate how the previous critical machines had been disposed. A figure of the layout of the test cell shows the critical machine to be located at the center of the test cell.[3]

Based on information included in the 1988 survey report, Building 4373 was reportedly designed to contain radioactivity in the form of fissile material and activation foils; accordingly, no liquid radioactive waste was produced and no liquid radioactive waste holdup tanks were included at building 4373.[4]

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[1] EPA/HGL, *Final HSA 5D* p. 103, citation 3:

> [3] Atomics International, Facilities and Data Department, Progress Report Fiscal Year 195 and Forecast Fiscal Year 1958, January 1958.

[2] EPA/HGL, *Final HSA 5D* p. 103, citation 6:

> [6] Ashley, R.L., Atomics International Document No. NAA-SR-7300, Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities, May 25, 1962.

[3] EPA/HGL, *Final HSA 5D* p. 104, citation 1:

> [1] Thiele, A.W., Atomics International Document NAA-SR-MEMO-7029, SNAP 8 Critical Experiment Summary Hazards Report and Operations Manual, February 1, 1962.

[4] EPA/HGL, *Final HSA 5D* p. 104, citations 2 & 3:

> [2] ETEC Document, GEN-ZR-0012, Radiological Survey of Buildings T373 and T375, August 8, 1988.
>
> [3] Author Unknown, Facility Information Bldg 373, Date Unknown.

The administrative and general operating area, located on the opposite side of the shield wall from the test area, included a 9'x11' change room that led to the fuel storage room and main test cell, a 20'x20' L-shaped control room, a laboratory area, instrument shop, equipment room, and office area. The building was surrounded by a chain-link security fence and included a secondary fence that prevented the use of the areas west and south of the main test cell. According to the report, the walls at this location "may not provide adequate shielding in the event of an excursion."[1]

According to the January 1962 summary hazards report and operations manual, the fuel elements used in the building were stored in the fuel storage room in the shipping bird cages provided by "Fuel Fabrications." While only one bird cage was permitted in the test cell during fuel loading operations, no cages were reportedly permitted in the test cell curing critical experiments.

A Log Book of operations at Building 4012 describes several incidents over many months, involving contaminated birdcages containing broken pieces of SNAP 8 fuel and highly irradiated metal shavings, which were apparently circulated around the SNAP complex repeatedly. Several incident reports throughout the SNAP Complex detail the receipt of "contaminated birdcages" in various stages of severe contamination.[2]

Between 1957 and May 1962, several tests on SNAP critical assemblies were completed, as indicated in the summary below.[3]

- SCA-1. Initiated October 1957. This assembly consisted of a pseudo sphere of zirconium hydride-enriched uranium dioxide blocks. Basic reactor parameters of the SNAP 2 reactor concept were determined.

- S2ER Critical Experiment. Initiated June 1959. The S2ER components were assembled and preliminary tests conducted at zero power.

- SCA-2. Initiated about September 1960. A clean, cylindrical geometry core was studied, using the core and reflector components from the conduction-cooled SNAP10 reactor.

- SCA-3. Initiated October 1961. An assembly of about a 1-cubic foot core volume was built to study the characteristics of the SNAP4 reactor. Plate-type fuel elements and a water coolant were used.

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[1] EPA/HGL, *Final HSA 5D* p. 104, citation 4:

> [4] Ashley, R.L., Atomics International Document No. NAA-SR-7300, Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities, May 25, 1962.

[2] Atomics International Health Physics Log Book, Building 4012, 10/12/62-7/27/66 File: HDMSP001852993.pdf

[3] EPA/HGL, *Final HSA 5D* p. 105, citation 5:

> [5] Ashley, R.L., Atomics International Document No. NAA-SR-7300, Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities, May 25, 1962.

Future experiments that were planned, but have not yet been confirmed, included the following:[1]

- SCA-4C. This assembly was to use prototype SNAP2/10A core and reflector components, as a final design check on the flight reactor system. The test was tentatively scheduled to begin in mid-1962.

- S8ER Critical Experiment. The S8ER components were to be used to determine the nuclear parameters of the SNAP 8 reactor design. The test was tentatively scheduled to begin in mid- 1962.

- SCA-4A. This assembly was to provide a flexible reflector assembly to permit optimum design of the reflector controls for the SNAP2/10A reactor. This test was tentatively scheduled to begin late in 1962.

The evaluation report indicated that following these tests, the facility was to be deactivated and that the critical experiment program would be continued in Building 4012. Prior to being deactivated, a meeting held in March 1960 discussed the expanded use of Building 4373. According to a letter summarizing the meeting, it was recommended that the “water test room” adjacent to the critical assembly in Building 4373 be used for intermittent liquid metal tests. The letter stated that the measured dose in the room is 1 mrem/hr during operation of the critical assembly. The letter did not indicate the nature of the liquid metals tests to be conducted.[2]

According to some documents, SNAP critical tests in Building 4373 ceased in 1962 or 1963. However, an undated facility information sheet for Building 4373 indicated that a log book of the facility operations was kept and maintained in the control room. Documents received to date have included the Building 4373 log book, dated January 11, 1962 through May 28, 1965, that appear to indicate operations continued after 1963. A summary of select entries of the log book is presented below. However, the log book indicates routine surveys of beryllium and birdcages containing 93% enriched uranium.[3]

An April 8, 1963 internal letter provided a summary of a March 20, 1963 meeting that provided a review of Building 4373 operations. According to the letter, Building 4373 was being used to test the SCA-4C in early 1963. The meeting summary indicated that the experimental program in Building 4373 was extensive despite previous correspondence indicating that Building 4373 was not recommended for a long-range program of critical experiments, due to “certain undesirable aspects of the ventilation system and the building design.” However, it was reported the maximum credible accident for the facility assumed no containment and that changes to the ventilation system would require extensive modification to the building structure. It was recommended that Buildings 4012 and 4024 be used as much as possible for critical tests at the SSFL. The letter also indicated that the meeting recommended that “serious consideration

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[1] EPA/HGL, *Final HSA 5D* p. 105, citation 5:

> [5] Ashley, R.L., Atomics International Document No. NAA-SR-7300, Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities, May 25, 1962.

[2] EPA/HGL, *Final HSA 5D* p. 106, citation 1:

> [1] Jarrett, A.A., Letter Re: Expanded Use of Building 373, March 30, 1960.

[3] EPA/HGL, *Final HSA 5D* p. 106, citation 3:

> [3] Log Book, Building 373, January 11, 1962 to May 28, 1965.

should be given to using a weak source during fuel loading, in order to provide possible additional safety to personnel." The meeting minutes indicated that no source was used during fuel loading in Building 4373 prior to this time.[1] The HSA research team reviewed the entire collection of available documents provided by Boeing, DOE and other sources and could not find information to indicate if a radioactive source was used in Building 4373 after March 1963. According to the log book for Building 4373, the SCA-4C was being dismantled in May 1963 for storage at Building 4005.[2]

In addition, Atomics International held a semiannual review of Building 4373 on September 16, 1964. According to the minutes of that meeting, Building 4373 continued to conduct experiments under the SNAP Critical Assembly Program. From March to September 1964, testing was completed in support of the SNAP-10B program. The meeting summary indicated the testing involved "the investigation of the worths of reflector under different arrangements, core critical loading measurements and materials reactivity effect studies." The experiments were classified in more detail, as follows:[3]

> *"Some experiments were studies involving materials such as samarium, gadolinium, and various fuel element cladding materials. In these experiments, the reactivity effects of the materials placed in the core were measured. Other experiments included studies of different types of control elements, and included the sliding drum, the tapered drum, and split drum type."*

The meeting minutes also indicated that Building 4373 would be used in the next six months in support of the SNAP-10B and SNAP 8 reactor concepts, and experiments would be conducted to obtain data on neutron lifetime, the worth of individual control drums and other reactor constants. The minutes indicated that an addendum to the Summary Hazards Report would be required for experiments related to the SNAP-8 program, and the building would require modification. Documents were not located to indicate whether the building modifications required to accommodate the SNAP-8 program were made to Building 4373 following this meeting.[4]

The meeting summary indicated that no unusual incidents occurred during the "past survey period." It was reported, however, that a "slight case of U-235 foil contamination did occur."

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[1] EPA/HGL, *Final HSA 5D* p. 106, citation 4:

> [4] Remley, M.E., Internal Letter Re: Review of Bldgs 012 and 373 (NDFL) Recommendations and Minutes of Meeting of March 20, 1963, April 8, 1963.

[2] EPA/HGL, *Final HSA 5D* p. 106, citation 5:

> [5] Log Book, Building 373, January 11, 1962 to May 28, 1965.

[3] EPA/HGL, *Final HSA 5D* p. 106, citation 6:

> [6] Remley, M.E., Internal Letter Re: Semiannual Review of Building 373 – Recommendations and Minutes of Meeting of September 16, 1964, September 24, 1964.

[4] EPA/HGL, *Final HSA 5D* p. 107, citation 1:

> [1] Remley, M.E., Internal Letter Re: Semiannual Review of Building 373 – Recommendations and Minutes of Meeting of September 16, 1964, September 24, 1964.

According to the minutes, "contamination levels were of minor concern and were easily cleaned up."[1]

According to a June 24, 1965 internal letter regarding a March 29, 1965 meeting and a review of Buildings 4012 and 4373 for the use of poison-loaded Mylar films in critical experiments, Building 4373 had been approved for Mylar film experiments in SCA-41 and SCA-4B. The letter indicated the purpose of the experiments was to use Mylar films to introduce neutron absorbing material in experimental studies of proposed SNAP 2 and SNAP 10 reactor cores. The objective was to develop a reactor core that would be subcritical when immersed in water, but would have the desired excess reactivity when filled with NaK and surrounded by the reflector and control drum assembly. The experiments were designed to have the fuel elements and core vessel have layers of gadolinium of several thicknesses. The gadolinium was to be attached with Mylar film. The experiments in Building 4373 were to be with dry cores.[2]

On June 8, 1965 Atomics International submitted comments on a draft reactor safety survey report dated April 22, 1965. The report was titled, "SNAP Critical Assembly-4A, Building 373." Atomics International provided the following additional information regarding the Mylar experiments being conducted in Building 4373:

> *"At the time of the survey an experiment was in progress to provide information that might result in the design of SNAP reactors that would be subcritical when accidentally immersed in water. This reduction in the reactivity of the water flooded and reflected systems as compared to the beryllium reflected system would be achieved through the use of an absorber with a strong low energy resonance, such as gadolinium, which would produce a shift in the effective energy of the neutrons causing fission. In this experiment the poison was in the form of gadolinium oxide applied to a Mylar film, which was applied to either the fuel elements or to the core vessel as required by the experiments program."*

The letter also stated that Atomics International was in the process of developing and implementing a procedure for the in-place testing of "absolute" filters, including those in Building 4373, which was to be done in the near future.[3] Available documents reviewed by the research team do not provide the results of those tests.

According to the log book, it also appears that Building 4373 served as a monitoring and tagging station for "birdcages" containing various fuels. According to a number of log book entries, birdcages were monitored and tagged at Building 4373 and were then shipped to Building 4064. A log book entry dated July 11, 1963 indicated that personnel "tagged and shipped 8 birdcages

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[1] EPA/HGL, *Final HSA 5D* p. 107, citation 2:

> [1] Remley, M.E., Internal Letter Re: Semiannual Review of Building 373 – Recommendations and Minutes of Meeting of September 16, 1964, September 24, 1964.

[2] EPA/HGL, *Final HSA 5D* p. 107, citation 3:

> [3] Remley, M.E., Internal Letter Re: Review of Buildings 012 and 373 and the Use of Poison Loaded Mylar Films in the SCA-4A and -4B Experiments, Minutes of Meeting of March 29, 1965, June 24, 1965.

[3] EPA/HGL, *Final HSA 5D* p. 108, citation 1:

> [1] Remley, M.E., Letter Re: Comments on Draft Report of Reactor Safety Survey Report, SNAP Critical Assembly- 4A, Building 373, June 8, 1965. (Export Controlled Document)

containing SNAP 10FS-1 backup fuel" to Building 4064. The same day, it was reported that the SCA-4 fuel would be returned to Building 4373. On July 17, 1963, personnel monitored and tagged 8 birdcages containing SCA-4 fuel to be shipped to Building 4064, and personnel received 4 birdcages containing S10FS-1 fuel. The entry that day indicated that, "a total of 44 S10FS-1 fuel is now in" Building 4373. There are a number of additional references to the tagging and monitoring of birdcages at Building 4373; however, additional information regarding the nature and extent of these operations could not be located.[1]

At the conclusion of the SNAP critical tests, the facility was modified to include a non-nuclear liquid metal NaK test loop to support the SNAP Experimental Reactor. At this time, industrial planning maps refer to the building as a "critical cell and development test building," and it is referred to as such until 1975, when industrial maps refer to Building 4373 as a "test building." According to the undated facility information sheet for Building 4373, NaK experiments were conducted in the North Laboratory Room 102 and in the North Test Room 113. The small test loop was used to pre-test a NaK/NaK heat exchanger, EM pumps, electrical heaters, valves, piping and instrumentation. Other non-nuclear test loop programs carried out in the Building 4373 were RuK test loops, boiling mercury test loops and boiling potassium loops. The facility has since been used intermittently for storage of non-radiological materials.[2]

According to a 1988 survey report, Building 4373 had no significant radioactivity releases during its operation. Building 4373 was reassigned for non-nuclear use following a radiological survey of the building to ensure the area was "clean." Documents available to date did not include the referenced radiological survey. The report stated that "most" radioactive materials handled in Building 4373 were totally encapsulated or "in a condition which would not release radioactivity to the environment." Radioactive materials handled at the building included fully encapsulated highly enriched uranium. Activation foils were used for flux mapping in Building 4373.[3]

A July 1966 review of Building 4373 indicated it had been shut down "for some time." The review stated that the SCA-4A "machine" remained in Building 4373 and was being considered for transfer to Building 4012 for further operations. Based on a 1969 safety analysis report, the

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[1] EPA/HGL, *Final HSA 5D* p. 108, citation 2:

[2] Log Book, Building 373, January 11, 1962 to May 28, 1965.

[2] EPA/HGL, *Final HSA 5D* p. 108, citations 3-8:

[3] ETEC, Document No. GEN-ZR-0012, Radiological Survey of Buildings T373 and T375, August 8, 1988.

[4] Rockwell International, A4CM-AN-003, *Area IV Characterization Survey Plan*, March 30, 1994.

[5] Rockwell International, Document No. N001ER000017, *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, December 20, 1989.

[6] Author Unknown, *Facility Information Bldg 373*, Date Unknown.

[7] Atomics International, Santa Susana Map , July 14, 1964.

[8] Atomics International, Nuclear Development Field Laboratories, Santa Susana, March 1975.

[3] EPA/HGL, *Final HSA 5D* p. 108, citation 9:

[9] ETEC, Document No. GEN-ZR-0012, Radiological Survey of Buildings T373 and T375, August 8, 1988.

machine remained in Building 4373 in 1969. Atomics International received permission from the AEC to operate the SCA-4A in Building 4012 on February 12, 1970.[1]

In addition, the July 1966 annual review indicated that following the removal of fuel from the facility, a terminal radioactivity and beryllium survey was performed by Health and Safety. The results of the survey were not presented in the annual review report.[2] However, a 1984 letter regarding environmental assessments indicated that Building 4373 was contaminated with radioactive materials and that decontamination of the facility had been performed. In 1987, the building was reported to be unoccupied, abandoned, and inactive. It was reported that it had not been used in over 20 years. It was requested that the building be cleaned out, the trash disposed of, and a post added to designate the building as "inactive."

In 1988, Building 4373 was reported as being dilapidated inside, with many interior walls removed. Conduit and miscellaneous debris was scattered about and hanging from the ceiling. The 1988 survey report described the building as a "mess."[3] In 1989, a search for alkali wastes was conducted by Rockwell International in Area IV. Sodium, potassium, or lithium were identified as being located in an old loop within Building 4373, indicating that the building had not been cleared of old equipment.[4] As of 1994, the building remained abandoned; however it is unclear whether its condition had been improved or changed since the 1988 survey report.[5]

In 1995, Rockwell International developed a procedure to demolish the rubidium loop still located in Building 4373. According to the procedure report, the original loop was built in the early 1960's to investigate the heat transfer and fluid flow characteristics of boiling rubidium at temperatures of 1,400 to 1800˚ F.

6.1.1.2 Building 4373 Radiological Incident Reports

There were no incident reports during the operational period of Building 4373, contained in the Incident Report Database. However, documents obtained by EPA from Boeing indicate that on September 23, 1963 an incident occurred involving a high airborne activity reading on the air monitor. During this incident, alpha activity was observed to rise from 50 to 200 cpm, and beta activity rose from 1,000 to 10,000 cpm.

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[1] EPA/HGL, *Final HSA 5D* p. 109, citation 4:

> [4] Remley, M.E., Atomics International Letter Re: Annual Review of Buildings 012 and 373 – Minutes of Meeting of May 3, 1966, July 7, 1966.

[2] EPA/HGL, *Final HSA 5D* p. 109, citation 4:

> [4] Remley, M.E., Atomics International Letter Re: Annual Review of Buildings 012 and 373 – Minutes of Meeting of May 3, 1966, July 7, 1966.

[3] EPA/HGL, *Final HSA 5D* p. 109, citation 8:

> [8] ETEC, Document No. GEN-ZR-0012, Radiological Survey of Buildings T373 and T375, August 8, 1988.

[4] EPA/HGL, *Final HSA 5D* p. 109, citation 9:

> [9] Robinson, K.S., Rockwell International Internal Letter Re: Alkali Metal Waste in Area IV, January 22, 1989.

[5] EPA/HGL, *Final HSA 5D* p. 109, citation 10:

> [10] Rockwell International, A4CM-AN-003, *Area IV Characterization Survey Plan*, March 30, 1994.

According to a February 1964 recounting of this incident, the cause of the temporary high reading was unknown but was believed to have been from “naturally occurring radioactive elements.” This, according to the document, was “based on the fact that the incident is qualitatively reproducible by leaving the cell door open with the fan off, during certain weather conditions.” The health physicist assigned to Building 4373 at that time discounted the possibility of a fuel leak or fuel contamination because smear surveys did not show any contamination within the building. It was noted that the incident could have been related to an earthquake that had occurred early during the same day.[1] The HSA research team was unable to locate additional information about this event.

A September 1964 semiannual review of Building 4373 operations indicated that a “slight case of U-235 foil contamination” occurred, but that “contamination levels were of minor concern and were easily cleaned up.” Additional documentation regarding this contaminating incident could not be located in available historical documents.[2]

During the pre-demolition survey of Building 4373, on August 22, 1995 a Health Physicist (HP) found three radioactive prefilters in the ventilation system on the roof of Building 4373. According to the incident report, the filters were thought to have been in continuous use from 1957 to 1962, and were not replaced or removed since building operations ceased. The filters were removed and taken to Building 4020 for storage in a radioactive materials storage area.

Following the removal of the prefilters, which had apparently remained on the roof of Building 4373 in excess of 30 years, the ventilation system was surveyed and released, although the incident report did not provide the results of the survey. The survey results of each pre-filter indicated 11,250 dpm/100 cm^2 of beta activity. Gamma spectroscopy determined that the activity was predominantly Cs-137. As a result, the incident report summarized that the high levels of Cs-137 were the result of building operations, as well as from atmospheric weapons testing (Incident Report A0664).[3]

The HSA provides a detailed account of the 1998 Rocketdyne Radiological Survey that involved Buildings 4373, 4374, and 4375 as well as subsequent radiological investigations and radiological use authorizations.

The preliminary MARSSIM Classification for Building 4373 is Class 1 because of the building’s former operations as a critical facility in support of the SNAP program.

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[1] EPA/HGL, *Final HSA 5D* p. 110, citation 6:

> [6] Remley, M.E., Atomics International Letter Re: Semiannual Survey of the SNAP Critical Facility and Minutes of Meeting of February 17, 1964, February 27, 1964.

[2] EPA/HGL, *Final HSA 5D* p. 110, citation 7:

> [7] Remley, M.E., Atomics International Letter Re: Semiannual Review of Building 373 – Recommendations and Minutes of Meeting of September 16, 1964, September 24, 1964.

[3] EPA/HGL, *Final HSA 5D* p. 111, citation 1:

> [1] Harcombe, Richard, Internal Letter Re: Radiological Incident Report A0664, August 25, 1995.

6.1.1.3 Building 4373 Select Log Book Entries: January 11, 1962 - May 28, 1965

Date	Log Entry
10/19/1962	A smear survey was made of the birdcage that was decontaminated. The contamination level was < 1dpm alpha, and <30 dpm beta-gamma.
10/19/1962	A smear survey was made of 6 birdcages, reactor room, storage room, and change room. The results follow. All birdcage 3 dpm/100 cm2 alpha to 60 dpm/100 cm < 30 dpm/100 cm
10/31/1962	Called operations and told them the results of a smear survey taken on the birdcages and in the reactor vault. Everything was clean except for the tritium source. A smear was taken on the outside of the glass tube. 10,000 dpm tritium.
11/5/1962	Made a smear survey for tritium, beryllium, and beta-gamma. Found four positive tritium smears in the reactor vault, three of these were on the neutron accelerator. 11,700 dpm end plate / 18,050 dpm first glass tube / 600 dpm on the aluminum pipe / 500 dpm on the mockup plate - all were tritium. Found on positive beta-gamma near the outside of the RX vault door, 89 dpm beta-gamma.
11/30/1962	Monitored and tagged 8 birdcages containing 93% Enr. U. fuel elements. Smears showed <1 dpm alpha and <30 dpm beta-gamma. All 8 birdcages were shipped to Bldg. #064 [4064].
12/3/1962	1100 - Monitored and tagged 6 birdcages containing 93% enriched U fuel elements. Birdcages read 0.8 mR/hr @ the surface.
12/3/1962	Smeared out 5 birdcages for shipment to Building [4064]. Smeared critical assembly and components. There were less than 30 dpm. The control drums and drives are going to Building [4010] and the core container is going to Building [4012].
1/22/1963	A complete smear survey of the building was taken. [Beryllium] smears of the SNAP 4 reactor, and tritium smears of the neutron-tritium target accelerator were taken. The results are listed below.* Tritium Smears in cpm.** 1-A = 143, 2-A=103, 3-A=185, 4-A=Bkg, 5=A=Bkg, 6-A=Bkg
3/6/1963	A smear survey of Building [4373] revealed <30 dpm/100 cm encountered from Bldg [4028] when these smears were being counted (1.83-30 dpm). Operations were notified and received their copy of the smear survey. Approx. 5 smears were counted on the manual counter to check the possibility that contamination exists. All smears indicated <30 dpm/100 cm^2 beta-gamma.
3/7/1963	A smear survey was conducted on two birdcages containing fuel cladding and fuel. The smear revealed the following: I. The birdcage containing one fuel rod (no cladding) Bottom of can, sides, and top: 125 dpm/100 cm Fuel rod - 140 dpm/100 cm II. The birdcage containing fuel cladding 4 fuel casings (cladding): 28 dpm/100 cm
5/1/1963	A smear survey of two birdcages containing 93% enriched fuel elements to be shipping to Building 4064 revealed 1.3x10 revealed 80 dpm alpha inside and 9 dpm alpha outside. The operations crew was requested to decontaminate the cages on the outside prior to shipping.
6/24/1963	A smear survey was conducted by H&S on 10 ea. birdcages at Building 4373. The birdcages contained 10FS1 fuel elements. The birdcages were shipped to 4373 from HQ. Results included:*** Cage #1: Small metal chips were found on the outside of the birdcage in the bottom corner - 3,400 dpm alpha and 5,000 dpm beta-gamma (approx.)

Date	Log Entry
11/11/1963	Took Be smear of reactor, inserts, and parts bins. Sent them to HQ, made a radiation survey of a 10 min critical of a loading. The top of the reactor read 100 mR/hr, the center rod 120 mR/hr, the peripheral rods read 50 mR/hr apiece, the highest birdcage (with a load of 5 elements) read 2.5 mR/hr at the surface. Smear results: no βγ activity. However, alpha contamination was found inside the B of E containers and 18 dpm alpha was found in the corner of the lattice on a birdcage. No other alpha smear was over 8 dpm. Bkg. was 0.1 cpm.
11/14/1963	Received verbal results of the Be smear survey conducted 11 Nov. 1 parts bin, 2 reflectors and the inserts were over allowable limits.
2/4/1964	A smear survey at the request of [redacted] of the reactor room following the removal of foils from the reactor yielded the following: Reactor table - 4.4x10 Reactor room floor - 60 dpm/100 cm Change room floor - 15 dpm/100 cm Control room floor - 100 dpm/100 cm [Redacted] was notified and a follow-up survey initiated. Immediate decontamination was requested. The request was complied with.
2/25/1964	A smear survey of Building 4373 recorded the following: Reactor room and SS storage vault floor - ~10dpm/100 cm Change room floor - 12 dpm/100 cm Control room floor - ~4 dpm/100 cm Hall floor - ~2 dpm/100 cm
3/11/1964	A smear survey of the reactor room, SS vaults, change room, and control room revealed contamination to be within permissible limits with the exception of one spot in the control room which was 2 dpm/100 cm
4/14/1964	Smear survey of reactor room, SS vault, change room, control room, and hall failed to reveal any significant α contamination.
7/31/1964	Smear survey of reactor room indicated 2x10 and adjacent area was <5 dpm/100 cm

* The log book did not present any results of the beryllium smears.
** The locations (i.e. 1-A, 2-A) corresponded to a position on the neutron-tritium target accelerator.
*** The research team did not provide the result of each of the birdcages measured and reported.
Bkg=background

Section 6.1.2

Building Number: **4012**
Building Alias: **012 / T012**

Building Name: **SNAP Generalized Critical Bldg.**

Building Function: **1962-1968 SNAP Critical Testing**
Neutron Pulse Generator
1970-1972 NASA Heavy Metal Reflected Fast Spectrum Reactor (HMRFSR)
1979 - ETEC Radiography & X-Ray

Notes: **DOE-NASA**
Tritium Use & Contamination
Beryllium (Be) Use & Contamination
NASA Nuclear Reactor: HMRFSR

Radionuclides of Concern: americium (Am-241), beryllium (Be), cesium-137 (Cs-137), plutonium isotopes (Pu-238, Pu-239, Pu-240, Pu- 241), strontium-90 (Sr-90), tritium, and natural and enriched uranium (U-234, U-235, U-238).

6.1.2.1 Description of Operations & Processes

Building 4012 was constructed in 1962 as the Systems for Nuclear Auxiliary Power (SNAP) Critical Test Facility. Building 4012 was located near the northern property line of Area IV, where the terrain near the boundary becomes very rugged and there is a 40-foot drop in elevation. The Building 4012 complex originally consisted of two sections connected by an enclosed walkway. The HSA provides a detailed description of the building's features and schematics, however the Critical Cell (Room 110) was used to test SNAP critical assemblies and the Fuel Storage and Equipment Room (Room 109) was located adjacent to the critical cell.

Operations began in 1962 with experiments using three SNAP critical assemblies (SCA-41, SCA-4B, SCA-5). Clad reactor fuel elements (U-ZrH) were stored in the fuel storage tubes located in Room 109. The SNAP critical experiments continued intermittently through 1968, when the fuel was shipped to Building 4064 (Source & Special Nuclear Material Storage Vault) and the facility was placed in "stand-by" mode.

In 1970, critical experiments for the **NASA-sponsored** Heavy Metal Reflected Fast Spectrum Reactor (HMRFSR) began and were conducted until 1972.

In 1979, a portion of the facility was modified for use by ETEC Quality Assurance in performance of X-ray machine and source radiography. The most major modification involved the removal of four fuel storage tubes and enclosure of the fuel storage room to serve as the radiographic darkroom. This use was terminated in 1992 and all radioactive sources were transferred to the RMHF for storage.[1] In 1986, part of the Building 4012 complex was demolished to build Building 4228, the Sodium Component Test Installation (SCTI) Power Pak facility, on top of Building 4012.

Contaminated items were generally placed in cardboard “ice cream” cartons, tagged for identification, and placed in collection bins outside the facility.[2] An estimated 1 gram of uranium-235 (U-235) was present for every cubic foot of trash. Periodically, the contents of this barrel were sent to the RMHF for burial or recovery.[3]

The HSA provides a detailed description of radiological investigations and decontamination/cleanup of releases at Building 4012. However, in 1973 fixed alpha contamination inside Building 4012 was painted over with eggshell-colored paint and stenciled, “Caution: Fixed Alpha Radioactive Material.”

In 1985, a comprehensive radiological survey indicated the presence of alpha contamination in both Rooms 109 and 110. The Equipment Area in Room 109 exhibited alpha contamination at the entrance door (840-1,400 dpm/cm^2), overhead light fixtures (2,800 dpm/cm^2), air conditioning duct (840-2800 dpm/cm^2), radioactive exhaust duct (4,200 dpm/cm^2), and steel door frame between Rooms 109 and 110 (1,960 dpm/cm^2). Spot checks of the concrete floor surface under the floor tile revealed contamination levels of 1,400-2800 dpm/cm^2.

Rockwell International adopted its own “acceptable limits” for the radiological investigation of buildings associated with SNAP, based on the use of enriched uranium for SNAP programs. According to Rockwell International, the ambient gamma exposure inside SNAP buildings was actually lower than outdoor natural background, and elevated rates inside the facilities were attributed to “primordial isotopes in the building material,” thus requiring little or no further investigation. Survey of the fuel storage area of Room 109 revealed contamination of the concrete floor (up to 6,500 dpm/cm^2). Survey of the fuel storage tubes indicated contamination levels up to 6,000 dpm/cm^2. [It should be noted that general SSFL Health Physics standards for safety placed a limit of 30 dpm/cm^2 on surface contamination].

Rockwell International adopted its own “acceptable limits” for the radiological investigation of buildings associated with the SNAP program, based on enriched uranium used for SNAP programs. According to Rockwell, the ambient gamma exposure inside SNAP Criticality buildings was actually lower than outdoor natural background, and elevated rates were attributed to “primordial isotopes in the building material,” thus requiring no further investigation.

The MARSSIM preliminary classification for Building 4012 is Class 1 because of its former use.

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[1] EPA/HGL, *Final HSA 5B,* p. 26. citation 7:

> [7] Pascolla, A.L., *Decontamination and Decommissioning of Building T012, ETEC No. 012-AR-0001*, Boeing North American Inc., Rocketdyne Division, May 8, 1997, pgs. 3-4, 10-11.

[2] EPA/HGL, *Final HSA 5B,* p. 30. citation 5:

> [5] Gavigan, F. X. et al., Reactor Safety Survey Report, SNAP Critical Assembly -5 (SCA-5), Building 012, February 23, 1965, pgs. 10-11.

[3] EPA/HGL, *Final HSA 5B,* p. 30. citation 6:

> [6] Internal Correspondence from Heneveld, W.H. to Schaubert, V.J., North American Rockwell, *Reference: SS Material Control for Bldg 012*, March 30, 1971, pgs. 3-4.

6.1.2.2 Building 4012 Radiological Incident Reports

The EPA HSA research team did not locate any incident reports pertaining to Building 4012 in Boeing's Incident Reports Database. However, CORE Advocacy located the SSFL Health Physics Department Log Book for Building 4012, which documented operations and incidents at Building 4012 between October 12, 1962 -July 27, 1966.[1]

Incidents reflected in the Building 4012 Log Book are summarized below. The Log Book does not specifically reference isotopes involved in each incident. Clues of context and building operations suggest that uranium was the primary isotope of concern.

The Log Book describes several incidents over the course of months that involved contaminated "birdcages" containing broken pieces of SNAP 8 fuel and highly irradiated metal shavings. CORE Advocacy notes that there are numerous references throughout incident reports associated with many facilities at SSFL, which document receipt of "contaminated birdcages" in similar condition, throughout this era of site operations. Details contained in the Building 4012 Log Book and other incident reports associated with SSFL Area IV facilities suggest the contaminated birdcages were repeatedly circulated throughout the facility. By all indications, the problem of "contaminated birdcages" presented quite a phenomenon at SSFL over the course of several months.

Tritium use and contamination resulting from the neutron pulse generator are referenced at length. Beryllium use and contamination are also noted. After 1963, the Log Book entries become sporadic, and there are only eight entries between July 1964 and August 1966. This could suggest a lapse in consistent record keeping. However, given the frequency of noted events and contamination of Building 4012, it is reasonable to assume that daily operations resulted in several incidents that were not documented, and/or where corresponding documentation has been lost or destroyed.

Measurements in the table below are written as indicated in the Log Book. CORE Advocacy recommends a thorough review of the Log Book to ensure accurate interpretation, and addition of the Log Book to the Incidents Database.

6.1.2.3 Building 4012 Health Physics Log Book Entries

Date of Incident	Location of Incident	Isotopes	Description of Incident
10/12/1962 - 10/15/1962	4012	Uranium	Contaminated "birdcages" of new fuel
10/19/1962	4012	Unknown	Smear survey results taken from the floor and reactor vault door indicate contamination.
10/24/1962	4012	MFP	Map-5 fixed filter air monitor alarmed. Vacuum pump "very hot." Air samples in the vault were 1.3x10 alpha. Alarm sounded 5 minutes after reactor shutdown.

[1] Atomics International Health Physics Log Book, Building 4012, 10/12/62-7/27/66 File: HDMSP001852993.pdf

Date of Incident	Location of Incident	Isotopes	Description of Incident
11/2/1962	4012		Air sample in reactor vault 2.8 x 10
11/12/1962	4012		Results of immersion water sample 2.08/10
11/12/1962	4012		Result of routine facility smear 341 dpm/100 cm critical cell room.
12/18/1962	4012	Uranium	10 Birdcage smears revealed dose rate from each birdcage to be 2.5-3 mR/hr.
12/18/1962	4012 Fuel Storage Vault	Uranium	Broken pieces of “hot” SNAP 8 fuel found loose/uncontained. Smallest piece counted 257 dpm alpha.
12/18/1962	4012 Fuel Storage Vault	Uranium	More broken fuel found in birdcages (“slag”). Counts ranged between 159 dpm alpha - 1394 dpm alpha. Top of the neutron source can measured 44 dpm beta-gamma “due to laying pieces of U on top.”
12/18/1962	4012 Fuel Storage Vault	Uranium	Numerous smears taken of contaminated birdcages. All tested high. A planchet of residue found on birdcages measured 27,000 dpm / 100 cm beta-gamma. Alpha activity was not counted “because of the possibility of contaminating the chamber.”
12/21/1962	4012 Fuel Storage Vault	Uranium	4 birdcages indicated surface measurements of 2.5 mR/hr beta-gamma.
1/7/1963	4012 Equipment Room		Smear detected 50 dpm/100 cm
1/9/1963	4012 Equipment Room		Smear detected 40 dpm/100 cm2
1/18/1963	4012		Fire in the air conditioning and furnace unit.
1/29/1963	4012		Smear of 75 dpm/100 cm
2/9/1963	4012		Smear 90 dpm/100cm
2/11/1963	4012 Exhaust		Meter survey of exhaust filters revealed .08 mR/ht at surface. Smears were taken after filters were changed.
2/25/1963	4012	Pu-Be	Pu-Be source used during mock-up loading of S8ER. Neutron survey revealed 6.5 mrem/hr
2/26/1963	4010 to 4012		Transfer of the mock-up S8ER reactor core from Bldg 4012 to 4010. “Motion pictures were taken to illustrate the method that will be used to transfer the core from Bldg. 4012 to 4010.”
3/8/1963		Tritium	New tritium target installed in the neutron pulse generator. Tritium contamination noted on neutron generator. Employees observed working on neutron generator without gloves or lab coats. Employee smears revealed 2x10 immediate bioassay.

Date of Incident	Location of Incident	Isotopes	Description of Incident
3/11/1963	4012	Tritium	Personnel notified to mop floors and clean all surfaces possibly contaminated with tritium on 3/8/1963.
3/15/1963	4012 Radioactive Liquid Holdup Tank		Attempt to sample R/A liquid hold up tank revealed no provisions for sampling the system; no pump system for pumping R/A liquid out or to circulate the water. Tank was 3/4 full at the time of the discovery. The only drain in the tank went to sewage system via a valve and gravity drain. Recommendations made to address ASAP.
3/18/1963	4012	Tritium	Smear of neutron generator revealed 120 dpm/100 cm tritium survey could not be conducted at the time because the gas proportional counter was being repaired at the Instrumentation Bldg.
3/26/1963	4012 Radioactive Liquid Holdup Tank	MFP	Water sample obtained from R/A Liq. Holdup Tank. Metal pipe inserted to stir the water to obtain sample, which revealed 1.14 x 10-6 µc/cc. Dumped 500 gallons. No indication of where.
4/8/1963	4012 Fuel Storage Vault and Critical Cell	Uranium	15 birdcages found containing broken fuel fragments and shavings. Brought to 4024 (location of gas proportional counter). Revealed 5.5 x 10^5 dpm alpha and 6.0 x 10 of birdcages revealed 200 dpm alpha on smear paper. A GM tube placed over black powder revealed .07 mR/hr beta-gamma at 2 inches. Fuel Vault and Critical Cell area red-tagged until complete smear survey could be conducted.
4/9/1963	4012 Fuel Storage Vault and Equipment Room	Unknown	During birdcage smears smoke was observed and the air smelled like something was burning. Investigation by fire department declared building was safe to enter; probably a transformer that shorted out.
4/10/1963 - 4/15/1963	4012 Fuel Storage Vault & Equipment Room	Uranium	Investigation into contaminated birdcages (17) containing metal shavings and fuel fragments. Metal shavings and fuel fragments measured between 1.0x10 contamination and sampling are documented; continued problems with broken fuel and metal shavings found in the bottoms of birdcages delivered to SNAP.
4/22/1963	4012 Critical Cell		Air samples revealed 6x10
5/31/1963	4012 Reactor Dunk Tank		Water sample revealed 7.9 uuc/liter beta-gamma.
7/31/1963	4012		5 Ice Cream Cartons of R/A compressible waste measured .05 mR/hr at the surface.
8/2/1963	4012 Reactor Dunk Tank		Water sample was 6.9x10 to be disposed due to completion of the SCA-4 Water Emersion Tests.
11/14/63 - 11/19/63	4012 Room 110	Be	Beryllium box containing approximately 65 lbs of Be pars ranged from 0.1-1.0 ugm and 1.0-30 µgm.
12/10/1963	4012		11 ice cream cartons of R/A waste measured .15 mR/hr @ surface.

Date of Incident	Location of Incident	Isotopes	Description of Incident
1/23/1964	4012		R/A liquid holdup tank sample 2.2x10 released. 3.3x10 “released” refers to.
2/4/1964	4012		Smears of bldg. 4012 revealed 2x10 instrument repair room on the gamma spectrometer. Overage of $4x10^2$dpm/100 cm change room.
8/3/1964	4012 Fuel Storage Vault	93% EU	.328 gr. of 93% enriched U spilled. Smears revealed no spread of contamination; no personnel contaminated. Maximum of 585 dpm/ $100cm^2$ alpha.
2/2/1965	4012 Critical Cell		Reactor approx 50 watts max - 10 watts min. for 20 minutes. Sample volume 1.5x103 [illegible]. Activity was 8.6x10-10 µc/cc beta-gamma.
2/4/1965	4012 Fuel Storage Vault		R/A Ice Cream cartons of R/A compress. waste. all cartons indicated 51 mR/hr beta-gamma.
3/30/1965	4012 Critical Cell and Fuel Vault		Routine smear survey of facility. Dose rate survey of reactor assembly indicated 500 mR/hr gamma at 1” inch. Alpha survey of Fuel Vault revealed fume hood with 2,000 dpm on ledge and 10,000 dpm inside.
7/22/1965	4012 Test Vault		Smear survey revealed 105 dpm/100 cm area.
7/27/1966	4012		Smear survey results of 800 dpm beta-gamma including 588 dpm/100 cm^2 on hood apron. Max on floor was 229 dpm/100 cm $100 cm^2$ alpha, beta, gamma.

Section 6.1.3

Building Number: **4019**
Building Alias: **019 / T019**

Building Name: **SNAP Flight Systems Nuclear Qualification Tests (SNAP-10A)**
Fissile Material Storage
ETEC Construction Staging & Computer Facility

Building Function: **Nuclear Qualification & Vacuum Tests / Criticality Acceptance Tests / Fissile Material Storage**

Notes: **DOE-NASA**
Possible Tritium

Associated Buildings: **4719 Electrical Substation**

Radionuclides of Concern: Am-241, Cs-137, H-3 Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, U-234, U-235, U-238,

6.1.3.1 Description of Operations & Processes

Building 4019 was constructed in 1962 as the Systems for Nuclear Auxiliary Power (SNAP) Flight Systems Nuclear Qualification Test Building, located near the northwest property line of Area IV. Building 4019 is located between SNAP Buildings 4013 and 4059.

The HSA provides a detailed description of Building 4019's features and schematics. It contained a high bay and low-bay office-control center, a below-grade test cell, and a vacuum test chamber. The low bay contained the control room, personnel change room, equipment room, and offices. It was originally built with cinderblock walls for nuclear fuel element storage.

Building 4019 was built to conduct criticality acceptance tests of SNAP reactors before they were delivered to the AEC for **launch as space-power systems.** The criticality tests of the SNAP-10 Flight System 3 (S10FS3) reactor were conducted in Building 4019 in 1963 before the reactor was operated in the SNAP Environmental Test Facility (Building 4024).[1]

In 1964 and 1965, three SNAP 10-A flight systems (FS-1, FS-4 and FS-5) were assembled and tested in Building 4019. Boeing indicated that all nuclear materials were removed from the building when the last SNAP reactor was removed in 1965, and the facility was used for "other

[1] EPA/HGL, *Final HSA 5B,* p. 40. citation 6:

> [6] The Boeing Company, Rocketdyne Environmental Affairs, *Building 4019 – SNAP Flight System Critical Facility*, January 8, 2003, p. 1.

[1] EPA/HGL, *Final HSA 5B,* p. 40. citation 8:

> [8] The Boeing Company, Rocketdyne Environmental Affairs, *Building 4019 – SNAP Flight System Critical Facility*, January 8, 2003, p. 1.

purposes" during the 1970's and 1980's.[1] However, a 1968 letter indicates that fissile materials were being stored in Building 4019.[2]

According to the U.S. Nuclear Regulatory Commission (NRC), fissile material is any "nuclide that is capable of undergoing fission after capturing low-energy thermal (slow) neutrons." This current definition means the "three primary fissile materials are uranium-233, uranium-235, and plutonium-239. This definition excludes natural and depleted uranium that has not been irradiated, or has only been irradiated in thermal reactors."[3] Upon termination of the SNAP program in 1970, all SNAP components were removed. Building 4019 was re-designated the ETEC Construction Staging and Computer Facility.[4]

Rockwell International adopted its own "acceptable limits" for the radiological investigation of buildings associated with the SNAP program, based on enriched uranium used for SNAP programs. According to Rockwell, the ambient gamma exposure inside SNAP Criticality buildings was actually lower than outdoor natural background, and elevated rates were attributed to "primordial isotopes in the building material," thus requiring no further investigation.

In 1995, ORISE performed verification survey activities to validate cleanup procedures and survey methods used by Rockwell-Rocketdyne. The verification survey found residual beta-gamma surface contamination in excess of U.S. DOE guidelines in a 1-square meter area of the Building 4019 high bay. The average beta-gamma total surface activity was 5,900 dpm/100 cm^2, exceeding the DOE limit of 5000 dpm/100 cm^2. This result, combined with other deficiencies (including lack of access to the Building 4019 vault and inadequate documentation of previous surveys), led ORISE to recommend additional decontamination and surveys.

The HSA provides a detailed chronology of radiological investigations and decontamination / cleanup for release surveys associated with Building 4019.

The preliminary MARSSIM classification for Building 4019 is Class 1 due to former use.

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[2] EPA/HGL, *Final HSA 5B,* p. 40. citation 9:

> [9] Internal correspondence from Bunch, D.F. to Alexander, R.E., Atomics International, a Division of North American Aviation, Inc., *Reference: Emergency Preparedness Meeting with SAN Personnel*, dated January 25, 1968.

[3] EPA/HGL, *Final HSA 5B,* p. 40. citation 1:

> [1] "Fissile Material," U.S. Nuclear Regulatory Commission, http://www.nrc.gov/reading-rm/basic- ref/glossary/ fissile-material.html (August 2, 2010).

[4] EPA/HGL, *Final HSA 5B,* p. 40. citation 2:

> [2] Liddy, P., *Building 4019 Final Status Survey Report*, The Boeing Company, June 10, 1999, p. 7.

6.1.3.2 Building 4019 Radiological Incident Reports

There has been one incident associated with Building 4019 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

6.1.3.3 Building 4019 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0304	4/10/1976	LARGE TANK	Ir-92	Stuck gammagraph source uncoupled by unbadged operator.

In addition to the incidents listed in Boeing's Incident Report Database, the following sodium potassium (NaK) incidents were noted in a 1964 Log Book.

- On June 23, 1964 a NaK leak detector alarm went off while testing SNAP 10AFS1. The following day, NaK was noticed inside the vacuum chamber, with the highest concentration of NaK around the instrument compartment. On June 25, 1964 the "vacuum chamber center section was raised above floor level … to observe NaK from the spill." The next day, the SNAP 10 FS1 unit was out of the vacuum center section, approximately 6 feet above the high bay floor. People were taking pictures, but only one was wearing the proper NaK protective clothing.[1]

- On June 29, 1964 a NaK fire was observed inside the A.P.V. of Building 4019. [APV may stand for Advanced Propulsion Valve or Vessel]. According to a log book, "the NaK fire looked quite large and close to out of control. 3 or 4 metal-X extinguishers were emptied before control was attained." A large amount of NaK was pouring out of the instrument compartment and a fireman on duty assumed it was coming from the "Rx coolant system." The expansion compensator, which was discovered to be the source of the NaK leak, was cut out of the Rx coolant system. The following day was spent cleaning up from the fire.[2]

[1] EPA/HGL, *Final HSA 5B,* p. 43. citation 2:

[2] Unknown Author, *Log Book, Building 4019, 1/20/64 to 6/3/65*, January 20, 1964, HDMSP001853466- HDMSP001853468.

[2] EPA/HGL, *Final HSA 5B,* p. 43. citation 3:

[2] Unknown Author, *Log Book, Building 4019, 1/20/64 to 6/3/65*, January 20, 1964, HDMSP001853466- HDMSP001853468.

Section 6.1.4
Building Number: **4024**
Building Alias: **024 / T024**

Building Name / Function: **SNAP 2 Development Reactor (S2DR)**
SNAP 10-A Flight Simulation Reactor (S10FS1)
SNAP 10-A Flight Simulation Reactor (S10FS3)
SNAP 10-A Flight Simulation Reactor (S10FS5) Storage
SNAP Transient Reactor (SNAPTRANS-1)
Liquid Metal Fast Breeder Reactor (LMFBR) Support
Clinch River Mock-up Reactor Operations
Storage, D&D of Hot Lab (Bldg. 4020) Equipment

Notes: **DOE-NASA**
Tritium

Radionuclides of Concern: The primary radiological constituents of concern have been identified as Co-60 and Eu-152 as a result of activation in the concrete and piping of the subterranean test vaults. Secondary radiological constituents of concern at Building 4024 include Cs-137 and Sr-90 (fission products); **H-3**, Eu-154, Fe-55, Ni-59, Ni-63, Mn-54, potassium-40 (K-40), and sodium-22 (Na-22) (neutron activation products); Th-232, U-234, U-235, and U-238 (nuclear fuel material); and Am-241, Pu-238, Pu-239, Pu-240, Pu-241, and Pu-242 (transuranic elements).[1]

6.1.4.1 Description of Operations & Processes

Building 4024 was constructed in 1959 and used for testing SNAP reactors in a simulated space environment. The sub-grade test cell complex comprising Building 4024 consisted of three parallel cells (two power-test cells and a center transfer cell), a partial rear corridor that interconnected the cells, and the operating gallery. A detailed description of Building 4024's features and measurements is provided in the EPA-HSA.

The SNAP 2 Developmental reactor prototype was tested at a nominal power level of 65 kWt without any power conversion system equipment. It was tested in Vault No. 1 of Building 4024. The SNAP 10-A Flight System 3 (S10FS3) reactor was tested in a different vault. The SNAP Transient (SNAPTRAN-1) reactor criticality tests occurred at Building 4024, as well as tasks related to the Liquid Metal Fast Breeder Reactor (LMFBR) and Clinch River Mock-Up reactor. During later years of site operations, Building 4024 was used for the storage and decontamination tasks associated with Building 4020 Hot Laboratory.

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[1] EPA/HGL, *Final HSA 5-A,* p. 42, citations 167-169:

[167] The Boeing Company, "Building 4024 Decontamination and Decommissioning Engineering Evaluation/ Cost Analysis," May 1, 2007.

[168] Tuttle, R.J., Listing of Locations in SSFL Area IV Associated With Radioactive Materials," September 1989.

[169] The Boeing Company, Engineering Evaluation & Cost Analysis (EE/CA) Community Meeting Microsoft PowerPoint® Presentation, February 21, 2007.

Building 4024 was modified in 1962. An additional control room was added, along with a new room ("Vault Number 2"), which contained vacuum pumps and other heavy equipment associated with the SNAP 10-A Space Nuclear Reactor (S10FS-1 / S10FS-3). The vacuum chamber allowed for a simulation of the operational environment in outer space.[1]

Power Test Vault Number 1 housed a SNAP-2 Demonstration (a.k.a. "Developmental") Reactor (S2DR) that operated for 5,000 hours at 30 and 50 thermal kilowatts (kWt) between April 1961 - December 1962. The S2DR generated 13 MWd of power and contained 390 x 10^3 Ci of radioactivity at the end of operation. The Hot Lab (Building 4020) was used to examine the fuel and components from the reactor following the operation. The EPA research team could not find additional historical information regarding the operation of the S2DR in Building 4024.

According to a 1962 document, Power Test Vault Number 2 was scheduled to provide shielding and containment for the SNAP 10-A Flight System (S10A-FS-1) in a vacuum chamber located within the test vault. The vacuum chamber was designed to simulate the space environment, and the reactor was put through various paces including shock and vibration testing that simulated space-launch. The reactor system test was scheduled to begin in late 1962 and would be completed and removed some time in 1963. The EPA research team did not find documentation indicating that the S10A-FS-1 was tested in Building 4024, but the EPA research team did locate documentation that the S10A-FS-3 was tested there.[2]

CORE Advocacy located an Atomics International document[3] that cautioned against exceeding specifications limits due to the rate of temperature rise, describing that the results of the intended testing were not exactly known. The letter emphasized that the <u>rate of the heat rise</u> would be the governing factor, rather than the ultimate temperature (provided that the specification limits were not exceeded). Part of the testing involved exposing the reactor to thermal shock and extreme temperature fluctuations, but Atomics International stressed that the effect on the device could not be accurately predicted; according to Atomics International, the thermal shock was greatest during the first few seconds of energizing at room temperature conditions when full voltage to the reactor was applied. The heat (watts) generated was almost three times the amount that it was designed for (at 800 degrees Farenheit).

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[1] EPA/HGL, *Final HSA 5-A,* p. 25, citation 84:

> [84] Atomics International, Document NAA-SR-7300 Special, *"Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities,"* May 25, 1962.

[2] EPA/HGL, *Final HSA 5-A,* p. 26, citations 89-93:

> [89] Rockwell International, Document N001ER000017, Rev. C.,*Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, May 30, 1991.
>
> *[90] Sapere Consulting, Inc. and The Boeing Company, Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries, May 2005*
>
> *[91] Clark, R., and Potter, G., SEC Petition Evaluation Report Summary: SEC-00093, Santa Susana Field Laboratory- Area IV, April 28, 2009.*
>
> *[92] Atomics International Document, N704FDP990006 Rev. A., "Building T024 (SETF) Facilities Dismantling Plan," July 31, 1981.*
>
> *[93] Atomics International, Document NAA-SR-7300 Special, "Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities," May 25, 1962.*

[3] J. Susnir / I. Rowe, Atomics International Interoffice Letter, *"Duty Cycle SNAP 10-A Actuators, Room Ambient Conditions,"* May 20, 1963. HDMSP001906220.pdf

Atomics International warned that continuous duty for approximately one minute, just once, may or may not produce deleterious effects but the repetition of this would probably have a harmful effect, and the degree was uncertain. The author of the letter (I. Rowe, Supervisor of the Electro-Magnetic Devices Component Development Group in the Reactor Development Department), stated, “I hesitate to give consent to any unregulated operations for an extended time and recommend constant current control for these operations. However, if this is impossible, then I would reluctantly and with great reservation consent to not more than any one minute of unregulated energizing and more important, limit this to three times during the life of the actuator. Even so, the effects on the unit are indeterminate. A failure later on due to stresses caused is entirely feasible.”

The prototype SNAP 10-A Flight System (S10FS-3) reactor operated for 10,000 hours at about 40 kWt between January 1965 and March 1966 and set the record for the longest continuous operation of a nuclear reactor system with 10,000 hours of uninterrupted operation.

On April 27, 1966 a preliminary draft radiation engineering analysis report by the Radiation Safety Unit of Atomics International presented information on the removal of the S10FS-3 reactor core, coolant pump and associated piping from the building. The materials were to be transported to the Hot Laboratory, Building 4020. At the time of removal, the reactor was to have been shut down for a period of 45 days. The EPA HSA provides a detailed account of the sequential removal of the items but the EPA research team was unable to locate documentation indicating the route that may have been followed during the transfer to Building 4020, which may have put workers at other locations at risk of exposure.[1]

On July 14, 1966, an internal letter reported that the building 4024 cells were being decontaminated following the conclusions of the SNAP10FS-3 ground tests. At the time of the letter there was no immediate work planned for the cells, and the letter therefore requested the maximum permissible contamination levels the cells could be left in, on standby status.[2] Such maximum permissible contamination levels should be taken into consideration when estimating worker dose at Building 4024, because the building remained functional and in use between 1966 and 1976.

A November 1976 document outlined the working procedures to be used to remove the vacuum vessel from the west cell of Building 4024. The document, in advance of a general radiological

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[1] EPA/HGL, *Final HSA 5-A,* p. 27, citations 94-95:

> [94] Heine, W.F., Atomics International, *Preliminary Draft Radiation Engineering Analysis: Radiation Safety Analysis*, April 27, 1966. HDMSP001852876.
>
> [95] Lords, R.E., Westinghouse Idaho Nuclear Company, Inc., *SNAP and AI Fuel Summary Report*, Report WINCO- 1222, August 1994.

[2] EPA/HGL, *Final HSA 5-A,* p. 27, citation 96:

> . [96] Wilson R.F., Atomics International Letter Re: Building 024 – FS-3 Vault and Transfer Cell Contamination Levels, July 14, 1966.

survey of the cells, indicated that the vacuum vessel was slightly activated. While the document outlined the dismantling procedure, it did not indicate the date of final removal.[1]

SNAP Critical Assembly 4B operated in the east cell for a short time at low power. SNAP Transient Test (SNAPTRAN-1) support reactor, also critical, operated in the east cell for a short time. Typically SNAPTRAN-1 was operated at low power, except for some pulsed operation. This reactor last operated in 1971, and it was the last reactor to be tested in Building 4024.[2]

According to an undated Rocketdyne Environmental Affairs document, following termination of each project, all equipment and fuel was removed from the facility. The document does not indicate where all the equipment and fuel were taken upon removal; however, an August 1994 SNAP and Atomics International Fuel Summary Report states that within a few months of shutdown, reactors were disassembled (either on site or after having been transported whole to the Hot Laboratory in Building 4020), and select elements were examined in extensive post-irradiation studies at Building 4020. Following examination, the fuels were sent to the Idaho Chemical Processing Plant (ICPP). As of 1994, the fuels remained in underwater storage at the ICPP. EPA's HSA research team could not locate additional historical information for the termination of each project.[3]

On January 30, 1973 permission was granted in an internal letter for the storage of Building 4019's SNAP 10A FS-5 system in Building 4024.[4] A document drafted December 13, 1972 outlined the procedures for the transfer of the reactor from Building 4019 to Building 4024. According to the document, the SNAP 10A FS-5 was a complete power system that was loaded with fuel and NaK, and acceptance tested. The fuel was identified as 93% enriched U-235 with a total mass of 5 kilograms of material, 4.75 kilograms compromising U-235.

The system had been stored in Building 4019, and was to be removed and transferred to Building 4024 for permanent storage in 1973, via the south end of Building 4019 to the east roll-up door of the high bay of Building 4024.[5] The permission letter reported that a nuclear safety

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[1] EPA/HGL, *Final HSA 5-A,* p. 28, citation 97:

[97] Rockwell International Document, N704DWP990024, "Dismantling and Removal of 10FS3 (SNAP) Vacuum Vessel from Building T024, Detailed Working Procedure," November 16, 1976.

[2] EPA/HGL, *Final HSA 5-A,* p. 28, citation 98:

[98] Atomics International Document, N704FDP990006 Rev. A., "Building T024 (SETF) Facilities Dismantling Plan," July 31, 1981.

[3] EPA/HGL, *Final HSA 5-A,* p. 28, citations 99 & 100:

[99] Rocketdyne Environmental Affairs, *Building 4024 – SNAP Environmental Test Facility*, Undated.

[100] Lords, R.E., Westinghouse Idaho Nuclear Company, Inc., *SNAP and AI Fuel Summary Report*, Report WINCO- 1222, August 1994.

[4] EPA/HGL, *Final HSA 5-A,* p. 28, citation 101:

[101] Ketzlach, N., Internal Letter Re: New MBA for SNAP 10FS-5 Storage, January 30, 1973. HDMSP001840067.

[5] EPA/HGL, *Final HSA 5-A,* p. 28, citation 102:

[102] Heneveld, W.H., NSA-652-160-001 *Transfer of SNAP 10A FS-5 from Bldg 019 to Bldg 024*, December 13, 1972, HDMSP001856104.

analysis (NSA) should be prepared for handling the elements outside the reactor and should be reviewed by the Fuels Committee. However, information regarding the final transfer of the system to, and the removal of the system from, Building 4024 could not be located.[1]

According to a December 1976 radiological survey plan for Building 4024, the Building 4024 test vaults became radioactively contaminated during the dismantling of the reactors upon completion of operations. The plan stated that the test vaults were lined with aluminum and were decontaminated by site personnel to safe limits of less than 50 dpm. Radiation surveys performed after decontamination of the test vaults indicated activation of the vault walls and equipment within the vaults, including TV camera traverse rails, vault light fixtures, and the environmental test vacuum vessel for S10FS3. In addition, beryllium metal contamination was also detected to be present during the SNAPTRAN reactor operations. According to the plan, the beryllium contamination resulted from the use of bare (not anodized) beryllium metal plates as neutron reflectors for the SNAPTRAN. The plan stated the beryllium contamination was cleaned up to less than 0.1 µg/100 cm^2 following SNAPTRAN operations.[2]

According to the 1976 plan, no significant radioactive contamination was ever detected in the radioactive liquid waste retention tanks; radioactive gaseous waste retention tanks contained atmosphere from the test vaults. Rockwell International stated in the plan that analysis of the gas within the tanks identified only argon-41, which has a decay half-life of 1.83 hours. Rockwell International indicated that no other long-lived isotopes were reported to have been detected during reactor operations.[3] However, it bears noting that several of the assertions made by Rockwell International border on the absurd, and directly contradict the standardized regulations of the time. (For instance, according to a report authored by Rockwell International, a reading of 7,500 dpm / 100 cpm^2 was considered “acceptable” for surface contamination of beta and gamma emitters. This report is discussed in detail, below).

Following the termination of the SNAP program, Building 4024 was used intermittently on different Liquid Metal Fast Breeder Reactor (LMFBR) tasks. In 1987, the most recent program to utilize the building was the testing of a mockup of the Clinch River fuel handling systems.[4] SSFL worker records indicate that Rocketdyne employees previously thought to be confined within SSFL Areas I, II and III routinely performed Clinch River-related job tasks at Building 4024.[5] There are also indications that the Space Shuttle Main Engine (SSME, NASA) may have been

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[1] EPA/HGL, *Final HSA 5-A,* p. 28, citation 103:
[103] Ketzlach, N., Internal Letter Re: New MBA for SNAP 10FS-5 Storage, January 30, 1973. HDMSP001840067.

[2] EPA/HGL, *Final HSA 5-A,* p. 28, citation 104:
[104] Rockwell International Document, N704TP99009, “Radiological Survey Plan, Support of D&D Program Operations – T-024 (SNAP 2 and 10), December 9, 1976.

[3] EPA/HGL, *Final HSA 5-A,* p. 29, citation 105:
[105] Rockwell International Document, N704TP99009, “Radiological Survey Plan, Support of D&D Program Operations – T-024 (SNAP 2 and 10), December 9, 1976.

[4] EPA/HGL, *Final HSA 5-A,* p. 29, citation 108:
[108] ETEC, Site Consolidation Assessment, April 16, 1987. p. 41.

[5] Worker Records provided upon request, redacted unless authorized to review.

developed in the Building 4024 High Bay, which involved Rocketdyne employees with Area I, II or III “Time Clock Locations” at SSFL.

3.4.5.1 Radiation Surveys & Surveillance - Building 4024

Progress reports for maintenance and surveillance of facilities in 1987 show that monthly maintenance and surveillance activities included radiation surveys and groundwater sampling. In April 1987, it was reported in the progress report that no significant removable activity was found during the monthly radiation survey, and that sampling of water showed to radioactivity above background. However, in January 1987 samples of water from the pipe chase room at Building 4024 showed low levels of Co-60. <u>It is important to note the monthly report did not provide information to indicate what other radionuclides were included in the sampling program, how frequently samples were taken, or what the reportable levels were</u>.[1] In 1989, DOE’s Office of Environmental Audit indicated insufficient monitoring and sampling practices at SSFL.[2]

Weekly surveillance and maintenance activities were conducted in 1988 and 1989.[3] According to a 1989 factual perspective of the SSFL facilities, Building 4024 contained approximately 15 mCi of confined activation radioactivity in concrete. Because of the design of the facility, the cost of D&D of the facility was determined to be expensive. According to the report, “the confined radioactivity is decaying and will meet release criteria when the SSFL is released for unrestricted use.” Accordingly, the report stated Rockwell would continue surveillance of the facility in the interim.

According to Boeing, between 1997-1999 Building 4024 was used as a staging and decontamination area for the Hot Lab (Building 4020) concrete blocks. Weekly monitoring measured airborne releases to the environment. Monitoring included, but was not limited to, the following radionuclides that were determined to possibly be present in the process of decontaminating the blocks: Sr-90, Cs-137, Th-230, U-234, U-235, U- 238, Pu-238, Pu-239, Pu-240, and Am-241.

As of 2011, D&D of Building 4024 was incomplete. A chronology of radiological investigations at Building 4024 follows:

• A radiation survey was carried out in test cell 2 of Building 4024 on April 1, 1966, to establish the dose rates surrounding the S10FS-3 reactor core. The purpose of the survey was to provide measured dose rate data for comparison with calculated dose rate data prior to the removal of the test cell shield blocks. At the time of the survey, the reactor had been shut down for a period of 15 days. The data were obtained by taking measurements in 1-foot increments by lowering the detection instrument into the #3 reactor instrument thimble. The radiation dose rates various

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[1] EPA/HGL, *Final HSA 5-A,* p. 30, citations 110 & 111:

[110] Wieseneck, H.C., ETEC Monthly Progress Report-April 1987, May 20, 1987.

[111] Wieseneck, H.C., ETEC Monthly Progress Report-January 1987, February 20, 1987.

[2] U.S. DOE Office of Environmental Audit, *“Environmental Survey Preliminary Report, U.S. DOE Activities at SSFL,”* 1989.

[3] EPA/HGL, *Final HSA 5-A,* p. 30, citation 112:

[112] Gaylord, G.G., *SFMP Weekly Reports*, 1988 through 1989.

from 24.0 R/hr 8 feet lowered from the high bay floor, to 87.0 R/hr at the midline of the reactor core 15 feet lowered from the high bay floor, to 36.0 R/hr 21 feet lowered from the high bay floor, at the floor level of reactor test cell 2.[1]

- A remote radiation survey of the transverse corridor of test cell 2 was performed on April 30, 1966. The purpose of the survey was to evaluate the radiation levels at the entrance to the transverse corridor with door B-104 open. The levels at three additional points were also evaluated. At the four points where measurements were taken, the radiation intensity varied from .055 R/hr to 22.5 R/hr. The survey concluded that operations personnel could enter the transfer lock with door B-104 open, if necessary.[2]

- On May 3, 1966, an Atomics International internal letter provided the results of a second radiation survey of SNAP 10FS-3, located in test cell 2 of building 4024. The survey, performed on April 30, 1966, measured radiation of the reactor after the reactor had been shut down for a period of 45 days. The data were obtained by lowering a Victoreen Radacon Model 510 detector into the #3 reactor instrument thimble, approximately 8 feet from the axis of the reactor core. The results measured that, if the reactor core is assumed to be the point source, the maximum dose rate 1 foot from the core was approximated to be 3.07×10^3 R/hr. If the source geometry was assumed to be a 1 foot line source when the detector is located at the midline of the core, the dose rate was approximated to be 2.6×10^3 R/hr at 1 foot from the core.[3] The letter did not provide information to indicate the purpose of the survey; however, it should be noted that the tests on the reactor ceased in March 1966 and decontamination of the cells had begun by July 14, 1966.[4] It should also be reiterated that maximum permissible contamination levels were sought, in order to leave the cells in “standby” status.[5]

- A February 11, 1977 internal letter from R.K. Owen to W.F. Heine of Rockwell International provided preliminary survey results of Building 4024, noting that the “complete radiological survey of building 024 appears to require more extensive effort than originally expected.” According to the letter, test vault 1 (S2DR and SNAPTRAN-1), test vault 2 (SNAP10FS-3), the vacuum equipment room, and radioactive liquid waste system were marked with a 1-meter square grid for a detailed smear and instrument survey. The letter did not indicate the type of

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[1] EPA/HGL, *Final HSA 5-A,* p. 33, citation 128:

. [128] Owen, R.K. Atomics International Letter Re: Radiation Survey of SNAP 10FS-3 Reactor in Test Cell 2, Building 024, April 12, 1966.

[2] EPA/HGL, *Final HSA 5-A,* p. 33, citation 129:

. [129] Owen, R.K., Atomics International Letter Re: Remote Radiation Survey of Transverse Corridor of Test Cell 2, Building 024, May 3, 1966.

[3] EPA/HGL, *Final HSA 5-A,* p. 33, citation 130:

. [130] Owen, R.K., Atomics International Letter, Re: Radiation Survey #2, SNAP 10FS-3 Reactor in Test Cell 2, Building 024, May 4, 1966.

[4] EPA/HGL, *Final HSA 5-A,* p. 33, citation 131:

. [131] Wilson R.F., Atomics International Letter Re: Building 024 – FS-3 Vault and Transfer Cell Contamination Levels, July 14, 1966.

[5] EPA/HGL, *Final HSA 5-A,* p. 27, citation 96:

. [96] Wilson R.F., Atomics International Letter Re: Building 024 – FS-3 Vault and Transfer Cell Contamination Levels, July 14, 1966.

instrument used. In test vault 1, the floor showed 55 dpm/100 cm^2 in one location, while the remainder of the survey grids showed less than 20 dpm. The letter does not indicate whether the contamination was fixed or removable. A light fixture that was surveyed on the south wall measured 4 mR/hr. According to the letter, “one storage hold lid was lifted. The liner appears to be floating, suggesting that the lower part of the hole is filled with water, but this could not be checked at the time.”

The EPA HSA research team did not find any additional information on the “storage hold lid” or its location, and, as a result, could not (at the time the HSA was written) determine if it was in contact with groundwater.[1] In addition, the floor of test vault 2 was randomly smear-checked following removal of the vacuum vessel. The letter does not provide information to indicate the number of smears performed; but the smears found no contamination about 20 dpm. Radiation levels in the vacuum equipment room were reported to be at the 1977 background levels. The letter did not provide 1977 background levels. The radioactive liquid waste system measurements comprised the “low level waste tank water,” the “suspect tank water,” and the “sump water.” The letter did not provide information to indicate the location of these liquid wastes. The results as reported in the letter are presented as follows:[2]

- Low level waste tank water

  o alpha – 1.2 x 10^{-9} µCi/mL

  o beta – 1.7 x 10^{8} µCi/mL

- Suspect tank water

  o alpha – 2.1 x 10^{-9} µCi/mL

  o beta – 1.4 x 10^{-8} µCi/mL

- Sump water

  o alpha – 8.8 x 10^{-10} µCi/mL o beta – 2.5 x 10^{-8} µCi/mL

- According to an undated report titled, “Long-Range Plan for Decommissioning Surplus Facilities at the Santa Susana Field Laboratories,” a partial decontamination project of Building 4024 was performed in 1978. The source document does not indicate how the items were decontaminated or where the decontamination took place. **The acceptable limits for residual radioactivity for surface contamination were reported by Rockwell International to be 7,500 dpm/100 cm^2 maximum beta-gamma emitters and 300 dpm/100 cm^2 maximum alpha emitters. Accessible surfaces within the cell and support areas were cleaned to acceptable removable contamination limits of 100 dpm/100 cm^2 beta-**

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[1] EPA/HGL, *Final HSA 5-A,* p. 33, citation 132:

[132] Owen, R.K., Rockwell International, Re: Preliminary Survey Results – Building 024, February 11, 1977.

[2] EPA/HGL, *Final HSA 5-A,* p. 33, citations 133 & 134:

[133] Owen, R.K., Rockwell International, Re: Preliminary Survey Results – Building 024, February 11, 1977.

[134] The alpha and beta measurements are those reported in the letter; however, their values are very low. It is important to note that the micro were hand written on the document, which may have been a result of the original document having been drafted on a type writer, or may have been added in error.

gamma and 20 dpm/100 cm² alpha.[1]

- **A November 1978 radiological survey report presents the findings of a September 1978 survey to ensure that the facility met unrestricted release criteria. The survey included 800 smears from the walls, floors, and remaining piping and equipment. No beta contamination in excess of 50 dpm/100 cm**² was reported; no alpha activity was reported for any areas of Building 4024 including the test vaults, transfer cell, operating gallery, high bay, and equipment rooms and support area. **The acceptable limits for residual radioactivity for surface contamination were reported by Rockwell International to be 7,500 dpm/100 cm² maximum beta-gamma emitters and 300 dpm/100 cm² maximum alpha emitters.**

According to the report, smears were counted for alpha and beta activity on a Nuclear Measurements Corporation automatic counting system with an average background of 25 cpm for beta and a counting efficiency factor of 2.35 dpm/cpm for beta. The report stated that alpha contamination was not suspected; however, had there been alpha contamination it would have been detected by the Nuclear Measurements Corporation system, and during the course of the survey of removable contamination no alpha activity was detected.

Rockwell International also performed a survey of surface radiation. This survey was conducted throughout the building and surrounding area using a beta-gamma ion chamber. Beta-gamma surface dose rate limits were 0.1 mrad/hr (average) and 0.5 mrad/hr (maximum). The maximum beta-gamma surface contamination detected outside of the power vaults was 0.07 mrad/hr with an average background of 0.05 mrad/hr. Inside the power vaults, beta-gamma surface contamination was found to range from 0.5 mrad/hr to 2.5 mrad/hr. Inside the corridor to the power vaults, beta-gamma surface contamination ranged from 0.02 mrad/hr to 1.8 mrad/hr. According to the report, the center floor drain in the lower level operating gallery was found to be contaminated during decommissioning and disposal operations. Following an acid cleaning, water and smear samples indicated 0.08 mrad/hr using the ion chamber and 200 cpm using a Technical Associates Model Pug-1. The report summarized that contamination was "probably located in the threads at the bottom of the vertical pipe."

Soil samples were also collected in the yard during and following the removal of the liquid and gas holdup tanks. According to the report, all samples were less than 30 pico curies per gram (pCi/g). The soil samples were counted on a Nuclear Chicago automatic counting system with a KCI standard, with an average background of 30 cpm and a counting efficiency factor of 3.29 dpm/cpm. The report approximated the natural activity of uncontaminated soil in this area to be 20 to 30 pCi/g; however, the report did not identify or provide a reference to how these natural activity values were determined.

Concrete cores drilled in the power vault walls and corridors were found to have a maximum specific activity of 818 pCi/g. The average specific activity was 103 pCi/g. Rockwell International analyzed fourteen cores at 1-inch increments to a depth of between 10 and 11 inches, for a total of 144 samples. The average specific activity was 103 pCi/g.

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[1] EPA/HGL, *Final HSA 5-A,* p. 35, citation 136:
Rockwell International Document N001T1000200, Long-Range Plans for Decommissioning Surplus Facilities at the Santa Susana Field Laboratories, Date Unknown.

Rockwell International collected water samples from the drain pipe in the operating gallery, hot waste storage vaults, cooling system water waste holdup tanks, groundwater during the removal of the waste tanks, and the vacuum cleaning line in Power Vault 2. The report indicated all the samples were below the limit for Sr-90. However, some water was found to be contaminated above the limit during decommissioning and disposal work, and it was transferred to the RMHF for disposal. The report did not indicate the volume of water that was found to be contaminated above the limit during decommissioning and disposal.[1]

- On March 26, 1981, additional concrete sampling in the power vaults began to determine the amount of concrete needed to be removed to meet 1981 unrestricted release criteria. Potential radiological hazards were identified as being limited to the high bay area (including cell complex), electrical/mechanical support, and yard areas. Two general areas of concern in the high bay were the cells and the S10FS-3 reactor support equipment room. Additionally, the electrical/mechanical support area contained other equipment and systems that were potentially contaminated.

  As a result of exposure to neutrons escaping from the two operating reactors, the walls, ceiling, floor and remote handling equipment of the test cells were activated. The survey indicated that 12 to 22 inches of concrete would need to be removed for surface radiation to meet the acceptable dose rate of 0.1 mR/hr. Only two radionuclides, Co-60 and Eu-152, were identified as the principal contaminants found to contribute significantly to radiation greater than background. The report identified the following activation products as contributing to contamination at Building 4024: Fe-55, Mn-54, and Eu-154.[2]

- According to a December 1992 safety review report regarding tritium production and release at SSFL, production of tritium by the operation of the S2DR, and later the S10FS3, occurred by the following ways[3]:

  o Neutron absorption by lithium-6 present in the concrete biological shield – The concrete used for the inner 2 feet of the shield differed from the concrete usually used at SSFL in that limestone aggregate was substituted for the normally used granitic gravel. The natural lithium content of this concrete was measured in 1992 to be 6.2 ppm. Using this concentration and an average flux of 1.2 x 108 n/cm2/sec at 37 kWt for the first 112 cm of concrete (and considering

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[1] EPA/HGL, *Final HSA 5-A,* p. 36, citations 137 & 138:

. [137] Rockwell International Document N001T1000200, *Long-Range Plans for Decommissioning Surplus Facilities at the Santa Susana Field Laboratories*, Date Unknown.

[138] Rockwell International Document, N704TI990044, "Radiological Survey Results – Release to Unrestricted Use, Building 024, SSFL," November 28, 1978.

[2] EPA/HGL, *Final HSA 5-A,* p. 36, citations 139 & 140:

. [139] Atomics International Document, N704FDP990006 Rev. A., "Building T024 (SETF) Facilities Dismantling Plan," July 31, 1981. (This document was referenced in the May 2005 HSA but has not yet been obtained.)

[140] Rockwell International Document N001T1000200, *Long-Range Plans for Decommissioning Surplus Facilities at the Santa Susana Field Laboratories*, Date Unknown.

[3] EPA/HGL, *Final HSA 5-A,* p. 36, citation 141:

. [141] Tuttle, R.J., Rockwell International Report RI/RD92-186, *Tritium Production and Release to Groundwater at SSFL*, December 1, 1992.

that this flux was uniform over all the walls, floor, and ceiling in the vault) the activity of tritium produced in the concrete of Vault 1 by operation of S2DR is estimated to be 0.16 Ci at shutdown in December 1962. In a similar manner, adjusting for power level and operating time, the tritium activity produced by operation of S10FS3 in Vault 2 is estimated to be 0.20 Ci at March 1966.

o Neutron absorption by lithium-6 present in soil surrounding the biological shield – The thick concrete biological shield with the added boron content absorbed nearly all the neutron that escaped from the reactor (less than 1 neutron per million produced by the reactor reached the soil), and so the production of tritium in the soil was negligible.

o Ternary fission – This was calculated to produce 0.21 Ci in the fuel of the S2DR by December 1962, and 0.26 Ci in S10FS3 by March 1966.

o Neutron absorption by lithium-6 present as an impurity in NaK coolant – Tritium produced in this manner was negligible for both reactors.

o Neutron absorption by lithium-6 in the lithium hydride shield – This activity was estimated from the calculation for S8DR at Building 4059, adjusting for power and time, for the S10FS3 operation. The natural isotopic fraction of 7.42 atom percent was used to estimate a production of 2,200 Ci in the S10FS3 shield.

- In September 1995, ORISE conducted an independent verification survey at Building 4024. Surface scans were performed over 50 to 100% of accessible floors and lower walls (up to 2 meters) for alpha, beta and gamma activity. In the fan room, elevated direct beta radiation was identified. While, in all other areas, alpha, beta and gamma radiation was within the 1995 range of ambient site background. Acceptable contamination limits and gamma exposure rates for releasing a facility for unrestricted use are prescribed in the U.S. Department of Energy (DOE), the U.S. Nuclear Regulatory Commission (NRC), and the State of California guidelines. The lowest, most conservative limits were chosen from these guidelines and incorporated into the final survey criteria for Building 4024. The surface contamination limits for alpha and beta were excerpted from DOE Order 5400.5 and NRC Regulatory Guide 1.86 (see Table below). The ambient gamma exposure rate limits at 1 meter were excerpted from an NRC Dismantling Order because at 5 microroentgens per hour (µR/hr) it was more conservative than the DOE value of 20 µR/hr, and more consistent with as low as reasonably achievable principles.[1]

[1] EPA/HGL, *Final HSA 5-A,* p. 36, citation 142:

[142] ORISE Report, 96/C-5, "Verification Survey of Buildings T019 and T024, Santa Susana Field Laboratory, Rockwell International, Ventura County, California," February 1996.

6.1.4.2
Surface Contamination Guidelines from DOE Order 5400.5 (1990) and NRC Regulatory Guide 1.86 (1974)
Allowable Total Residual Surface Contamination (dpm/100 cm²)

Radionuclides	Average	Maximum	Removable
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, and I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, and I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000β-γ	15,000β-γ	1,000β-γ

External Gamma Radiation: The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/hr. *Source: U.S. Atomic Energy Commission (now NRC) Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors, June 1974, p. 1.86-5 U.S. Department of Energy Order 5400.5, Radiation Protection of the Public and the Environment, February 8, 1990, p. IV-6.*

Surface activity measurements were conducted at 76 floor and wall locations. Excluding the power vaults, surface activity levels were less than 55 dpm/100 cm² for alpha and ranged from less than 1,400 to 33,000 dpm/100 cm² for beta. Removable alpha measured less than 12 dpm/100 cm², and removable beta measured less than 16 dpm/100 cm². The maximum beta-gamma total surface activity guidelines (15,000 dpm/100 cm²) as exceeded in the hot gas compression room of Building 4024. Exposure rate measurements were made at four locations in Building 4024, but none were made in the power vaults. Excluding the power vaults, exposure rates ranged from 11 to 13 micro roentgen per hour (μR/hr). Background was 8 μR/hr. Interior exposure rates satisfy DOE and NRC exposure rate guidelines. ORISE determined that existing documentation for Building 4024 was inadequate to support the determination that DOE guidelines for unrestricted release were met. Deficiencies noted included inadequate final status survey methods, no discussion of specific contaminants, inconsistent specification of all applicable guidelines and presentation of data that may be compared to the guidelines, absence of quantitative laboratory data, and absence of adequate figures documenting remediated areas and measurement and sampling locations.[1]

The EPA-HSA contains more details about subsequent, chronological radiological investigations of Building 4024 and recommendations for the final D&D activities.

6.1.4.3 Radiological Use Authorizations

A review of a database documenting the use authorizations related to SSFL, the EPA research team identified two use authorizations relating to Building 4020 (Hot Lab). Authorization No. 46 relates to the use of Cs-137 and Pu-Be sources in Building 4024, and Authorization No. 112 relates to the "surveillance of Building 4024."

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[1] EPA/HGL, *Final HSA 5-A,* p. 38, citation 143:

[143] ORISE Report, 96/C-5, "Verification Survey of Buildings T019 and T024, Santa Susana Field Laboratory, Rockwell International, Ventura County, California," February 1996.

Authorization No. 46 was issued to Atomics International August 5, 1971 and expired on September 5, 1971. As referenced above, the authorization was for the use of a Cs-137 source and a Pu-Be neutron source in the high bay section of Building 4024. The authorized materials included 4.5 Ci of sealed source Cs-137, 5 Ci or sealed Pu-Be source identified as Pu-239, and an additional 10 mCi of sealed source Cs-137.[1] According to the user application dated August 3, 1971, the purpose of the test was to observe the effect of gamma rays and neutrons on an infrared sensor. The application noted that there would be no contaminated materials since the sources were encapsulated.

Authorization No. 112 relates to the surveillance of Building 4024 under the Surplus Facilities Management Program. The first available use authorization was issued on January 16, 1978 and expired January 16, 1979. The authorization operation was listed as “decontamination and disposition of Building 024.” the authorized materials were listed as being, “activation product radioactivity” of an unknown quantity in the building’s structure and concrete.[2] The authorization was renewed yearly; and in March 1992, the authorization was modified to include the following operations; surveillance and maintenance activities for contaminated areas, future decontamination and decommissioning activities (however not scheduled for the duration of the 1992 annual authorization), and storage of empty radioactive materials containers. By 1994, Authorization No. 112F included required environmental monitoring at Building 4024. This monitoring included quarterly radiation surveys and quarterly contamination surveys.[3]

Subsequent use authorizations after Boeing took over site operations (1996) added the storage and survey of contaminated waste materials from Building 4020 Hot Lab decontamination and decommissioning operations. The requirement was that a running inventory of Building 4020 materials stored in Building 4024 would be maintained, but no additional controls for these operations were identified in the authorizations. In 1997, added operations included the decontamination of Building 4020 materials.

While active decontamination of Building 4020 materials occurred in Building 4024, personnel were to perform weekly routine surveys of radiation and contamination levels. During periods when decontamination activities did not occur, personnel were instructed to perform monthly surveys. By 1999, use authorizations expanded to include the storage of radioactive sources pending transfer to a third party recycling or disposal vendor, and the authorization continued to

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[1] EPA/HGL, *Final HSA 5-A,* p. 40, citation 153:

[153] Baumesh, L., and Heine, W., Authorization No. 46., August 5, 1971.

[2] EPA/HGL, *Final HSA 5-A,* p. 40, citation 155:

[155] Tuttle, R., Authorization No. 112, January 16, 1978.

[3] EPA/HGL, *Final HSA 5-A,* p. 41, citations 156-161:

[156] Barnes, J.G., and Rutherford, P.D., Authorization No. 112D, March 18, 1992.

[157] Barnes, J.G., and Rutherford, P.D., Authorization No. 112F, April 20, 1994.

[158] Barnes, J.G., and Rutherford, P.D., Authorization No. 112H, January 30, 1996.

[159] Barnes, J.G., and Rutherford, P.D., Authorization No. 112I, January 14, 1997.

[160] Barnes, J.G., and Rutherford, P.D., Authorization No. 112I, January 14, 1997.

[161] Barnes, J.G., and Rutherford, P.D., Authorization No. 112L, March 15, 1999.

list the storage and survey of contaminated waste material from Building 4020 as an “operation.” However, the decontamination of building blocks was expanded to include “L-85 lay down area,” but did not provide additional detail to describe what was meant by, “L-85 lay down area.”

6.1.4.4 Building 4024 Open Storage Areas

Aerial photographs over the years of Building 4024 operations show open storage areas between 1967-1972, container leakage and open storage areas in 1980, 1983, and potentially 1985.

The preliminary MARSSIM Classification for the building 4024 area is Class 1, due to its site operations, results of previous radiological investigations, and current building status. EPA’s research team emphasized that there were radiological incidents at Building 4024 and documented evidence of radiological releases; significant information is lacking regarding excavation activities at Building 4024. Additionally, EPA emphasized that past characterization studies for Building 4024 were focused on delineating the extent of contamination to standards that were applicable at the time, and EPA made additional recommendations for appropriate characterization of the Building 4024 area.

6.1.4.5 Building 4024 Radiological Incident Reports

There have been several incidents associated with Building 4024 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

6.1.4.6 Building 4024 Radiological Incident Report Summary: Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0535	3/6/1962	SETF High Bay	Active Corrosion Products	Welder burned with NaK in High Bay
A0634	2/19/1970	Building 4024 General Mills	None Identified	Maintenance Workers Unknowingly Worked on Contaminated General Mills
A0686	4/28/1998	Building 4024 Yard	None Identified	Non-Contaminated Skin Rash

- On March 6, 1962 a welder began grinding on the upper weld of the “PCS” in the high bay. The welder stopped, removed the tape over the lower weld and NaK ran out onto his hands and left leg. The welder “flipped” the NaK off his hands and his coveralls started to burn. The welder removed the coveralls and entered the shower. The Fire Department cleaned up the approximately 1/4 cup of NaK. According to the incident report, health and safety personnel found no detectable beta and gamma contamination in the high bay or on the welder

(A0535).[1]

- On February 19, 1970, maintenance workers unknowingly worked on contaminated general mills (A0634). [2]

- On April 28, 1998, an employee working at Building 4024 developed a skin rash on left thigh and both ankles. The employee believed the rash to be "beta burns" caused by beta radiation. A thorough investigation of the worker and the area found no radiation or contamination. The employee was diagnosed with poison oak at the West Hills Medical Center (A0686).[3]

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[1] EPA/HGL, *Final HSA 5-A,* p.32, citation 122:

[122] Sessions, S.D., "Radiological Safety Incident Report A0533, SETF High Bay, Building 24," March 21, 1962.

[2] EPA/HGL, *Final HSA 5-A,* p.32, citation 123:

[123] The research team has not yet received the incident report for this incident. The incident was documented in Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California*, *Volume 2 – Area IV Site Summaries,* May 2005, p. V-3.

[3] EPA/HGL, *Final HSA 5-A,* p.32, citation 124:

[124] Liddy, Patricia, "Incident Report File A0686, Worker Concern Over Skin Rash," May 1, 1998.

6.2 SNAP COMPLEX: ADDITIONAL LOCATIONS / OPERATIONS

Several important SNAP buildings/facilities were not included in the 2006 Site Profile. The SNAP Complex at SSFL consisted of numerous structures that functioned to support SNAP operations. As such, some were designated as “non-radiological” facilities. However, in some cases, evidence of radiological processes and radiological incidents at these locations has been discovered.

This section a partial list of SNAP Complex buildings/facilities that should be included in the 2006 Site Profile, based on their contributions to the SNAP program, involvement in radiological processes, and proximity to sources of radiation. It is not possible to obtain a comprehensive understanding of facility operations without a robust description of the SNAP Program and SNAP Complex.

>> Interesting Fact: Many are unaware of NASA operations in Area IV, particularly those involving the SNAP program (a joint DOE-NASA endeavor). SNAP Building 4373 (Section 6.1) provides an excellent example of NASA-DOE building operations; prior to 1958 the location was operated by Rocketdyne Space & Information Division for the testing of high-powered, solid rocket fuel. NASA operated a nuclear reactor (HMRFSR) in SNAP Building 4012, the world’s largest CT-Scanner in AETR Building 4100, and developed the Space Shuttle Main Engine and International Space Station in SNAP Building 4057, under LMEC/ETEC programs. In many instances, NASA’s Area IV collaborations with DOE relied on the participation of Rocketdyne Space & Information workers commonly excluded from EEOICPA due to their “Time Clock Location” assignments in Areas I, II and III.[1]

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[1] According to DEEOIC, North American Aviation’s original contract with the AEC permitted the company’s discretionary use of all its facilities in the fulfillment of its contractual obligations with the government. As such, workers of all areas rotated as needed.It is not always possible to determine worker locations or establish eligibility. See file: Turcic_Long_ETEC.pdf

Section 6.2.1

Building Number: **4013**
Building Alias: **013/T013**

Building Name/Function: **SNAP Component Assembly & Performance Building**
X-Ray Booth
ETEC Thermal Transient Facility (TTF)

Notes: **DOE-NASA**

Associated Buildings: **4713 Electrical Substation**
4823 Time Clock Location
4413 Uninterruptible Power Supply (UPS)

Radionuclides of Concern: The HSA research team found no evidence that nuclear or radioactive materials were known to have been handled in Building 4013. However, radionuclides associated with potential migration from SNAP Buildings 4012 and 4019 include: Am-241, Cs-137, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, U-234, U-235 and U-238 (natural and enriched). In addition, H-3 and Be were used in proximity to Building 4013, and may have migrated to this location via surface water flow or airborne release.

6.2.1.1 Description of Operations & Processes:

Building 4013 was constructed in 1962 as a non-nuclear Systems for Nuclear Auxiliary Power (SNAP) component assembly and performance testing building. It was situated near the northwest property line of Area IV where the terrain is very rugged and there is a 40' drop in elevation. Building 4013 was situated between the SNAP Critical Test Facility Buildings 4012 and 4019.

Assembly and checkout of several SNAP units were accomplished in the 1960's at Building 4013: PSM-1, PSM-3, PSM-1A, FSEM-2, PSM-1B, FSM-1, FSEM-2A, FS-3, FSEM-4, FS-4 and FS-5. Building 4013 featured a general assembly area, electronic assembly area, "T/C" assembly area with X-Ray booth, mechanical area, shop support area with welding booth, and receiving/holdup area.

In 1970, Building 4013 was re-designated the ETEC Thermal Transient Facility. Half the high bay was used for thermal testing since that time, and the other half was used for seismic test equipment.[1] Authorizations for building modifications and improvements to support SNAP programs was also granted in 1970. Improvements included the installation of new partitions,

[1] EPA/HGL, *Final HSA 5B,* p. 34, citation 1:

> [1] Chapman, J. A., *Radiological Survey of Buildings T019 and T013; An Area Northwest of T059, T019, T013, and T012; And a Storage Yard West of Buildings T626 and T038, GEN-ZR-0010,* Rockwell International, Rocketdyne Division, August 26, 1988, pgs. 2, 10, 17, 20, 24, 92.

floor tile, ceilings, doors, air conditioning equipment, ducting, utilities, diffusers, and equipment pads for clean room and low-bay cooling requirements, in addition to a new paint job.[1]

Although Building 4013 was designated a “non-radiological” facility, its proximity to the SNAP Critical Facility (Building 4012) and storage of radiological materials necessitates its consideration for potential worker exposure and its inclusion to the SSFL Site Profile.

In 1988, Rockwell International performed a final status survey of Building 4013 along with Building 4019 and two adjacent areas to determine if any radioactive material remained that required further surveying or decontamination, thus acknowledging that Building 4013 may have been impacted. The HSA provides a detailed chronology of the radiological investigations and decontamination/cleanup and release of Building 4013. Rockwell International adopted its own “acceptable limits” for this survey, based on enriched uranium used for SNAP programs.

Due to Building 4013’s location between SNAP Critical Test Facility Buildings 4012 and 4019, potential radioactive material migration via surface water flow or airborne release from these facilities may affect Building 4013. In addition, previous characterization studies for the building 4013 were focused on delineating the extent of contamination to standards that were applicable at the time, and not to the standards required during the EPA Area IV Study. Moreover, leakage from Building 4019 was observed in aerial photographs, which could have affected Building 4013, and storage containers of unknown contents were present at Building 4013.

The preliminary MARSSIM classification of Building 4013 is Class 1 due to the potential for radioactive material migration via surface water flow and airborne releases from SNAP Critical Test Facility Buildings 4012 and 4019.

6.2.1.2 Building 4013 Radiological Incident Reports

There has been one incident associated with Building 4013 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

6.2.1.3 Building 4013 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0369	4/9/1963	X-RAY BOOTH		Investigation of possible over-exposure appears to be a medical exposure.

• No Incident Report summary was provided by the HSA research team.

[1] EPA/HGL, *Final HSA 5B,* p. 34, citation 2:

[2] Correspondence from Pollman, A.P., U.S. Atomic Energy Commission, to Petersen, R.C., Atomics International, Reference: Building 013 Modifications and Improvements, SNAP, Contract AT(04-3)-701, dated October 16, 1970.

Section 6.2.2

Building Number: **4025**
Building Alias: **025/T025**

Building Name/Function: **SNAP Remote Handling Mock-Up Building**

Notes: **DOE-NASA**
"Non-Radiological" Designation
Radiological processes documented
Possible Tritium

Associated Buildings: **4725 & 4924 Electrical Substations**
4925 Mechanical Equipment Slab
4926 SRE Mock-up Equipment Bldg.

Radionuclides of Concern: Co-60 (Suggesting another sealed source in the building); Radionuclides associated with potential migration from the RMHF Building 4075 include isotopes of uranium, thorium, plutonium, and mixed fission products. Radionuclides associated with nearby SNAP Building 4024 include Am-241, Cs-137, Co-60, Eu-152, Eu-154, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, H-3, U-234, U-235, U-238

6.2.2.1 Description of Operations & Processes

Building 4025 was constructed in 1959 as the Remote Handling Mock-Up Building to support the Systems for Nuclear Auxiliary Power (SNAP) reactor tests. It was designated a "non-nuclear" facility.[1] However, there is a radiological incident associated with this building, which involved Co-60. According to the HSA research team, this suggests other sealed sources used in the building.

In addition, Building 4025 was located approximately 200 feet from the Radioactive Materials Handling Facility (RMHF) Building 4075, which stored and processed high levels of radioactive waste, and in close proximity to Building 4024. Proximity to the RMHF and Building 4024 likely impacted ambient radiation conditions, and this location was likely subject to radioactive material migration from both nearby buildings. Moreover, given site activities during the 1980's when Building 4025 was re-designated as ETEC's Instrumentation and Inventory Building, and the outside area surrounding it was used as a storage yard for salvageable materials and scrap components, it is likely that materials stored at this location were contaminated with radioactivity.

The HSA contains detailed information about the building's features and schematics, and references a floor-plan that depicts a pit at the southern end of the middle bay, as well as other

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[1] EPA/HGL, *Final HSA 5B,* p. 48, citations 1 & 2:

> [1] *Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.*
>
> [2] *Chapman, J. A., Radiological Survey of Buildings T049, T042, T027, T032, and T025, GEN-ZR-0013, Rockwell International, Rocketdyne Division, August 8, 1988, pgs. 9, 17, 22, 24, 26, 31, 35, 109-114, 119-120.*

documentation that references two 10’x10’ pits. No other information on the pits has been located at this time.

Building 4025 was used as the Remote Handling Mock-Up Building through 1970 for remote handling and viewing of mock-up work in support of SNAP2/10A tests, SNAP 8 tests, and other nuclear reactor tests. Following cancellation of the SNAP program in 1970, Building 4025 was designated the ETEC Instrumentation and Inventory Building used for component assembly, storage, a salvage location, and instrumentation work at least through 1988.

The preliminary MARSSIM classification for Building 4025 is Class 1 because of its proximity to SNAP Building 4024, RMHF Building 4075, and OS-2, and the potential of radioactive material migration via surface flow or airborne release from the nearby buildings.

6.2.2.2 Building 4025 Radiological Incident Reports

There has been one incident associated with Building 4025 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

6.2.2.3 Building 4025 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0306	11/16/1979	Shielded Area	Co-60	Off-scale dosimeter during gammagraph operation.

The HSA provides a detailed chronology of radiological investigations and decontamination/ cleanup of releases associated with Building 4025. However, during the 1988 Rockwell International radiological survey of Building 4025, background radiation levels were found to vary considerably and had to be statistically corrected. The most important factor influencing ambient background radiation conditions around Building 4025 was its close proximity to the Radioactive Materials Handling Facility (RMHF), which stored high levels of radioactive material. The exterior storage yard was approximately 200 feet from RMHF Building 4075. After correcting for background radiation, the survey concluded that no residual radioactivity was found above Nuclear Regulatory Commission acceptance limits of 5 µR/h in 1988.[1]

[1] EPA/HGL, *Final HSA 5B,* p. 49, citation 4:

> [4] *Chapman, J. A., Radiological Survey of Buildings T049, T042, T027, T032, and T025, GEN-ZR-0013, Rockwell International, Rocketdyne Division, August 8, 1988.*

Section 6.2.3

Building Number: **4027**
Building Alias: **027/T027**

Building Name/Function: **SNAP Mechanical Vibration/Shock Testing Facility**
S10FS-1 Acceleration Tests
Storage of Gamma Radiography Equipment
Storage of Hazardous Waste
Offices, Shop Support, Darkroom
Radiological Uses & Incidents

Notes: SNAP was a DOE-NASA project involving North American Aviation Space & Information Division, Rocketdyne.

Radionuclides of Concern: Building 4027 is located in proximity to the RMHF; therefore direct radiation and sky shine from RMHF affects ambient radiation conditions in the area.[1] Radionuclides of concern at the RMHF include all radionuclides that are included in the background study plus any additional radionuclides identified during the HSA. Additionally, sealed, fully-encapsulated, radiography sources and/or equipment may have been stored in Building 4027; however, no known "loose radioactive material" was handled in the building.[2]

6.2.3.1 Description of Operations & Processes:

Building 4027 Area includes Building 4027, Building 4625, Substation Building 4727, and the surrounding area. Building 4027 was one of a series of buildings that supported the 1950-and-1960 era SNAP Program, used as engineering development and test sites. It was constructed in 1961. The building's operational history is one of many that provides insight on the need for Rocketdyne employees from the Space & Information Division (S&ID) that may have been associated with SSFL Areas I, II or III to participate in SNAP operations on an as-needed, often undocumented basis.

Despite the building's designation as a "non-radiological" facility, according to an April 1987 Site Consolidation Assessment, Building 4027 was used for storage purposes, including sealed sources for gamma-radiography and hazardous waste. Additionally, an undated listing of SSFL Site Waste Generators, as well as a 2003 Environmental Assessment for Cleanup and Closure

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[1] EPA/HGL, *Final HSA 5-A,* p. 49, citation 215:
[215] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.

[2] EPA/HGL, *Final HSA 5-A,* p. 49, citation 216: Ibid.

identifies Building 4027 as a "weld shop."[1] Weld shops at SSFL routinely handled a variety of tasks, from all areas and types of facilities. When one weld shop was not available, others would be used as needed. The handling of radiological materials or radioactively contaminated equipment at this location cannot be ruled out, if it was used as a weld shop.

In 1963 the building was expanded to include Building 4625, which operated as a non-nuclear Component Storage Building.[2] Building 4027 featured a high bay laboratory area, offices, shop support, and at one time a large darkroom. Vibration and shock tests were performed in Building 4027 in support of the SNAP launch schedule.[3]

According to an August 15, 1963 incident report, the building conducted acceleration tests on the S10FS-1 system, which included beryllium and $NaNO_2$ to simulate NaK in the S10FS-1 system. The acceleration tests typically involved vibration and shock tests to evaluate the effects of high acceleration experienced during Atlas rocket missions.

According to an August 6, 1964 Atomics International letter the use of cyclohexane and/or cycloheptane in the NaK system of the SNAP 10FS-3 in Building 4027 was authorized.[4] In 1965, such tests included the testing of the SNAP 8 drum drive mechanism and the SNAP 10FS-5 reactor.[5]

On August 13, 1963 an Atomics International employee notified the Health and Safety Department at Santa Susana that a bottle of water that had been exposed to possible radioactive and beryllium contamination had been used for a drinking water supply in Building 4027. The contents of the bottle had been used during acceleration tests related to the S10FS-1 in Building 4027. The employee removed the bottle from the water cooler because employees

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[1] EPA/HGL, *Final HSA 5-A,* p. 47, citations 202-207:

> [202] ETEC, *Site Consolidation Assessment*, April 16, 1987. p. 22.
>
> [203] ETEC: GEN-ZR-0013, "Rad. Survey of Buildings T049, T042, T027, T032, & T025," Aug. 26, 1988.
>
> [204] Tuttle, R.J., Listing of Locations in Area IV Associated With Radioactive Materials," Sept. 1989.
>
> [205] Boeing, *R/A Waste Certification Plan (WCP) for ETEC Facilities,* EID-04758, Feb. 21, 2001. p. 5.
>
> [206] Unknown, SSFL Waste Generators, Undated.
>
> [207] DOE, *Environmental Assessment for Cleanup and Closure of ETEC,* DOE/EA-1345, March 2003. p. 2-10

[2] EPA/HGL, *Final HSA 5-A,* p. 46, citation 196:

> [196] Drawing 303-027-A4, "Expansion of Non-Nuclear Mechanical Vibration and Shock Testing, Building 027 Expansion, Floor Plan, as built," 1964.

[3] EPA/HGL, *Final HSA 5-A,* p. 46, citation 197:

> [197] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.

[4] EPA/HGL, *Final HSA 5-A,* p. 46, citation 199:

> [199] Atomics International Internal Letter, Letter Re: SNAP 10FS-3, Building 027, Santa Susana, August 6, 1964.

[5] EPA/HGL, *Final HSA 5-A,* p. 47, citation 200:

> [200] Wilmes, R.F., Atomics International Internal Letter Re: Weekly Progress Report for Industrial Hygiene and Safety Unit, Santa Susana, Period Ended 1-16-65, January 19, 1965.

were complaining about the taste of the water. Upon doing so, the employee noted a strip of masking tape that had written on it: “DO NOT DRINK, WATER CONTAMINATED WITH $NaNO_2$.”

According to the investigation, on July 19, 1963 personnel drained the water from the S10FS-1 assembly into two 5-gallon water bottles of the type used for drinking water supply at SSFL. The bottles were tagged and sealed for chemical analysis. An unknown person moved the bottles to the water cooler, and one of the bottles was placed on the water cooler on August 12, 1963. By **August 13, 1963, approximately one half of the content of the water showed beta and gamma contamination of less than 5 x 10^{-8} uc/cc, alpha contamination of less than 1 x 10^{k} uc/cc, and beryllium contamination of 0.21 ug/cc.** The incident report did not provide the results of the $NaNO_2$ concentrations, and did not indicate the ultimate disposal of the remainder of the contaminated water (Incident Report A0023).[1]

Building 4027 was included in the DOE SSFL Site Survey to determine if any residual radioactivity was accidentally left behind as a result of operations in support of the SNAP program. However, due only to the building’s designation as a non-radiological facility, it was assumed no radioactive materials were handled and according to the 1988 survey report, “only gamma exposure rate measurements were acquired in order to assess radiological condition because no radioactive or nuclear materials are known to have been handled here.” In the high bay, the maximum net gamma measured 3.8 µR/hr (corrected for background and statistically tested against an NRC acceptance limit of 5 µR/hr).The average net gamma measured 0.46 µR/hr. Based on the median value of exposure rate measurements in the vicinity of Building 4027, the ambient background value for gross gamma was determined to be 9.09 µR/hr. All beta surface activity measurements made “for indication” showed no detectable activity. Based on the results of the interior survey of Building 4027, the conclusion was made that this area passed the NRC criteria at the time for unrestricted use.

Within the storage area, the maximum net gamma measured 2.8 µR/hr (corrected for background and statistically tested against an NRC acceptance limit of 5µR/hr). The average net gamma measured –1.26 µR/hr. Based on the median value of exposure rate measurements in the vicinity of Building 4027, the ambient background value for gross gamma was determined to be 17.40 µR/hr. All beta surface activity measurements made “for indication” showed no detectable activity. Based on the results of the exterior survey of Building 4027 and the storage yard, the conclusion was made that this area was not contaminated and passed the NRC criteria at the time for unrestricted use.

Because of limited information regarding the possible storage of sealed sources for gamma-radiography in Building 4027, and the presence of staining indicative of a possible leak of unknown material from Building 4024 toward Building 4027 in 1980 aerial photographs, a preliminary MARSSIM Class of 2 has been assigned to Building 4027.

6.2.3.2 Building 4027 Radiological Incident Reports

There have been several incidents associated with Building 4027 that could have resulted in a release to the environment and worker exposure. The following table provides information

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[1] EPA/HGL, *Final HSA 5-A,* p. 48, citation 209:

[209] Busick, D.D., Internal Letter North American Aviation, Inc., Re: Water Supply, Building 027, Aug. 15, 1963.

presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

6.2.3.3 Building 4027 Radiological Incident Report Summary: Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0023	8/13/1963	Building 4027	None Identified - Beta, Gamma, Alpha contamination identified	Approximately 30 people drank contaminated water from a bottle placed onto the water cooler, which had been filled with contaminated water drained from the S10FS-1.

• On August 13, 1963 an Atomics International employee notified the Health and Safety Department at SSFL that a bottle of water had been exposed to possible radioactive and beryllium contamination had been used for a drinking water supply in Building 4027. The contents of the bottle had been used to simulate NaK in the S10FS-1 system during acceleration tests in Building 4027. The incident is described in detail above.

Section 6.2.4

Building Number: **4032**
Building Alias: **032/T032**

Building Name/Function: **SNAP Thermal & Vacuum Environmental Test Facility**
Component Testing / Radiography
Static Sodium Test Facility (SSTF)
Liquid Metal Fast Breeder (LMFBR) Sodium Tests
Clinch River Reactor Programs
Liquid Metal Development Laboratory
Inherently Safe Shutdown Systems (ISSS)
Radiological Uses & Incidents

Notes: SNAP was a DOE-NASA project involving North American Aviation Space & Information Division, Rocketdyne.

Radionuclides of Concern: Based on incident reports alone, Co-60 and Ir-192 would be the radionuclides of concern at Building 4032.

6.2.4.1 Description of Operations & Processes

Building 4032 was constructed between 1962-1965 in support of SNAP. It was used for component and instrumentation testing, and radiography. In 1975, the building housed small sodium test facilities associated with the “FFTF program,” associated with the Liquid Metal Fast Breeder Reactor (LMFBR) and Clinch River reactor programs. Between 1978-1983, radiological sources were used to determine the positioning of non-radioactive rods for use in developing the fuel rod control system in mock-up reactors. As of 1988, the building was still an active sodium test loop and sodium component/instrumentation test facility. It housed the Liquid Metal Development Laboratory (LMDL-1), which carried out applied research in support of liquid metal cooled reactors. The ISSS (Inherently Safe Shutdown System) Test Program was developed at Building 4037.

In 1996 during environmental remediation, approximately 15,390 pounds of sodium were removed from a below-ground drain tank. By 1998, the facility was being used for storage and component size reduction in support of water-vapor-nitrogen (WVN) cleaning.[1]

The preliminary MARSSIM Classification for Building 4032 is Class 2 based on the building's location within ETEC and incident history.

6.2.4.2 Building 4032 Radiological Incident Reports

There have been several incidents associated with Building 4032 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

6.2.4.3 Building 4032 Radiological Incident Report Summary: Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0299	3/27/1971	Outside	Ir-192	Radiographer made exposure adjacent to building with employee inside the building
A0586	4/20/1974	Welded Pipe	Ir-192	Unattached collimator allowed gamma graph source to fall out of guide tube
A0319	8/13/1981	Test Area	Co-60	Gamma graph source failed to return and went undetected
A0098	2/16/1982	High Bay	Ir-92	Off-Scale Dosimeter Dose
A0310	3/17/1987	High Bay	None Identified	Security, on rounds, entered radiation area of field radiography set up

[1] EPA/HGL, *Final HSA 5-A,* p. 51, citations 223-229:

[223] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.

[224] The Boeing Company, *Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1998*, RD99-115, September 22, 1999.

[225] Rockwell Aerospace, Rocketdyne Division Annual Site Environmental Report Santa Susana Field Laboratory and De Soto Sites 1993, RI/RD94-126, October 21, 1994.

[226] Sapere Consulting, Inc. and The Boeing Company, Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries, May 2005.

[227] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.

[228] Rockwell International Corporation, Site Development Plan 1977-1981, United States Energy Research and Development Administration Liquid Metal Engineering Center, June 1975.

[229] Sapere Consulting, Inc. and The Boeing Company, Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries, May 2005.

- On March 27, 1971 during the performance of field radiography on pipe welds located just outside Building 4032, a Liquid Metal Engineering Center (LMEC) employee entered the building through a posted door. The employee was not observed by the radiographer who exposed the 27 Ci or Ir-192 in a “60 degree collimator” for a period of 11 minutes. The employee was discovered in the building by the radiographer after the source had been returned to the source safe. An investigation of the incident determine the LMEC employee was exposed to a maximum radiation level of 6 mR/hr (A0299).[1]

- On April 20, 1974 while gamma graphing pipe welds in Building 4032, the 65 Cu iridium-192 (Ir-192) source was driven out for a routine exposure. The source went completely out the end of the guide tube and fell to the floor. When the remote hand crank was operated in an attempt to retrieve the source, it was discovered that the drive cable was disconnected from the hand crank mechanism. Recovery of the source was done by disassembling the guide tube on the remote hand crank assembly and exposing the end of the drive cable. The drive cable and source were pulled back through the guide tube by hand until the source was replaced in the source storage container. A contamination survey of the area, guide tubes, and the source storage container found no detectable contamination. The maximum radiation exposure received by personnel involved in the recovery was documented as 12 mrem as indicated by pocket dosimeter readings. The area was secured approximately 2 hours following the incident. (A0586).[2]

- On August 13, 1981 an employee conducted a field radiography of the “SASS-ACA” test article in Building 4032. After completing the fourth exposure, the employee retracted the source and set the brake on the control unit. He approached the source with his radiation monitor and detected no activity strength on his meter, which was set on the X1 scale. At a distance of approximately 4 feet from the exposed source, the meter went off-scale. The meter continued to go off-scale when the meter was switched to X-10 and X-100 scale. Following investigation, it was found the source “did not crank completely into the projector after the exposure. It has apparently hung up approximately 1/4 to 1/2 inch outside the projector in the guide tube. The monitor did not register a reading until being 4 feet from the exposed source because the projector orientation was such that it provided shielding from his approach direction. The source project contained approximately 56 curies of Co-60 (A0319).[3]

- On February 16, 1982 an employee checked his dosimeter and found the gamma exposure meter to be off-scale while performing a fourth exposure on a test article in Building 4032. The

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[1] EPA/HGL, *Final HSA 5-A,* p. 53, citation 236:

. [236] Heine, W.F., Internal Letter Re: Radiography Incident Report A-0299, April 2, 1971.

[2] EPA/HGL, *Final HSA 5-A,* p. 53, citation 237:

. [237] Klostermann, J.P., Rockwell International Internal Letter Re: Gammagraph Source Incident Building T032, April 24, 1974.

[3] EPA/HGL, *Final HSA 5-A,* p. 53, citation 239:

. [239] Breese, J.W., Rockwell International Internal Letter Re: Radiation Exposure Occurrence, August 20, 1981.

employee shut down radiographic operations immediately. Investigation of the occurrence found the dosimeter to be "defective" (A0098).[1]

- On March 17, 1987 security personnel entered Building 4032 while the building was being "X-Rayed." The film badge of the employee was analyzed for exposure; however, the findings of the analysis are not presented in the incident report. The incident did not result in environmental contamination (A0310).[2]

The discovery of a "defective dosimeter" (A0098) and failure to document worker dosimeter readings (A0310) following an exposure incident raises serious questions about the integrity of all worker dosimetry records. If personnel was unable to rely on functional dosimeters and if dosimeter readings were not recorded following exposure incidents, it is unlikely that reliable or relevant dose reconstructions can be achieved. These examples of poor and inconsistent worker monitoring practices support the determination of an expansive Special Exposure Cohort (SEC).

[1] EPA/HGL, *Final HSA 5-A,* p. 54, citation 240:

. [239] Breese, J.W., Rockwell International Internal Letter Re: Off-Scale Reading of Personal Dosimeter, February 19, 1982.

[2] EPA/HGL, *Final HSA 5-A,* p. 54, citation 241:

[241] Unknown Author, Industrial Security Preliminary Investigation Report, Incident A-0310, March 17, 1987.

Section 6.2.5

Building Number:	**4036**
Building Alias:	**036/T036**
Building Name	**SNAP Offices 1-3**
Other Buildings:	**4037 (037/T037)** **4038 (038/T038)**
Notes:	**SNAP: DOE-NASA / Rocketdyne S&ID** **Proximity to RMHF - Ambient exposure risk** **Workers unlikely to have been monitored**

Radionuclides of Concern: The EPA research team did not find evidence that high activity radioactive materials were used or stored within Building 4036. However, its proximity to RMHF may have resulted in direct radiation and sky-shine from the RMHF, and affected ambient radiation conditions in the area. Radionuclides of concern at the RMHF include all radionuclides addressed in the background study plus any additional radionuclides identified during the EPA HSA. EPA expressed concern about radioactive materials release and potential drainage from the RMHF, which may have resulted in residual contamination.

6.2.5.1 Description of Operations & Processes

Although this location is designated as a "non-radiological" location, its proximity to the Radioactive Materials Handling Facility (RMHF) and Buildings 4021 / 4022 presented a potential for direct radiation and sky-shine, which may have affected ambient radiation conditions in the area.[1] In addition, releases of radioactive materials and drainage from the RMHF may have resulted in contamination.

Building 4036 was constructed between 1962 and 1965 to support SNAP operations and included an ambient radiation dosimeter at the east side of the building. The presence of the ambient radiation dosimeter on the outside of the building suggests awareness of potential radiation in the area. However, given the building's designation as a "non-radiological" location, it is likely that workers assigned to the location were not individually monitored.

Employment Summaries provided for employees assigned to this location may reference the "non-radiological" designation of the building and the worker's lack of dosimetry data to imply that the worker was not at risk of radiation exposure. However, the building's proximity to the RMHF and potential for increased ambient radiation levels should be considered.

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[1] EPA/HGL, *Final HSA 5-A,* p. 58, citation 268:

. [268] Unknown, Room and Area Numbering Plan Santa Susana Building 0036-0037, Snap Office Building, March 15, 1962.

A March 15, 1962 layout of the building shows there to be approximately 40 offices in the building.[1] The building appears to have been demolished in 1999. Based on available information, it appears radiological controls were not required during demolition. The EPA research team did not locate any radiological investigations at or near Building 4036. While there were no radiological burial or disposal locations identified in relation to Building 4036 operations, EPA noted its proximity to the RMHF and Buildings 4021 and 4022.

The preliminary MARSSIM Classification for the Building 4036 area is Class 2, due to its location within ETEC, proximity to Building 4021 and 4022 and the RMHF, and because no site investigation has been conducted.

[1] EPA/HGL, *Final HSA 5-A,* p. 59, citation 276:

. [276] ETEC Document, GEN-ZR-0013, “Radiological Survey of Buildings T049, T042, T027, T032, and T025,” August 26, 1988.

Section 6.2.6

Building Number: **4042**
Building Alias: **042/T042**

Building Name: **SNAP Thermal Test Facility**
SNAP Shield Casting Facility
SNAP Lithium Hydride Shield Fabrication
LMFBR Development Testing

Notes: **SNAP: DOE-NASA / Rocketdyne S&ID**
"Non-Radiological" Designation
Workers may not have been monitored for radiation exposure
AEC licensed UO_2 (15,000 lbs. of UO_2 powder) at this location

Radionuclides of Concern: Possible radionuclides at Building 4042 include U-235 and U-238.

6.2.6.1 Description of Operations & Processes

Building 4042 was constructed in 1963. The HSA research team could only located limited information regarding the building's features. It contained approximately 4,100 square feet of laboratory space, and had 38' ceilings. According to a 1988 plot plan, the building included three trenches (drainage could not be determined). Special features of this building included a lithium hydride casting furnace. The building also had other environmental chambers for testing in inert and vacuum environments. Building 4042 also contained facilities used for the development of an alcohol cleaning process for the removal of sodium from large components.

Building 4042 is identified as a SNAP program thermal and structure test facility, identified as a non-nuclear and test support facility. The SNAP Shield Casting Facility was used as a general test and lithium hydride shield fabrication building in support of the SNAP program. It was also used for sodium aerosol and related technology tests. After support work for the SNAP tests ceased, Building 4042 was used for testing liquid metal systems, also known as LMFBR Development Testing.

In 1973, the AEC SNAP Project Office granted Atomics International permission to use Building 4042 and the associated equipment for loading UO_2 into a "lower axial blanket shield." While the permission letter does not provide the amount of UO_2 used, the authorization permitted 15,000 pounds of uranium in the form of UO_2 powder. Permission was granted with the understanding that the work would not interfere with the SNAP Program closeout and the equipment and building would be cleaned of any UO_2 deposited during the operation.[1] Additional information regarding these operations could not be located.

While the 1986 plan of long-range D&D of facilities at SSFL identifies hazardous waste as being present at this location, no radiological waste is referenced. However, a December 20, 1989

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[1] EPA/HGL, *Final HSA 5-A,* p. 114, citation 616 & 617:

[616] Stamp, S.R., Letter Re: Temporary Use of Building 4042 at Santa Susana, February 14, 1973.

[617] Rockwell International Document, Use Authorization 62, February 6, 1973.

report titled, “Nuclear Operations at Rockwell’s Santa Susana Field Laboratory - A Factual Perspective” identifies Building 4042 as having contained a radioactive test loop.[1]

The EPA HSA research team did not located any radiological incident reports involving Building 4042, but did reference an incident involving mercury on February 24, 1965.

The preliminary MARSSIM Classification for the Building 4042 area is Class 1 due to its location within ETEC, the possible unconfirmed use of uranium in the building, the unknown nature of the materials that entered the trenches located within the building, and the presence of standing water south of the building.

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[1] EPA/HGL, *Final HSA 5-A,* p. 145, citation 619:

[619] Rockwell International, N001ER000017, Nuclear Operations at Rockwell’s Santa Susana Field Laboratory – A Factual Perspective, December 20, 1989.

Section 6.2.7

Building Number: **4057**
Building Alias: **057/T057**

Building Name **SNAP Launch Handling (DOE-NASA)**
Mobile Equipment Development (DOE-NASA)
Liquid Metal Engineering Center (LMEC) Lab
Static Sodium Test Facility
NASA: International Space Station Development
ETEC General Test Building

Notes: **DOE-NASA / Rocketdyne S&ID**
Proximity to RMHF - Ambient exposure risk
Proximity to Building 4059 - Radionuclide migration risk
Workers may not have been adequately monitored
Tritium

Radionuclides of Concern: U-238, U-234, U-235, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Cs-137, Sr-90, **H-3**, Fe-55, Co-58, Co-60, Ni-63, Ba-133, Eu-152, Eu-154, Eu- 155, Pm-147, Ta-182

6.2.7.1 Description of Operations & Processes

Building 4057 was constructed in approximately 1963 to house two sodium test rigs. It was used as the Launch Handling and Mobile Equipment Development Building, Liquid Metal Engineering Center (LMEC) Laboratory, and the Static Sodium Test Facility Building. In 1975, it was used for the research and development of the International Space Station (ISS) power generation system, before becoming the ETEC General Test Building. It was decommissioned in 1998 for laboratory use, and became a records room.

This location further illustrates shifting building uses and joint projects between DOE and NASA, a characteristic of SSFL site operations at various locations throughout Areas I, II, III and IV. Currently, Building 4057 is used to store Boeing records.

Because the building was used as a research laboratory, there is a possibility that radioactive materials may have been used. In addition, Building 4057 is located approximately 130 feet south of Building 4059; consequently, there is some potential that other radionuclides associated with Building 4059 may have drained / migrated to the area surrounding Building 4057, which include U-238, U-234, U-235, Pu-238, Pu-239, Pu-240, Pu- 241, Am-241, Cs-137, Sr-90, H-3, Fe-55, Co-58, Co-60, Ni-63, Ba-133, Eu-152, Eu-154, Eu- 155, Pm-147, Ta-182.

The preliminary MARSSIM Classification for Building 4057 is Class 1 due to its location within ETEC, close proximity to SNAP reactor Building 4059, and because no site investigation has been conducted.

6.2.7.2 Building 4057 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0164	02/26/2003	Cabinet Drawers		Six folders in cabinet drawers contain air/ wipe samples with low-level contamination.

• In 2003, Boeing found 16 folders containing air/wipe samples in cabinet drawers. Six were found to contain low levels of residual contamination, but this contamination had not escaped from the envelopes containing the filters. The majority of the contaminated samples measured less than the NRC Regulatory Guide 1.86 release limit of 1,000 dpm/100 cm^2 for removable contamination. Based on the survey results, the incident was deemed to be an insignificant hazard.[1] However, the incident report did not identify specific radionuclides tested for, and did not speculate on the source of the contaminated air/wipe samples.

[1] EPA/HGL, *Final HSA 5-C,* p. 33, citation 1:

[1] The Boeing Company, Incident Report No. 01684, February 26, 2003.

Section 6.2.8

Building Number: **4228**
Building Alias: **228/T228**

Building Name/Function: **(SNAP Critical Test Facility, Formerly Bldg. 4012)**
SCTI Power Pak Facility
SCTI Co-Generation Plant

Notes: **“Non Radiological” designation**
Formerly a Radiological Facility

Associated Buildings: **Building 4708 Electrical Substation**
Building 4807 / 4808 Electrical Equipment Pads
Building 4809 Air Blast Heat Exchanger
Building 4710 SCTI Power Pak Cooling Tower

Radionuclides of Concern: The HSA research team did not find evidence that radioactive materials were used in Building 4228. However, radionuclides resulting from former reactor operations in Building 4012, which supported the northwest end of Building 4228, include Am-241, Cs-137, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, U-234, U-235, U-238. In addition, H-3 due to Building 4012 operations.

6.2.8.1 Description of Operations & Processes

Building 4228 was constructed in the early 1980’s as the Sodium Components Test Installation (SCTI) Power Pak Facility. The northwest end of Building 4228 was built on top of the SNAP Critical Test Facility, Building 4012.[1] Because the new building was designated as “non-radiological,” workers did not have to wear dosimetry badges. However, as referenced, this building was constructed on top of the former SNAP Critical Test Facility Building 4012, where numerous radiological incidents were documented in the Health Physics Dept. Log Book. For more information on the operations of Building 4012, please see its section in this document.

The HSA provides a detailed description of the building’s features and schematics.

Building 4228 has been identified as the Power Pak Facility and the SCTI Co-Generation Plant. The SCTI Power Pak Facility was designed to harness the steam produced through SCTI’s sodium experiments, and to generate commercial electric power. The system operated from 1988 through 1993.

The preliminary MARSSIM classification of Building 4228 is Class 1 because Building 4228 is located on top of and south of former SNAP Critical Test Facility Building 4012, which is also identified as Class 1.

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[1] EPA/HGL, *Final HSA 5-A,* p. 52, citations 1 & 2:

> [1] Sapere Consulting, Inc. and The Boeing Company, Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries, May 2005, p. L-21.
>
> [2] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.

7.0 Civilian Nuclear Power Test Facilities

According to the 2006 Site Description, critical test facilities supported the development of civilian nuclear power and included Buildings 4009 and 4100.

The 2006 Site Description provides an incomplete definition of operations, processes, and incidents associated with Building 4009, including the second Van de Graaf Particle Accelerator used in Building 4009.

The 2006 Site Description vaguely referenced the CAT-Scan located in Building 4100 and used between 1980-2008 to inspect rocket engine components. It should be noted that the CAT-Scan, (the largest in the world) was operated by NASA and that Building 4100 (along with several other Area IV locations) involved NASA operations. Space Shuttle Main Engine (SSME) and International Space Station (ISS) operations occurred in Building 4100, which involved NASA aerospace employees of Rockwell (DOE contractor) typically associated with Area I, II and III work locations. NASA operations in Area IV, inclusive of the SNAP program, often required the presence and participation of DOE-contracted employees often thought to be disqualified from EEOICPA, based solely on the location of assigned “time clocks” in Areas I, II and III. The inclusion of all employees to EEOICPA - Areas I-IV - is strongly supported.

Section 7.1
BuildingNumber: **4009**
Building Alias: **09 / T09**

Building Name: **Organic Moderated Reactor (OMR)**
Sodium Graphite Reactor (SGR)
SGR “Hot Lab”
Van de Graaf Particle Accelerator
Engineering Development Facility
High Energy-Rate Forging (HERF) Program

Building Function: Reactor Operations / Criticality Testing / Hot Lab Activities

Notes: Enriched uranium and thorium were stored in the OMR and SGR fuel vaults and were used in the two critical assembly rooms during their operation. Up to 800 pounds of depleted uranium were stored in the OMR counting room under the Accident Debris program. In addition, a Van de Graaff accelerator was housed in the SGR graphite storage area during the early 1960s. In the 1980s, the OMR high bay was later used for HERF, which included the handling of depleted uranium. In addition: **Tritium.**

Radionuclides of Concern: Decay products from U-235, U-238, and Th-232 decay chains include Th-234, Th-228, actinium-228 (Ac-228), radium-226 (Ra-226), lead- 214 (Pb-214), bismuth-214 (Bi-214), Pb-212, Bi212, and thallium-208 (Tl-208). In addition, **H-3**, Sr-90 and Cs-137, Na-24, Co-57, Co-60, europium-152 (Eu-152), and americium-243 (Am-243) would have been formed.

7.1.1 Description of Operations & Processes

Building 4009 was constructed in two phases to first house the Organic Moderated Reactor (OMR) and later, the Sodium Graphite Reactor (SGR). The OMR and SGR facilities were pilot plants for developing large nuclear reactor power plants for commercial power generation, such as the Hallam nuclear power plant in Nebraska and the Piqua nuclear power plant in Ohio.

The OMR was used for testing uranium fueled reactors moderated and cooled by organic liquids. The critical assembly core used “slightly” enriched uranium fuel in a heterogeneous organic moderated lattice. The degree of uranium enrichment that “slightly” represents is unclear. Various types and configurations of fuel elements and core geometries were tested.

The SGR was used to determine the operating characteristics of reactors with cores cooled by sodium and moderated with graphite. The basic critical assembly of the SGR was a cylindrical array of hexagonal graphite cylinders into which various amounts and configurations of fuel and sodium (in cans or simulated by aluminum) could be inserted. The fuel used in the SGR was uranium metal and uranium carbide enriched up to 2.5%.

Both the OMR and SGR reactors were low-powered (less than 200 watts) critical assemblies. The OMR and SGR operated from 1959 and 1960, respectively, until 1965 and 1967, respectively.[1] In addition, as-built Drawing No. 303-009-E17 indicates that a Van de Graaff generator was installed in the SGR graphite storage area in August, 1960 and was moved to Building 4030 in about May, 1962.

According to Rockwell International's Final Decontamination and Radiological Survey 1990 report, after the OMR and SGR programs were terminated in 1967, all materials from the two critical assemblies were removed and transferred to "other laboratories" or were disposed of at "authorized sites" in the late 1960's and early 1970's. In June, 1966 Atomics International reported that it was sending OMR irradiated fuel to the Savannah River site for "recovery."[2]

Building 4009 was designated the Engineering Development Facility after decommissioning in the early 1970's. Sodium fire experiments intentionally exposing air to sodium were conducted in the OMR high bay, for finding new ways of extinguishing sodium fires. Also, during this time period, up to 800 pounds of depleted uranium were stored in the OMR counting room under the Accident Debris Program. The depleted uranium was received from the Los Alamos National Laboratory.[3]

The LANL depleted uranium was shipped off-site in the early 1990's. From the early 1980's until the 1990's, the former SGR high bay was used for the storage and underwater testing of Rocketdyne's In-Service Inspection (ISI) equipment, which was used for inspecting commercial power reactors off-site. This equipment sometimes became contaminated off-site with low levels of radioactivity. Containers of contaminated equipment were stored in a "controlled area" in Building 4009.[4] In May 1983, Rockwell ultrasonically inspected a contaminated and activated pipe specimen using ISI equipment.[5]

In October 1988, Rockwell requested a new authorization for the use of radioactive materials and radiation producing devices for the forging of depleted uranium in the former OMR critical assembly room. This was known as the high-energy rate forging (HERF) program, conducted under LANL; it was allowed under sub-item F of the State of California license, which authorized 30,000 pounds of source material in any form for research and development.

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[1] EPA/HGL, *Final HSA 8,* p.26, citation 3:

> [3] Energy Technology Engineering Center, *Organic Moderated Reactor and the Sodium Graphite Reactor*, at www.etec.energy.gov/History/Major-Operations/Organic-moderated.html.

[2] EPA/HGL, *Final HSA 8,* p.26, citation 4:

> [4] Internal letter from V. J. Schaubert to F. W. Schlapp, Re: *OMR Irradiated Fuel Shipment to Savannah River*, dated June 24, 1966.

[3] EPA/HGL, *Final HSA 8,* p.26, citation 5:

> [5] Memorandum from R. S. Frazier, Rockwell International, Re: *LANL DU Received at T009*, dated September 22, 1989.

[4] EPA/HGL, *Final HSA 8,* p.27, citation 1:

> [1] Rockwell Internal Letter from W. R. Johnson to W. E. Nagel, Re: Request for Radioactive Material and Radiation Producing Device User Authorization for ISI Operations at Building T009, June 10, 1987.

[5] EPA/HGL, *Final HSA 8,* p.27, citation 2:

> [2] Rockwell Internal Letter from R. J. Tuttle to Isotope Committee, Re: Short-Term Approval for Work with Radioactive Sample in Building 009, Santa Susana, May 9, 1983.

HERF involved a series of approximately 114 depleted uranium blanks (some alloyed with titanium) of 1-inch in diameter, inserted into the HERF press that used compressed air to accelerate a piston that hammered the blanks at approximately 300 ˚C. Reportedly, this process did not involve machining, sawing, filing or other processes that produced fines. All material was stored in wooden boxes in the former OMR critical assembly room, with a maximum of 1,000 kg of depleted uranium in Building 4009 at any one time. An inventory of shipping drums inidicates that 120 drums of uranium and depleted uranium were shipped from the EG&G facility at Rocky Flats, Colorado to building 4009 for the HERF project. The material was to be returned to Rocky Flats at the conclusion of the study.[1]

A Rockwell International internal letter, dated April 20, 1990 indicates that the HERF program has ended and that the former OMR critical assembly room is needed for the ISI program to store three cargo containers of radioactive equipment; each container having an external dose rate of approximately 2mrad/h.[2] An internal letter dated November 13, 1990 indicates that an effort is underway to upgrade Building 4009 to make it suitable for office use, which includes moving the HERF equipment from the former OMR critical assembly room to storage.[3] In 1995, Rockwell reported plans to upgrade Building 4009 to support a new proprietary sensor program, which would involve the high bays and removal of half the existing room, replaced by a new rolling roof, plus other installations. The use authorization licenses for Building 4009 were changed 102 times, before Building 4009 was released for unrestricted use in 1999.

In September, 1969 North American Rockwell conducted an analysis of the levels of induced radioactivity in the SGR structural steel and related components to assess the potential hazards associated with the demolition of the facility. Cobalt-60 (Co-60) was the only gamma emitting radionuclides detected in the steel with a high reading of 16 dpm/gram of steel.

In 1988, Rockwell performed a radiological survey to identify areas needing further radiological inspections or requiring remedial action. The survey covered the interior of the OMR side of the building, the SGR radioactive liquid hold-up tank and pit, the old sanitary leach field, and grease / sludge from sink clean-outs, shower drains, and matching equipment. A few locations on the OMR side of the facility were contaminated at levels below Rockwell's acceptance limits. The OMR fuel vault was contaminated with a maximum alpha activity of 92 dpm/100 cm^2 while Rockwell's "acceptable limit" in 1988 was 5,000 dpm/100cm^2.

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[1] EPA/HGL, *Final HSA 8,* p.27, citations 4 & 5:

> [4] Rockwell Internal Letter from P. H. Horton to L. J. Auge, Re: Start Up of High Energy Rate Forge (HERF) Depleted Uranium (DU) Operations at Building 009, SSFL, September 29, 1989.
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> [5] Schaubert, V. J., *Nuclear Materials Management Plan for the HERF Program*, Rockwell International Report No. N001NMP000003, October 31, 1989, pp. 3-4.

[2] EPA/HGL, *Final HSA 8,* p.27, citation 6:

> [6] Rockwell Internal Letter from J. M. Harris to R. Tuttle, Re: *Temporary RA Equipment Storage – T009*, April 20, 1990.

[3] EPA/HGL, *Final HSA 8,* p.27, citation 7:

> [7] Rockwell Internal Letter from F. C. Schrag to P. H. Horton, Re: *Plans and Work in Progress for Building 009*, November 13, 1990.

Maximum removable activity was 15 dpm/100 cm2 while the acceptable limit was 1,000 dpm/100cm2. A sludge sample collected from inside the inactive SGR radioactive liquid hold up tank contained fission products, uranium-238 (U-238) (18 pCi/g), thorium-232 (Th-232) (25.2 pCi/g), and possibly U-235 (0.81 pCi/g). No contamination was reportedly detected in the hold-up tank pit. Rockwell recommended that the tank and drain lines leading to it be removed and disposed of as radioactive waste. The OMR hold-up tank was not included in the survey. It is unclear why this was not surveyed, but the HERF program was in operation in the OMR high bay at the this time. Ambient exposure data in the area of the old sanitary leach field (partially paved) showed a mean exposure rate of 13 μR/h. In late 1989 and early 1990, all contaminated material was packaged and initially moved to the RMHF.[1]

The HSA contains a detailed chronology of radiological investigations and decommissioning/cleanup of Building 4009. In 2002, EPA contractor Tetra Tech EM, Inc. conducted oversight, sampling, and an independent technical review of documents for Building 4009. Tetra Tech noted that because of Boeing's security considerations, Building 4009 had not been accessible to EPA or Tetra Tech to conduct confirmation surveys. Tetra Tech reviewed the results from Rockwell's 1988 survey of the OMR and noted that rockwell had collected over 280 swipe samples in the SGR portion of Building 4009, and all results were below 5,000 dpm/100 cm^2 for beta-gamma activity, and were below 500 dpm/100 cm^2 for alpha activity. Tetra Tech reported that Building 4009 had been released from radiological controls by CDPHE and recommended no further survey action.[2]

The preliminary MARSSIM classification for the Building 4009 area is Class 1, due to its former use as housing two-critical assembly test facilities.

7.1.2 Building 4009 Radiological Incident Reports - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0378	07/05/1961	SGR Fuel Vault	Uranium Carbide	Can of powered UC ignited when opened.
A0372	06/11/1964	OMR Critical Assembly Room	Tritium - H3	Tritium target material for accelerator changed without monitoring.
A0157	06/05/1986	High Bay (does not specify OMR or SGR)	Am-241	Smoke detector source leaked after hose-down by the fire department

- On July 5, 1961 Atomics International personnel in the SGR fuel vault noticed that two 1-gallon containers of uranium-carbide fuel slugs were bulging at the top and bottom. Atomics International personnel transferred the fuel to the SGR Hot Lab vented hood. (It was

[1] EPA/HGL, *Final HSA 8,* p.31, citation 6:

> [6] Harris, J. M., *SGR Liquid Holdup Tank Decontamination and Decommissioning, T009,* Rockwell International Report No. N001DWP000025, August 1, 1989, pp. 3, 14.

[2] EPA/HGL, *Final HSA 8,* p.33, citation 5:

> [5] Tetra Tech EM, Inc., Final Rocketdyne Technical Support and Field Oversight Document Review for Buildings T009, T011, T019, T055, and T100, December 20, 2002, pp. 5-7.

previously learned that this fume hood had HEPA filters). The Fire Department was notified to observe the transfer. The container with the bigger protrusions was placed in a 5-gallon can with its lid secured tightly for the transfer from the vault to the Hot Lab hood. Then, the 1-gallon fuel container was removed from the 5-gallon container in the vented hood. When its lid was removed in the vented hood, a violent reaction and fire occurred with the release of gases. Uranium powder on 12 fuel slugs ignited, but the fire was put out by smothering it with G-1 powder. The second can was opened in the same manner with a less violent release of pressure. This can contained 18 slugs. All of the slugs were subsequently transferred to pans of cutting oil in the Hot Lab hood. According the Atomics International, all contamination was in the SGR Hot Lab hood; there was no damage to personnel, equipment, or property (A0378).[1]

- On June 11, 1964 between 3 and 4 curies of tritium target material were replaced in the OMR critical assembly room without the required monitoring by the Atomics International Health and Safety Department. The incident report states that the target material was for the Department 741 accelerator and that an outside vendor for the accelerator may have been involved. The employee was subsequently informed to contact the Health & Safety Department prior to any operations involving the disassembly or replacement of tritium targets (A0372).[2]

- On June 4, 1986 the high bay was washed down with a fire hose. This incident report does not state whether the location was in the OMR or SGR, but both high bays had sumps connected to individual radioactive hold-up tanks connected to the leach field. A bag placed over one of the smoke detectors was not sealed and filled with water during washdown activities. Plant Services was called to repair the damage to the detector. When an electrician empties the bag, water fell onto his hands, which subsequently registered 120 cpm direct reading of alpha contamination. The electrician was decontaminated. A gamma scan of both of his hands showed a very small amount of Am-241 (4.5E-4 microcurie) (450 pCi). This was considered “acceptable” by Atomics International, Health Physics Department, and the electrician was released. It was recommended that on future occasions, the Radiation & Nuclear Safety Branch be consulted to ensure that precautions are adequate to perform the work (A0157).[3]

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[1] EPA/HGL, *Final HSA 8,* p.29, citation 1:

> [1] Atomics International Inter-office Letter from J. P. Klostermann to E. C. Hickey re: Incident in Building 009 OMR on July 5, 1961, dated July 13, 1961.

[2] EPA/HGL, *Final HSA 8,* p.29, citation 2:

> [2] Atomics International Internal Letter from E. E. Owens to R. M. Hill, Re: *Incident in Building 009 OMR on June 11, 1964*, dated June 17, 1964.

[3] EPA/HGL, *Final HSA 8,* p.29, citation 3:

> [3] Rockwell International Radiological Safety Incident Report from R. McGinnis to J. Chapman, dated June 10, 1986.

Section 7.2

Building Number: **4100**
Building Alias: **100 / T100**

Building Name: **Advanced Epithermal Thorium Reactor (AETR)**
Fast Critical Experiment Laboratory (FCEL)
Radiation Safety / Computed Tomography Laboratory
NASA Space Shuttle - Int'l Space Station

Building Function: **Reactor configuration tests: Thorium, Uranium, Fast-Neutron**

Notes: **• DOE-NASA***
* Computerized Tomography = Inspection of Rocket Engine Components
Drainage to Area III Silvernale Pond / Area II R-2 Pond
• **Tritium / Neptunium**

Radionuclides of Concern: U-233, U-234, U-235, U-236, U-238, Th-232, Np-237, Pu-238, Pu-239, Pu-240, and Pu-241 in the AETR and in January 1972 for use in the FCEL. Decay products would include Th-228, Ra-228, Th-230, Ra-226, Pb-210, Pa-231, and Ac-227.

7.2.1 Description of Operations & Processes

Building 4100 was constructed after 1962 for the Southwest Atomic Power Association; that use was terminated in 1974. It housed the Advanced Epithermal Thorium Reactor (AETR), which was a separable-half critical experiment operating at less than 200 watts (thermal), Fast Critical Experiment Laboratory (FCEL), and Radiation Safety and Computed Tomography Laboratory. Twenty reactor core configurations were studied including thorium, uranium, and later, high-energy fast neutrons in the FCEL.[1] The laboratories were used for radioactive sample counting and instrument calibration.

From 1980-2008, the high bay was used for high energy Computer Aided Tomography (CAT) scanners in the world - owned by NASA. NASA programs conducted at SSFL after 1980 included the Space Shuttle Main Engine (SSME), and the International Space Station (ISS). Due to NASA programs that relied on Rocketdyne Space and Information Division personnel associated with Areas I, II and III it is likely that worker rotation into Area IV occurred on a routine basis, with a lack of documentation.

Building 4001 contained an experimental critical assembly located within a high bay (Room 110), special nuclear material stored within a vault (Room 112), supporting rooms, and a control room (Room 109). Reportedly, racks in Room 112 were spaced accordingly to avoid criticality from stored items.

[1] EPA/HGL, *Final HSA 5-C,* p.47, citation 3:

[3] U.S. Nuclear Regulatory Commission, Rockwell International Corporation Docket No. 50-147, Order Terminating Facility License, October 1, 1980.

Photographs of Building 4100 from 1960 show the presence of debris and drums in a trench (80’x20’), which was used by contractors for burning and disposal of construction debris and possible hazardous substances.

The preliminary MARSSIM Classification of Building 4001 is Class 1 because of its former use.

7.2.2 Building 4100 AETR Radiological Incident Reports

There have been two incidents associated with Building 4100 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

7.2.3 Building 4100 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0217	12/17/1991	Respirator Laboratory	MFP	Respirator lab Washington Machine contaminated
A0220	10/23/1992	CAT X-Ray Cell		Contractor service rep. activated X-Ray system while employee was in cell.

*Incidents are written as they are presented in the incident database. The HSA research team believes that MFP is an acronym for Mixed Fission Products.

- On December 17, 1991 Rockwell performed a radiological survey on the internal respirator laboratory washing machine in Building 4100. A smear wipe indicated 173 dpm/100cm2. Gamma spectroscopy of a 4,000-second scan indicated 254 dpm/100cm2. Rockwell recommended that the respirator laboratory decontaminate and routinely survey the washing machine on a monthly basis (A0217).[1]

- On October 23, 1992 a contract service technician activated NASA’s 2.5 MVp CAT X-ray system while the cell was occupied by another individual. This was in violation of Rocketdyne procedure and California state law. The individual’s exposure was calculated to be approximately 5 mrem. Rockwell recommended that operating personnel be reminded to inspect the cell area thoroughly prior to activation of an X-ray system (A0220).[2]

[1] EPA/HGL, *Final HSA 5-C,* p.48, citation 2:

> [2] Saba, V. B., Rockwell Internal Letter to Radiation Protection and Health Physics Services, re: *Radiological Safety Report, Contaminated Respirator Laboratory Washer*, December 17, 1991.

[2] EPA/HGL, *Final HSA 5-C,* p.48, citation 3:

> [3] Barnes, J., Rockwell Internal Letter to Distribution, re: *CAT Scanner Operation with Individual in Cell*, October 23, 1992.

8.0 Nuclear Support Operations

According to the 2006 SSFL Site Description, beginning in 1956 several operations were conducted in Area IV to support nuclear programs. These operations included the manufacture, management, and disassembly of fuel for reactor operations as well as the operation of nuclear waste management facilities for *off-site* disposal.

However, it should be noted that not all disposal of radioactive materials occurred off-site. On-site disposal (through a variety of methods) is well documented. Onsite disposal of nuclear and non-nuclear materials included incineration, burning in open burn-pits, burial, combustion, dispersal, and submersion into unlined ponds. In addition, the 2006 Site Description does not reference the Site-Wide Water Reclaim System constructed by the AEC and Atomics International, which carried waste water, industrial effluent, and reactor blowdown to open reclaim ponds used by Area I, II and III personnel.

The 2006 SSFL Site Description indicates that, with the exception of the Radioactive Materials Handling Facility (RMHF), the Fuel Storage Facility (FSF), and the Radiation Instrument Calibration Laboratory, these nuclear support operations were terminated in 1988.

Several buildings and facilities associated with the RMHF have been excluded from the 2006 Site Description; among them one of the most significant contributors to onsite ambient radioactivity, the Building 4664 Low-Level Radioactive Waste Incinerator. Descriptions of the buildings and facilities associated with the RMHF, which are in need of inclusion to the Site Profile, can be found in Section 16.0.

8.1 Reactor Fuel Manufacturing

According to the 2006 Site Description, as part of the nuclear reactor development work performed for the government, three different reactor fuel manufacturing operations occurred at SSFL in Buildings 4003, 4055, and Building 4064.

The first operation was the assembly of fuel elements for the Sodium Reactor Experiment (SRE), the second was a plutonium fuel manufacturing facility, and the third was a uranium carbide fuel pilot plant. There was also a Fuel Storage Facility, used to store the Special Nuclear Materials (enriched uranium and plutonium) used to make the fuels.

However, the 2006 Site Description has excluded several operations and programs associated with Buildings 4003, 4055 and 4064. Building 4005 (UCPFF) alone engaged in numerous processes that were excluded from the 2006 Site Description, including the Apollo (NASA) Counterweight Coating Program, Molten Salt Test Facility (Coal Gasification), and other coal processes.

As a result, relevant data associated with incidents at these locations, including environmental releases and worker exposure, have been excluded from the SSFL Site Profile. Descriptions of additional buildings and facilities can be found in Section 16.0.

Section 8.2

Building Number: **4003**
Building Alias: **03 / T03**

Building Name: **Engineering Test Building (ETB) “Hot Cave”**

Building Function: **Fuel Element Assembly (SRE)**
Molten Uranium Research
Fuel Decladding
Irradiation Experiments
SNAP Fuel Analysis & Corrosion Tests

Other Related Buildings: **Substation Building 4693**
Support Building 4825

Notes: Tritium

Radionuclides of Concern: Uranium, thorium, transuranic elements, mixed fission products, and activation products. Possible radionuclides include natural and enriched uranium (U-238, U-234, U-235, U-236), isotopes of plutonium (Pu-239, Pu-240, Pu-241, Pu-242), americium-241 (Am-241), thorium-228 (Th-228), Th-232, Th-234, activation products **(tritium (H-3),** carbon -14 (C-14), sodium-22 (Na-22), Na-24, chromium-51 (Cr-51), manganese-54 (Mn-54), nickel-59 (Ni-59), Ni-63, iron-59 (Fe-59), cobalt-60 (Co-60)) and fission products (krypton-85 (Kr-85), strontium-89 (Sr-89), Sr-90, antimony-125 (Sb-125), iodine-129 (I-129), I-131, cesium-134 (Cs-134), Cs-137, cerium-144 (Ce-144), barium (lanthanum)-140 (Ba (La)-140), niobium-95 (Nb-95), ruthenium-103 (Ru-103), Ru-106, xenon-133 (Xn-133), Xe-135, promethium-147 (Pm-147), samarium-151 (Sm-151), europium-152 (Eu-152), radium-226 (Ra-226), actinium-228 (Ac- 228).

8.2.1 Description of Operations & Processes

Building 4003 was constructed in 1957.[1] It was known as the Engineering Test Building (ETB) and the “Hot Cave.” Between 1957-1964 it was used to assemble fuel elements for the SRE. In this operation, uranium and thorium metal slugs were loaded into metal tubes, the remaining tube space was filled with sodium and the tubes were sealed. The Hot Cave portion of the building was designed and constructed to investigate the chemistry of molten uranium, and to study the separation of fission products and plutonium from uranium systems.

The HSA provides aerial photographs and a detailed description of building features and specifications. Building 4003 contained offices, a change room, several laboratories, a Freon

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[1] EPA/HGL, *Final HSA 6,* p.12, citation 1:

[1]ETEC website at: www.etec.energy.gov/History/Major-Operations/SRE.html

compressor, a concrete pit, a tank pit, a sump, an expansion tank, a boiler, and a cooling tower.[1] It should be noted that because Building 4003 contained offices, employees that may have been assigned to the offices may have been considered "non-radiological" employees. However, given the operations at the facility, such a designation may grossly misrepresent their exposure risks.

Building 4003 also contained an exhaust system that included nine fume hoods, valves, ducts, blowers, filters, filter plenum chambers, and a stack. In addition, Building 4003 contained two radioactive waste sinks connected to 5-gallon bottles, and a highly shielded area designed for remote manipulation of radioactive materials, known as the "Hot Cave." The Hot Cave contained identical east and west "hot cells," a pair of mechanical manipulators for each of the two cells, a transfer tunnel, liquid waste lines, east and west cell "small" radioactive liquid waste holdup tanks located below the Hot Cave, and a hot cell exhaust system with HEPA filters and two blowers located on the roof of Building 4003.

The west hot cell of the Hot Cave was used primarily for kilogram-scale processing experiments involving chemical reactions of irradiated reactor fuels at temperatures up to 1,800˚ C. The east hot cell was used primarily for mechanical operations, such as decladding, component disassembly, and inspection. The transfer tunnel was used for sample handling, waste removal, inter-cave transfer, and the storage of kilocurie sources.[2] According to DOE, later activities involved bench-scale research into reprocessing of used (or irradiated) fuel assemblies. The research involved the removal of fission products from used fuel.[3]

Building 4003 was also used for the analysis of Systems for Nuclear Auxiliary Power (SNAP) fuel burn-up samples and the evaluation of irradiation experiments. Use of the Hot Cave ended when the SNAP program was terminated in 1973.

The 2006 Site Profile indicates that "some traces of radioactivity were later found in the drain line, which was removed." However, according to Atomics International (1973), the inner surfaces of the Hot Cave were found to be "grossly" contaminated with mixed fission products. According to the HSA, containment of this high-level contamination required continuous operation of the radioactive exhaust system as well as filtering and sampling activities. Radioactive contamination was found to be on the internal surfaces of the hot cells, in the liquid waste lines, the liquid waste holdup tanks, the radioactive exhaust system ducting and on filter

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[1] EPA/HGL, *Final HSA 6,* p.12, citations 3 & 4:

> [3] Montgomery Watson Harza, Table 1, List of Historical Document Map Features at SRE, August 1, 2003.
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> [4] Rockwell internal letter from C. D. Bingham to W. F. Heine, Re: Application to Perform Radiochemical Operations in Building 003A (ETB Annex), December 10, 1970.

[2] EPA/HGL, *Final HSA 6,* p.13, citation 10:

> [10] Strausberg, S., Gardner, W. J., Guon, J., Luebben, T. E., and Mills, T. H., *Modified Hot Cave Facility for Reprocessing Experiments*, Atomics International Report No. NAA-SR-2687, June 30, 1958, p.3.

[3] EPA/HGL, *Final HSA 6,* p.14, citation 1:

> [1] ETEC website at: www.etec.energy.gov/History/Major-Operations/SRE.html.

plenums. In 1974, the building 4003 facilities were declared “excess” and a facilities dismantling plan was prepared.[1]

Atomics International informed the AEC that the alpha-emitting radionuclides present were from enriched uranium; some transuranics may also have been present. The beta-gamma emitting radionuclides resulted from fission products and stainless steel activation products.[2] Atomics International commenced D&D in January 1975 and ended in June 1975. Dismantling of the Hot Cave was completed in April 1975.

After 1961, Building 4003 was connected to a site-wide (Areas I, II, III, IV) sewage treatment system. In 1982, the sewer lines were found to be radioactively contaminated.[3] The sewage treatment plant began in the 1950’s to collect sanitary waste from Areas II, III, and IV. In addition to sanitary waste, the treatment plant received cooling tower discharges from non-chromated cooling tower systems and treated groundwater from various site groundwater recovery systems. The treated discharge was allowed to flow into the R-2A Discharge Pond in Area II. As part of the Site Wide Water Reclaim System, the Area II R-2A Pond serviced the Coca Rocket Engine Test Stands and Saturn V personnel. In July, 1982 Rockwell reported enriched uranium was identified in the sewer sump outside Building 4003 in the range of 23-32 µg/g. Rockwell concluded that ANL would object to the unrestricted use of Building 4003 but asserted that cleanup was impractical and almost impossible.[4]

The HSA provides a detailed chronology of radiological investigations and D&D activities associated with the Building 4003 area. The preliminary MARSSIM classification for the Building 4003 area is Class 1, due to its former use as an SRE support building and its proximity to SRE Building 4143.

8.2.3 Building 4003 Radiological Incident Reports

There have been several incidents associated with Building 4003 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

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[1] EPA/HGL, *Final HSA 6,* p.14, citation 2:

> [2] Graves, A. W., *Facilities Dismantling Plan for Building (D+D) T003 Hot Cave*, Atomics International Report No. FDP-704-990-001, October 10, 1974, p. 2.

[2] EPA/HGL, *Final HSA 6,* p.14, citation 3:

> [3] Atomics International letter from W. F. Heine to R. L. Westby, U.S. Atomic Energy Commission, re: *Contamination Limits for Release of KEWB and Building 003 for Unrestricted Use*, November 21, 1974.

[3] EPA/HGL, *Final HSA 6,* p.22, citation 1:

> [1] Letter from B. D. Sujata, The Boeing Company, to J. Evans, County of Ventura, re: *Information Regarding Permit – Septic Tank and Leach Field*, October 23, 2001.

[4] EPA/HGL, *Final HSA 6,* p.14, citation 4:

> [4] Rockwell International Telephone Conversation Record from W. Smith to B. F. Ureda, Re: *Building 003 Contamination*, July 2, 1982.

8.2.4 Building 4003 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0530	10/7/1959	ETB Maybe		Employee contaminated his hands when he failed to wear prescribed protective clothing.
A0423	12/22/1959	ETB	MFP	Contractor removed R/A exhaust stack without health physics cognizance.
A0549	7/22/1960	ETB Rm 160		Employee cut hand in controlled area.
A0295	2/1/1965	ETB & D004		Varied work location & late return of film badge resulted in exceeding guidelines. Employee exposure: 2,000 mrem gamma and 640 mrem beta
A0438	9/15/1969	ETB Hot Cell	MFP	Multiple projects resulted in employee exposure above guidelines. Employee exposure: 6,065 mrem
A0048	9/2/1969	ETB Chem Labs		ETB Lab equipment and floor found contaminated.

*Isotopes are written as they are presented in the incident database. The research team believes that MFP is an acronym for mixed fission products.

- On October 7, 1959, an employee performed maintenance on a radioactive contaminated sodium line with his bare hands. The employee was aware the line was contaminated. Both of his hands became contaminated to a level of 1.5 mrad/h. After 35 minutes of cleaning, the employee's hands were successfully decontaminated (A0530).[1]

- On December 22, 1959 contract personnel were working on the exhaust stack of the radioactive vent systems at the ETB without the knowledge of the health physics department, without the proper permit, and without film badges. The contract crew was unaware the exhaust system was radioactive. No personnel contamination was discovered. Work was immediately stopped until the proper permit was filled out and film badges assigned (A0423).[2]

- On July 22, 1960 an employee cut his hand during a drilling operation. No activity was found above background on his hand (A0549).[3]

[1] EPA/HGL, *Final HSA 6,* p.16, citation 2:

[2] Bell, C. E., Internal Letter, re: Violation of Health Phys. Practices, October 8, 1959.

[2] EPA/HGL, *Final HSA 6,* p.16, citation 3:

[3] Lang, J. C., Atomics International Internal Letter, re*: Notice of Rule Infraction*, December 31, 1959.

[3] EPA/HGL, *Final HSA 6,* p.17, citation 1:

[1] Illegible Author, Atomics International Internal Letter, re: Radiological Safety Incident Report, Room 160 ETB Annex, July 22, 1960, July 27, 1960.

- In October 1965, a missing film badge belonging to a chemist was found. The badge had been missing since January 1965 and when processed, indicated an exposure 2,000 mrem gamma and 640 mrem beta. When added to the chemist's February and March exposures, the quarterly total exposure was 2,600 mrem gamma and 1,870 mrem beta. Review of the chemist's duties in January suggested that he did in fact receive the exposure indicated on the film badge, despite the possibility of other factors affecting the reading. The chemist's lifetime accumulated exposure through September 1965 was 28.4 rem, below the permissible exposure of 65 rem at that time (A0295).[1]

- On September 15, 1969 film badges worn by an employee over the course of a calendar quarter were evaluated and the combined exposure from the badges was 6,065 mrem. This overexposure was found to be the result of multiple different operations at the ETB (A0438).[2]

- On September 2, 1969 a smear survey was requested for the upstairs laboratory at the ETB because contamination had been found on the floor. The contamination was first noted on an employee's shoe (200 cpm). The employee smeared the stairs and found up areas of contamination up to 1,000 dpm/100 cm^2. This prompted him to smear the floor where he was setting up equipment. Repetitive smears of the floor brought forth "hotter" and "hotter" results. The employee eventually roped off the area and requested further surveying of the lab. Additional smear surveys found gross contamination on the bench top and covered sink. A couple of spots read up to 1.5 rad/h. This material was easily removable. Parts of two ring stands on the work bench indicated 0.5 rad/h and were bagged up. Another "hot" area of the lab was located on an adjacent bench top where a survey detected 30,000 cpm. Smear surveys taken on September 4 and 5 1969 found contamination greater than 150,000 dpm/100 cm^2 (the counter detectibility limit) on the outside of a furnace, a balance, and a hot plate in the hood. The hot plate was measured to be 330 mrad/h. Also found in the hood, behind two lead bricks, was a bottle of liquid waste from earlier equipment, which read 5 rad/h. According to the incident report, the "episode was somewhat mysterious." It appears that there may have been two sources of contamination because gamma activity was missing from one set of smears. It was unknown whether a chemical or physical process had removed gamma emitters, such as cesium, from this area. As of September 8, 1969, the lab had been fairly well decontaminated and most items outside the hood were less than 100 dpm / 100 cm^2 beta-gamma (A0048).[3]

As part of the dismantling operations, Atomics International opened the west cell and conducted a radioactivity survey; the cell was found to contain significantly higher levels of radioactivity than the east cell. The west cell contained test analysis equipment and experimental residue. Miscellaneous waste was removed including three trays (7 rad/h) and two 1-gallon paint cans

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[1] EPA/HGL, *Final HSA 6,* p.16, citation 2:

> [2] Correspondence from Remley, M. E., Atomics International, to Levy, J., U.S. Atomic Energy Commission, *Re: Apparent Type B Radiation Exposure*, November 5, 1965.

[2] EPA/HGL, *Final HSA 6,* p.16, citation 3:

> [3] Bresson, J. F., North American Aviation Internal Letter, re: Film Badge Exposure – Contamination at the ETC, SS003, Bresson to Heine, 9/13/69, October 15, 1969.

[3] EPA/HGL, *Final HSA 6,* p.16, citation 4:

> [4] Bresson, J. F., North American Rockwell Corporation Internal Letter, re*: Contamination at the ETC, S003*, September 15, 1969.

(approximately 25 rad/h). These items were sent to the RMHF (Radioactive Materials Handling Facility) for disposal. Five prefilters (250 mrad/h) from the lower section of the cell and a 30-gallon bag of solid waste (2 rad/h) were then removed and the cell was vacuum cleaned again to remove most loose contamination. The roof shield blocks and associated manipulators were removed while the openings in the roof were covered with plastic sheeting to contain loose contamination. The remaining items in the cell were then removed. These included a Lucite enclosure, a shelf, a table, and 90 gallons of solid radioactive waste. Dry uranyl salt solution (25 rad/h at 10 cm) were removed from the floor. A container of SNAP burnup samples was located in the transfer tunnel between two cells. Using tongs, this container was transferred to a 5-gallon can and then into a lead cask, which was then transferred to RMHF.[1]

The HSA provides a detailed chronology of radiological investigations and decontamination / cleanup procedures, including Atomics International's excavation of the Hot Cave.

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[1] EPA/HGL, *Final HSA 6,* p.17, citation 3:

> [3] Ureda, B. F., Building 003Decontamination and Disposition Final Report, AI-ERDA-13158, February 25, 1976, pp. 13-15.

Section 8.3

Building Number: **4055**
Building Alias: **055 / T055**
Visitor Log Entry Code: **6013 / T055**

Building Name: **Nuclear Materials Development Facility (NMDF)**

Building Function:
- **Research, Development, Production of Nuclear Fuels and Radioactive Sources**
- **Advanced Fuel Systems Program (AFSP - LMFBR)**
- **Transuranic Waste Reduction Processes**
- **Molten Salt Combustion**
- **Support of the Fast Flux Test Facility (FFTF)**
- **Fission Research**
- **Fuel Fabrication**
- **Fabrication of U-Pu Sources for Irradiation Testing**

Associated Buildings: **Building 4155 - Guard Shack**
Building 4755 - Substation

Notes: **Tritium**
Discharge to the Area III Silvernale Pond
(Site-Wide Water Reclaim System)

Radionuclides of Concern: The primary special nuclear materials handled in the Building 4055 were plutonium and uranium. Accordingly the radionuclides of concern are uranium, Pu-239, and their decay and daughter products, primarily Am-241, decay products from U-235, U-238, and Th-232 decay chains include Th-234, Th-228, Ac-228, Ra-226, Pb-214, Bi-214, Pb- 212, Bi212, and Tl-208. In addition, **H-3**, Sr-90, Cs-137, Na-24, Co-57, Co-60, Eu-152, and Am-243 would have been formed.

8.3.1 Description of Operations & Processes

Building 4055 was constructed in 1967, specifically for developmental work involving plutonium. According to the 2006 Site Profile, the NMDF "incorporated all of the safety systems and safeguards required for such work," and no incidents associated with the NMDF are referenced. However, the HSA research team provided abundant detail on facility operations, processes, and incidents, which are summarized below. It should be noted that many of the incident reports, which are contained in the Incident Report Database, document stack failure at the Building 4055 Plutonium Facility, which may call into question emissions data NIOSH is currently using for SSFL environmental / ambient exposure.

The NDMF was used for a wide variety of purposes and programs. Based on historical documents, the major effort at Building 4055 involved plutonium-bearing fuels, primarily plutonium-239. These, according to a 1967 radiation and nuclear safety document, included Po-210, Pu-238, Pu-239, and Cm-242. For "feed material," any of the programs used various forms of plutonium, uranium, and "other radionuclides."

Following its construction, operations began in 1968 on two programs in support of the US Government's Fast Flux Test Facility. In 1970, the facility initiated a fabrication effort for ANL. Both programs, according to Rockwell's 1992 summary of plutonium capabilities, involved mixed uranium-plutonium oxide fuel pellets. In July 1968, a new program was initiated to develop a technique to "introduce micro-quantities of tungsten into mixed uranium-plutonium carbide" with the goal of the tungsten acting as a nucleating site for fission gas.[1]

According to a July 22, 1968 internal letter regarding the in-box filter systems at Building 4055, the high-efficiency in-box filter systems for the glove box trains that were involved in the mixed oxide and carbide programs had some deficiencies with regard to nuclear material recovery, accountability, and safety. The memo indicates that the in-box high-efficiency filter in those boxes that may house particularly dusty operations needed to be modified; the amount of "inaccessible areas and crevices" near the recessed filter unit needed to be reduced to minimize the accumulation of particulates; and identified a need to improve secondary inbox containment capabilities for the operations that generated significant quantifies of airborne particulates. Prior to 1968, employees engaging in these activities may have been at elevated risk.

A 1968 Atomics International internal letter regarding 12.3 gm of Pu introduced into Glove Box 15 describes modification to the Radeco air monitors to "prevent false alarms in the high level alarm circuit" that would result in building evacuation. The memo specifies the need to recalibrate alarm circuitry to avoid the sounding of stack monitor alarms, which could result in "unnecessary building evacuation." The memo described the modification of Radeco alarm plugs, so that pulling them would not cause an alarm to sound in the building (but a signal would still be received by the Control Center and only actuated at Building 4055 if the Control Center was notified by Health and Safety). New procedures for operations of counting equipment were introduced; including procedural changes so that determining alpha and beta air activity in the building would be determined by counting for alpha only. The memo specified that, based on the new schedule for daily health physics personnel and the "non-routine events that occur" at Building 4055, full-time coverage by the health physics department would be required.[2]

During the mid 1970's the NMDF conducted two programs concurrently. One involved the process development of synthesizing mixed plutonium-uranium carbide into high-density pellets to be used in the Advanced Fuel System Program for liquid metal fast breeder reactors. The second "demonstrated the use of molten salt oxidizer to reduce the volume of transuranic solid waste."

A 1981 onsite radiological contingency plan indicated that the procedures for handling analytical chemistry samples of plutonium-bearing fuel and other highly toxic material samples varied, according to the size of the sample and the nature of the analysis being performed

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[1] EPA/HGL, *Final HSA 5-D,* p. 77, citation 2:

> [2] Litwin, R.Z., Rockwell International Letter Re: RI Background and Capability to Develop a Weapons-Grade Plutonium Fuel Cycle and Disposal Evaluation for the PDR, October 5, 1992.

[2] Atomics International, Internal Letter to R.E. Remley from R.E. Alexander, Re: *Operational Safety Unit Weekly Newsletter for the Period Ending June 1, 1968,"* June 6, 1988. File: HDMSp01640028.pdf

A summary of contamination in the facility was presented in the final decommissioning report.[1] It was noted that the Chemistry Laboratory was suspected of low-level contamination, and only the most easily accessible locations in the Glove Box Room were suitably cleaned after one incident, while a portion remained contaminated following another incident. The radioactive filter system for the glove box exhaust system was contaminated, and the liquid radioactive waste holdup system was contaminated. In addition, it was noted that contamination existed inside the glove boxes, transfer tunnels between glove boxes, hoods in the controlled area, and above the glove box system. The decontamination plan noted that approximately 98% of all the plutonium contamination in Building 4055 was contained within the 38 glove boxes and ranged from 100 to 10,000,000 dpm/cm^2 (removable, per smear paper swipes). The high-volume air exhaust system ducts had suspected contamination levels of 0 to 100 dpm / 100cm^2, mostly alpha, from plutonium and its decay products.

The entire building was reportedly stripped to the walls, including contaminated equipment and surfaces, drain lines, and ventilation ducts and the final decommissioning report indicated the facility was decontaminated to levels that were “as low as reasonably achievable.”

On May 23, 1991, Rockwell International submitted a letter to the Ventura County Air Pollution control District regarding the activation of Building 4055 in support of new lasers and advanced technology research programs, including diamond coating technology. The letter indicated that the programs were operated out of the Van Owen Building at Canoga Park, but were being relocated to Building 4055.

8.3.2 Air Monitoring Data: Building 4055

According to the 1973 annual report for environmental and radioactive effluent monitoring, the gaseous effluent released to unrestricted areas was monitored at Building 4055. Monitoring included the volume of effluent releases, the average and maximum concentration (µCi/mL),

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[1] EPA/HGL, *Final HSA 5-D,* p. 81, citation 6:

[6] Rockwell International Report, AI-DOE-13559, Nuclear Materials Development Facility Decommissioning Final Report, March 31, 1987.

and the total activity released (Ci). The results of this yearly data are presented in the annual environmental monitoring and facility effluence reports from 1973 through 1986.[1]

The preliminary MARSSIM Classification for Building 4055 is Class 1 based on previous activities and incident reports.

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[1] EPA/HGL, *Final HSA 5-D,* p. 77, citations 1-18, 1-3:

[1] Moore, J.D., Environmental and Radioactive Effluent Monitoring Annual Report 1973, Undated.

[2] Rockwell International, Report No. ESG-79-7, Environmental Monitoring and Facility Effluent Annual Report 1978, April 1979.

[3] Rockwell International, Report No. ESG-81-17, Environmental Monitoring and Facility Effluent Annual Report 1980, May 27, 1981.

[4] Rockwell International, Report No. ESG-82-21, Environmental Monitoring and Facility Effluent Annual Report 1981, July 15, 1982.

[5] Rockwell International, Report No. ESG-83-17, Environmental Monitoring and Facility Effluent Annual Report 1982, June 1983.

[6] Rockwell International, Report No. ESG-84-9, Environmental Monitoring and Facility Effluent Annual Report 1983, March 1984.

[7] Rockwell International, Report No. RI/RD85-123, Environmental Monitoring and Facility Effluent Annual Report De Soto and Santa Susana Field Laboratories Sites 1984, March 1985.

[8] Rockwell International, Report No. ESG-84-9, Environmental Monitoring and Facility Effluent Annual Report 1983, March 1984.

[9] Rockwell International, Report No. RI/RD85-123, Environmental Monitoring and Facility Effluent Annual Report De Soto and Santa Susana Field Laboratories Sites 1984, March 1985.

[10] Rockwell International, Report No. RI/RD86-140, Environmental Monitoring and Facility Effluent Annual Report De Soto and Santa Susana Field Laboratories Sites 1985,April 1986.

[11] Rockwell International, Report No. ESG-79-7, Environmental Monitoring and Facility Effluent Annual Report 1978, April 1979.

[12] Rockwell International, Report No. ESG-81-17, Environmental Monitoring and Facility Effluent Annual Report 1980, May 27, 1981.

[13] Rockwell International, Report No. ESG-82-21, Environmental Monitoring and Facility Effluent Annual Report 1981, July 15, 1982.

[14] Rockwell International, Report No. ESG-83-17, Environmental Monitoring and Facility Effluent Annual Report 1982, June 1983.

[15] Rockwell International, Report No. ESG-84-9, Environmental Monitoring and Facility Effluent Annual Report 1983, March 1984.

[16] Rockwell International, Report No. RI/RD85-123, Environmental Monitoring and Facility Effluent Annual Report De Soto and Santa Susana Field Laboratories Sites 1984, March 1985.

[17] Rockwell International, Report No. RI/RD86-140, Environmental Monitoring and Facility Effluent Annual Report De Soto and Santa Susana Field Laboratories Sites 1985,April 1986.

[18] Rockwell International, Report No. RI/RD87-133, Environmental Monitoring and Facility Effluent Annual Report De Soto and Santa Susana Field Laboratories Sites 1986, March 1987.

[1] Rockwell International, Report No. RI/RD88-144, Environmental Monitoring and Facility Effluent Annual Report De Soto and Santa Susana Field Laboratories Sites 1987, March 1988.

[2] Rockwell International, Report No. RI/RD89-139, Environmental Monitoring and Facility Effluent Annual Report De Soto and Santa Susana Field Laboratories Sites 1988, May 1989.

8.3.3 Building 4055 NMDF Radiological Incident Reports

There have been several incidents associated with Building 4055 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

8.3.4 Building 4055 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0286	5/9/1970	Glove Box Room	Pu	Hole in Pu glove box glove contaminated employee.
A0222	6/26/1973	Glove Box Room	Pu	Glove box controller failure pressurized box releasing contamination to area
A0224	12/21/1977	Glove Box Room	Pu	Contaminated roll of green tape discovered in glove box room
A0063	1/10/1978	Glove Box 26	Pu	Employee contaminated during foam cleaning of glove box.
A0068*	5/4/1978	Glove Box Room	Pu	Leaking glove contaminated employee lab coat and surgeon gloves.
A0335	5/10/1978	Glove Box Room	Pu	Lost seal during change-out caused loss of vacuum and contamination.
A0071	6/15/1978	Glove Box Room	Pu	Radioactive Waste Compacted in “Suspect” Waste Compactor
A0225	6/30/1975	Stack Monitor	Pu	Stack monitor vacuum line disconnected in plutonium facility.
A0072	7/16/1978	Facility		Failure of air sampling pump and backup pump, shut-down operations
A0226	7/21/1978	Stack Monitor	Pu	Stack monitor in plutonium facility out of service for 84 hours.
A0073	7/24/1978	Support Lab	Pu	Floor contamination found in waste handling area.
A00582	6/26/1979	B-55 Glove Box	Pu Am	Maintenance of glove box furnace caused airborne activity.
A0081	5/10/1980	Stack Monitor	Pu	Failure of stack monitor system in plutonium facility.
A0250	10/31/1980	Support Lab		Contaminated green coveralls returned with deconned “blueline” coveralls.
A0085	5/31/1981	Stack Monitor	Pu	Failure of stack monitor in plutonium facility.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0091	11/7/1981	Glove Box Room		False airborne alarm in glove box room at plutonium facility.
A0100	3/24/1982	Compactor Area	Pu	Waste package with glass broke cutting hand of employee
A0113	2/7/1983	Glove Box Room	Pu	Plutonium oxide incised into the left index finger of an employee
A0114	3/27/1983	Stack Monitor		Response to Stack Monitor Alarm
A0164	8/29/1986	Outside		Overfilled portable radioactive liquid tank.

8.3.5 Incidents of Known Environmental Releases

- On January 4, 1971 a water line to the air-conditioning unit in the attic of Building 4055 leaked, causing water to run into office areas, change room, support area, and glove box room. Maintenance personnel attempted to pick up the water that had leaked with a vacuum cleaner. According to the internal letter documenting the incident, the radioactive waste system sump tank and the sample tank were both full, causing the water to back up in the support area drains. Personnel opened the valves to the 1,000-gallon holdup tank, which cleared the backed up water condition. According to the letter, a total of 800 gallons was collected. The water was sampled and measured to be 2.8×10^{9} µC/cc. The letter indicated that the "water was released to the Rocketdyne [Area III Silvernale, Site-Wide Water Reclaim System] pond."[1]

- A December 8, 1976 Rockwell International internal letter documented the release of radioactive sludge during the replacement of the radioactive waste line to the Building 4055 holdup tanks. According to the letter, removal of the old radioactive waste line was started by a contractor on December 6, 1976. The waste line was broken open where it exits Building 4055 a four smears were taken inside the pipe. The smears measured 0 dpm and the contractor was allowed to break out the remainder of the waste line. Approximately 2 hours after the initial start of work, water and sludge were observed running out of the line. Two sludge samples were taken and measured 15 and 53 dpm. Direct readings from inside the removed pipe read 700 dpm.

  Rockwell International surveyed the contractor personnel and instructed the contractor to cease work. Rockwell International staff removed the pipe and dirt where the sludge had run out of the pipes on December 7, 1976. Contaminated materials were put in "burial boxes" for disposal. A survey of the trench on December 7, 1976 indicated that no contamination was detected; however, the internal letter did not provide the results of the survey. The contractor

[1] EPA/HGL, *Final HSA 5-D,* p. 90, citation 1:

[1] Lane, W.D., North American Rockwell Internal Letter Re: Water Leak at the NMDF, January 14, 1971.

was informed that the trench was released, and was allowed to resume work.[1]

- On June 30, 1978 it was discovered that a stack monitor vacuum line had not been monitored for 23 days. Air samples taken directly from the room where the stack monitor was located were about twice the normal activity of the filtered air; however the incident report did not indicate what these levels were (A0225).[2]

- On July 21, 1978 it was discovered that a stack monitor in the plutonium facility was out of service for 84 hours due to an electrical failure. The incident report stated that airflow through a filter was maintained and no uncontrolled release of material occurred (A0226).[3]

- On March 27, 1983 Protective Services Control Center notified the facility health physicist of a stack monitor alarm. Upon investigation, the stack monitor chart showed an increasing count trend for about 1 hour to 26 dpm. The filter was removed and counted for alpha radioactivity. The result was 7 dpm alpha immediate and 3 dpm alpha after 19-hours of decay. After a 72-hour decay, the final count on the stack sample was 0 dpm for a 100-minute counting time. The event was attributed to “the effect of atmospheric inversion conditions on naturally occurring airborne radioactivity.” The alarm was reset and remained at normal levels. The incident report did not indicate whether the filter was reinstalled in the stack or if it was replaced with a new filter and disposed of (A0114).[4]

- On August 29, 1986 an unknown amount of water overflowed from the RMHF transfer tank onto asphalt at Building 4055. A summary of the incident was reported to have been included on an attached flysheet; however, the flysheet was not attached to the file obtained by the research team. As a result, additional information regarding this incident, including the location, cannot be provided at this time. Additional information may become available upon receipt of additional documents from Boeing’s 1.4 million document database.[5]

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[1] EPA/HGL, *Final HSA 5-D,* p. 91, citation 1:

[1] Bradbury, S.M., Rockwell International Internal Letter Re: Replacement of R/A Waste Line to Hold-up Tanks at Bldg. 055, December 8, 1976.

[2] EPA/HGL, *Final HSA 5-D,* p. 91, citation 2:

[2] Owens, D.E., Internal Letter Re: Incident Report, July 26, 1978.

[3] EPA/HGL, *Final HSA 5-D,* p. 91, citation 3:

[3] Owens, D.E., Internal Letter Re: Stack Monitor Failure at NMDF, August 1, 1978.

[4] EPA/HGL, *Final HSA 5-D,* p. 91, citations 4 & 5:

[4] Moore, J.D., Internal Letter Re: Quarterly Review of NMDF (T055) for Radiation Safety – First Calendar Quarter, 1983, July 7, 1983.

[5] Bradbury, S.M., Internal Letter Re: Radiological Safety Incident Report, March 29, 1983.

[5] EPA/HGL, *Final HSA 5-D,* p. 91, citation 1:

[1] Begley, F.E., Internal Letter Re: Radiological Safety Incident Report, October 21, 1986.

Section 8.4

Building Number: **4005**
Building Alias: **05 / T05**

Building Name: **1950's - OMRE Support**
1960's - Uranium Carbide Fuel Manufacturing Pilot Plant (UCPFF)
Apollo Counterweight Coating Program (DOE-NASA)
1970's - Molten Salt Test Facility (Coal Gasification)
Decontamination of Sodium Components
1980's - NOx-SOx Burner / Coal Processes

Building Function: Thermodynamic Testing related to the OMRE / Piqua Reactors, and Uranium Carbide Fuel Manufacturing / Coal Gasification Support

Note: **"Non-Radiological" designation**
Workers may not have been monitored
Radiological uses & incidents documented
1987 Contamination: 107,954 dpm/100 cm² (beta) 2,467 dpm/100 cm² (alpha)
DOE would not release for unrestricted use until 1994

Radionuclides of Concern: As the UPCFF, Building 4005 was used to react uranium oxide with graphite to convert it to uranium carbide. The facility operated for a period of 9 months during 1966 and 1967, using depleted uranium and enriched uranium.[1] Drain lines, duct work, walls and floor were found to be contaminated with natural and enriched uranium (U-238, U-234, and U-235) and fission products (C-14, Mn-54, S-35, Th-231, Th-234, P-32, Fe-59, and Co-60).[2] Protactinium-234m (Pa-234m) is excluded from the list of radionuclides of concern as a result of its short half-life of 1.17 minutes. However, for the purposes of dose reconstruction, its potential ingestion and/or inhalation by employees deserves consideration, given its properties and potential health hazards.

8.4.1 Description of Operations & Processes

Building 4005 was constructed in 1958 for non-nuclear testing of thermodynamic characteristics of proposed coolants for the Organic Moderated Reactor Experiment (OMRE) and Piqua

[1] EPA/HGL, *Final HSA 5-A,* p. 142, citation 600-602:

[600] Rockwell International, Decontamination and Decommissioning of the Uranium Carbide Fuel Facility – Building T005, 005-AN-002, September 28, 1993.

[601] Rocketdyne, Final Radiological Survey of Building 005, 005-ZR-0001, September 21, 1993.

[602] Rockwell International, Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective, N001ER000017, December 20, 1989. p. 19

[2] EPA/HGL, *Final HSA 5-A,* p. 142, citation 603 & 604:

[603] Rocketdyne, Final Radiological Survey of Building 005, 005-ZR-0001, September 21, 1993.

[604] Unknown Author, Laboratory Status Report, Building 005, circa 1959, 3 pages.

reactors.[1] During the mid-1960's, Building 4005 was converted into a small-scale production facility, the Uranium Carbide Fuel Facility, to study the operations associated with manufacturing reactor fuel assemblies out of uranium carbide for the AEC Heavy-Water Organic Cooled Reactor. The work was performed under the authority of the AEC's Chicago Operations Office, whose policy at the time exempted the operations in Building 4005 from licensure.

A 1968 Operational Safety Unit Weekly Newsletter[2] references the Apollo Counterweight Coating Program. Given SSFL's involvement in the Apollo program and SNAP, shield irradiation tests being conducted at the STR/STIR facilities nearby, and requirements of the Apollo shielding that were being developed, it is reasonable to deduce that this process involved NASA and North American Aviation Space & Information Division Rocketdyne employees. According to the memo, extensive contamination levels in the furnace room of Building 4005 during the Apollo Counterweight Coating Program ranged "from 40,000 dpm/100 cm^2 after breakout. [Employees] made reasonable efforts to decontaminate between melts. Contamination levels were usually reduced to less than 5,000 dpm/cm^2. Spread of contamination from the work area was minimal, since levels in the hallway and change area were always less than 200 dpm/100 cm^2." According to the document, finger ring badges were issued; extremity doses were incurred during the operation that were significant "but less than six rad for the entire six-week operation. Dose rates at contact with the freshly-cast counterweights ranged to 10 rad/hr, as did the crucible and mold." The document explains that decommissioning efforts at Building 4005 were underway; equipment leaving the facility was tagged as uncontaminated (less than 200 dpm/cm^2 beta, less than 50 dpm/100 cm^2 alpha). Equipment that was contaminated to higher levels was wrapped in plastic and sent to RMHF or Building 4063. In addition, the memo explains that Building 4005's furnace room (108 and 110) with an average radiation level of about 10,000 dpm/100 cm^2 beta and 500 dpm/100cm^2 alpha.

In the pilot plant, uranium oxide was reacted with graphite to convert it to uranium carbide, which was cast into pellets, machined, and assembled into cladding tubes to make fuel assemblies. During this time approximately 700 UCx cylinders (.25" in diameter x 3" long) were fabricated. In 1967, equipment was removed and surfaces were reportedly decontaminated to permit non-radiological use of the building. However, the 2006 Site Profile specified that uranium contamination at this location had not yet been "cleaned up," and several incidents documented after 1967 involved radioactive materials.

Beginning in 1972, Building 4005 was used as the Molten Salt Test Facility, a non-nuclear test facility consisting of the Molten Salt Test Bed and the Process Demonstration Unit (PDU). According to the 1992 environmental monitoring program plan, the molten salt gasification plant (PDU) was designed to demonstrate the technical feasibility of producing sulfur-free, low-Btu product gas by partial combustion of Illinois No. 6 coal in a sparged bed of molten, sodium carbonate salt ("make-up salt"). The process resulted in "green liquor," similar to that formed in a Kraft paper mill. This liquor (2 to 3 gallon per minute stream) was filtered and processed to regenerate sodium carbonate for recycle to the gasifier. According to the 1992, plan, these operations were first started in November 1978 and operated for a total of nine test runs until

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[1] EPA/HGL, *Final HSA 5-A,* p. 131, citation 552:

> [552] Rockwell International, Decontamination and Decommissioning (D&D) of the Uranium Carbide Fuel Facility – Building T005, 005-AN-002, September 28, 1993.

[2] Atomics International, Internal Letter to R.E. Remley from R.E. Alexander, Re: *Operational Safety Unit Weekly Newsletter for the Period Ending June 1, 1968,"* June 6, 1988. File: HDMSp01640028.pdf

final shutdown in June 1981. The total operating time was approximately 1,500 hours at an average coal feed rate of 0.25 tons per hour.

In addition to the above, in 1982, Building 4005 also contained a low NOx-SOx burner to determine the possibility of burning high-sulfur coal with reduced emissions of NOx and sufur dioxide. 48 test runs were completed between 1982 to 1988. According to the 1992 environmental monitoring program plan, the location had been partially remediated by removing bulk quantities of coal and fly ash.

It should be noted that throughout the building's function as a "non-radiological" facility devoted to coal gasification processes (from the early 1970's onward), according to the 2006 Site Description, the ventilation ducts, filters and piping that were contaminated with uranium still had not been "cleaned up." This suggests that the building, despite any designation as a "non-radiological facility" from the standpoint of personnel and potential exposure, was contaminated with radioactive substances for the entirety of its use as a Molten Salt Testing and NOx-SOx facility.

The building included a number of concrete pads that held equipment used in the Molten Salt Oxidation Project and radioactive filter plenums from the fuel fabrication project.[1]

Building 4005 was divided into several portions, including a small administration area, change rooms, chemistry laboratories, storage rooms and a large high-bay area. The building was connected to two underground radioactive liquid holding tanks by drain lines that extended from various laboratories and work areas within Building 4005, and were made of cast iron.

The preliminary MARSSIM Classification of Building 4005 is Class 1 becasue of prior history as a uranium carbide fuel facility, known site contamination, reported incidents, and unknown building demolition operations.

8.4.2 Building 4005 UCPFF Radiological Incident Reports

There have been several incidents associated with Building 4005 that could have resulted in a release to the environment and worker exposure. It should be noted that while the building was considered a "non-radiological" facility, incidents involving radioactive materials are documented. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

8.4.3 Building 4005 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0494	12/17/1959	Low Bay	N/A	Employee did not wear prescribed protective clothing in a controlled area
A0473	6/3/1960	High Bay	S-35	HBR and kerosene caught fire.

[1] EPA/HGL, *Final HSA 5-A,* p. 131, citation 554:

[554] ORISE, Verification Survey of Buildings 005, 023, and 064, Santa Susana Field Laboratory, Rockwell International, Ventura County, California, 94/K-14, October 1994.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0430	8/15/60	HBR Low Bay	N/A	Hot OMRE coolant spilled in hood, burning employee
A0603*	12/31/1966	UC Conv. Room	Uranium Carbide	Failed coolant line in UC conversion room
A0606	1/30/1967	Building 5 Pad	Uranium Carbide	Fire in roto cone duct work on service pad
A0605	2/13/1967	Room 115	Uranium Carbide	Fire reported in duct between “Queen City” and scrubber
A0649	7/18/1967	UCPFF	Uranium	A small fire occurred in the large particle collection tank.
A0215	8/8/1991	North Pad	Depleted Uranium	Contaminated oil dripped from radioactive exhaust duct to pad.

*Incident file name A0603 does not appear to be an incident report. Rather, the document is an internal letter dated Januaray 5, 1967, with the subject, “Radiation Safety Unit Weekly Highlights for the Week Ending December 31, 1966.” A portion of this letter has been redacted and it is possible the referenced incident description has been redacted and, as a result, cannot be summarized.

- On December 17, 1959 an employee was observed working the South Low Bay lab of Building 4005 without a “red line” lab coat or film badge in two separate instances.[1]

- On June 3, 1960 while high boiler residue was being drained from the impurities loop system, a fire broke out within its enclosure. The incident report indicated the fire occurred in the north high bay of the building. Smears of the outside surfaces of the enclosure and nose swipes at the time of the incident determined no detectable contamination. On June 6, 1960 the Building 4005 Health Physicist surveyed the entire area and found contamination of 80 dpm/100 cm^2 inside the enclosure on burned areas. According to the report, the highest radiation intensity, also on the burned areas, was approximately .9 mR/hr. The nature and quantity of the material could not be deciphered from the scanned document (gallons of 40% high boiler residue containing mainly S-35 and C-14?) (A0473).[2]

- On August 15, 1960, an employee was filtering treated “OMRE” coolant in a hood in the south low bay of Building 4005. The employee used a vacuum procedure in an attempt to improve the filtration. During this procedure, some of the liquid spilled onto the protective cotton gloves, seared through the gloves, and caused a second degree burn. The incident report stated that no contamination was detected on the worker’s skin (A0430).[3]

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[1] EPA/HGL, *Final HSA 5-A,* p. 136, citation 570:

[570] Atomics International, Notice of [Illegible] Infraction, A0494, December 18, 1959.

[2] EPA/HGL, *Final HSA 5-A,* p. 136, citation 571:

[571] Warren, J.W., A0473, Building 4005 North High Bay, July 1, 1960.

[3] EPA/HGL, *Final HSA 5-A,* p. 136, citation 572:

[572] Warren, J.W., A0430, Radiological Safety Incident Report, Bldg 005 Low Bay, August 15, 1960.

- On January 30, 1967 a uranium fire occurred in a retention tank of a vacuum system. Tank ducting was burned through, allowing a release of contaminated smoke to the building. According to the radiation safety unit weekly newsletter summarizing the incident, no large-scale dispersal of contamination and no personnel exposure occurred as a result of the uranium fire. Samples of the residue removed from the tanks following the fire were submitted for analysis; however, the results of this analysis were not provided in the documentation relating to this incident (A0606).[1]

- A February 23, 1967 radiation safety unit weekly newsletter stated that on February 13, 1967 a small fire occurred in a metal exhaust duct connecting a grinder with an air scrubber. A small amount of uranium carbide material had collected in an elbow of the duct and was ignited by a hot chip. No unfiltered release occurred, and damage was limited to burning of the paint on the surface of the duct. The newsletter states at the end of the same paragraph that "a total of 700 gallons of radioactive liquid effluent with a concentration of 3.7x10^{7} uc/cc were released from tank #4 to the surface drain." (A0605).[2]

- According to a radiation safety unit weekly newsletter for the week ending on July 8, 1967 an inspection of Building 4005 resulted in the discovery that an undiscovered fire occurred in the large particle collection tank resulting in the blistering and peeling of the facility vacuum system. The inspection determined that no release to the atmosphere resulted (A0649).[3]

- On August 8, 1991, personnel conducting a facility surveillance inspection observed an oil spill on the concrete pad under the radioactive exhaust duct. The area was surveyed with a GM beta-gamma probe that measured 8,000 dpm/100 cm^{2} beta-gamma. All removable contamination was bagged and removed from the area. The spill was painted and identified as fixed contamination. The exhaust duct was decontaminated at the suspect area and contained with tape and plastic. A "smear swipe" of the spill was collected and analyzed. Analysis determined that the material was depleted uranium with a total activity of approximately 2nCi (2x10^{9} Ci). The total activity of the spill was approximately 4 nCi, below the radioactive material labeling limit for natural uranium of 100 µCi (A0215).[4]

8.4.4 Radiological Investigations

Following the fuel fabrication program in 1967, the building was decontaminated to permit non-radiological use of Building 4005. However, only "some" of the radioactive liquid drain lines were

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[1] EPA/HGL, *Final HSA 5-A,* p. 136, citation 573:

[573]. Unknown, Internal Letter Regarding "Radiation Safety Unit Weekly Newsletter for Period Ending February 4, 1967," February 9, 1967.

[2] EPA/HGL, *Final HSA 5-A,* p. 136, citation 574:

[574] Unknown, Internal Letter Regarding "Radiation Safety Unit Weekly Newsletter for Period Ending February 13, 1967," February 23, 1967.

[3] EPA/HGL, *Final HSA 5-A,* p. 136, citation 575:

[575] Alexander, R.E., Internal Letter Regarding "Radiation Safety Unit Weekly Newsletter for Period Ending July 8, 1967," July 13, 1967.

[4] EPA/HGL, *Final HSA 5-A,* p. 136, citation 576:

[576] Wallace, J.H., Radiological Safety Report A0215, August 12, 1991.

removed. Additional decontamination was required in 1987; walls and floors of rooms and hallways; radioactive ventilation drops and drain lines, etc. The radioactive exhaust ducting, filter plenums, and underground radioactive drain lines were apparently not removed, since another characterization survey showed these items still in place and contamination was above 1987 DOE release limits. The acceptable limits were 1000 dpm/100cm^2, but the beta level detected was 107,954 dpm / 100 cm^2 and the maximum alpha level detected was 2,467 dpm/ 100 cm^2. The EPA HSA provides a detailed chronology of radiological investigations associated with Building 4005.

Section 8.5

Building Number: **4064**
Building Alias: **064 - T064**

Building Name: **Fuel Storage Facility**

Building Function: **Nuclear Material / Source Radioactive Material Storage**
Radioactive Waste Storage
Contained materials for TRUMP-S Tests

Notes: **Tritium / Neptunium**
Drainage through Area III to Area II Ponds

Radionuclides of Concern: U-233, U-234, U-235, U-236, U-238, Th-228, Th-232, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Ra-226, Cs-134, Cs-137, Sr-90, **H-3**, Na-22, K-40, Mn-54, Fe-55, Co-60, Ni-59, Ni-63, Eu-152, Eu-154, Pm-147, Ta-182, **Neptunium**

8.5.1 Description of Operations & Processes

Building 4064 was constructed in two phases; the first in 1958 and the second in 1963. It was built to meet AEC criteria for vaults for the storage of fissionable material, equipped with intrusion alarms, and fenced.[1] The HSA provides a detailed description of the building's features, equipment, schematics, and processes.

Building 4064 was designed and built as a special nuclear material and source radioactive material storage building. It was used for storing packaged items of source material (natural uranium, depleted uranium, thorium) and special nuclear materials (enriched uranium, plutonium, and U-233) of various forms and configurations. Originally, the north (Room 114) and south (Room 110 and 104 vault) contained steel racks for storing material. The south side was primarily used for the storage of highly enriched uranium and plutonium bearing items; the north side was primarily used for source material and "low" enriched uranium storage.[2]

Enriched uranium powders and source material powder packages were split into smaller units or combined into larger units in a glove box located in Room 104. The glove box was removed from Building 4064 at an unknown time. During shutdown and termination of the SNAP program, excess Zr-U (enriched uranium) alloy material was sectioned into lengths suitable for

[1] EPA/HGL, *Final HSA 6,* p. 158, citation 5:

[5] Boeing Environmental Affairs, Fact Sheet, *Building 4064 – Fuel Storage Facility*, February 10, 2000.

[2] EPA/HGL, *Final HSA 6,* p. 159, citation 4:

[4] Remley, M. E. General Storage Data for Buildings 064 and 022, October 7, 1977.

packaging for shipment in DOE containers. This was done in Room 104; the floor was covered with plastic sheeting and the Zr-U was sectioned using a hack saw.[1]

During the early 1960's, the metal racks in the south half of Room 110 were removed in order to store material in "bird cages" and drums. This storage included large quantities of special nuclear material recoverable scrap. At this time, the fenced yard areas in the front, side, and back of Building 4064 were used to store 55-gallon drums of low-level enriched recoverable scrap. This material was shipped off-site in the mid-to-late 1960's and early 1970's, and may have relied on packaging containers constructed by employees at the Building 4163 Box Shop. Rockwell International claims that residual contamination from handling bare metallic pieces was from enriched uranium, natural uranium, depleted uranium, and thorium. Most reactor contracts had ended by the early 1980's. After 1980, no special nuclear material powders were handled or repackaged at this location. After all fissionable material had been removed, miscellaneous equipment and containers of radioactive waste (principally soil) were stored in Building 4064. In 1993, all nuclear material was removed and Building 4064 was decontaminated.

The HSA provides a detailed description of previous radiological investigations and decontamination/cleanup of releases. In brief, Rockwell International discovered high alpha radioactivity on the concrete ramps leading to rooms 110 and 114 in 1988. The alpha activity was concluded to arise from natural elements in the concrete that could not be removed. Ambient gamma exposure rate measurements showed a contaminated area bordering and outside the eastern fence, but according to Rockwell, no contamination was detected inside the fenced-in storage yard. Ambient gamma exposure rate measurements made outside the fence in the 2-acre area showed an area of about 4,000 square feet contaminated with Cs-137. Two soil samples collected from an area of greatest exposure rate showed a Cs-137 radioactivity concentration of 2,500 pCi/g, regarded as 2,500 times Rockwell's background concentration. Beta activity was measured at 1,200 pCi/g in the area of greatest contamination.[2]

In 1992, Rockwell surveyed a 6,580-square-foot area comprising the fenced in yard that surrounded Building 4064 to assess its radiological condition. All alpha surface activity levels were found to be below "Rockwell International's acceptance limit" of 5,000 dpm/100 cm^2. All beta surface activity levels were found to be below "Rockwell International's acceptance limit" of 5,000 dpm/100 cm^2. All gamma exposure rates were found to be below "Rockwell's acceptance limit" of 5 µR/h above Rockwell's background rate of 15.3 5 µR/h. Rockwell concluded the fenced-in yard of Building 4064 met its criteria for release for unrestricted use.[3]

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[1] EPA/HGL, *Final HSA 6,* p. 159, citation 3:

> [3] Montgomery Watson Harza, DOE Leach Fields (Area IV AOC) RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Draft, October 2003, pp. 2-3.

[2] EPA/HGL, *Final HSA 6,* p. 164, citation 1:

> [1] Chapman, J. A., Radiological Survey of the Source and Special Nuclear Material Storage Vault-Building T64, GEN-ZR-0005, August 19, 1988, pp. 2, 91-92.

[3] EPA/HGL, *Final HSA 6,* p. 164, citation 8:

> [8] Kneff, D. W., Tuttle, R. J., and Subbraman, G., *Radiological Assessment of the Building T064 Fenced-in Yard*, Rockwell International, N704SRR990035, January 12, 1994, pp. 10, 40-41.

In 1992 ORISE concluded Rockwell's cleanup was incomplete upon identifying three Cs-137 hotspots in the site yard. Rockwell subsequently remediated the hotspots and revised the Building 4064 side yard guidelines to meet a more restrictive 10 mrem/yr maximum dose rate for a residential scenario.[1]

In 1993, Rockwell removed all known radioactively contaminated equipment, components, and structures from Building 4064, as well as asbestos containing materials. All radioactive waste was packaged and shipped to an unnamed disposal facility. This activity may have relied on the construction of shipping containers by employees in the Building 4163 Box Shop.[2]

The preliminary MARSSIM classification for the building 4064 area is Class 1, due to its location within the ETEC and its former use as storage for radioactive source and special nuclear materials and radioactive waste.

8.5.2 Building 4064 Radiological Incident Reports

There have been several incidents associated with Building 4064 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

8.5.3 Building 4064 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0523	3/10/1959	SS Vault SSFL		Personnel entered vault area without required film badges.
A0028	2/18/1963	Yard SS Vault	MFP	Cask drain plug rusted out, draining contaminated water onto the ground.
N/A	5/3/1963	SS Vault	U	Cans of UC exploded inside SSFL vault.
A0468	10/8/1964	SS Vault	U	Can of UC exploded inside a "birdcage" shipped to SSFL Vault.
A0622	7/20/1967	SS Vault SSFL	U308	Outside transfer of U powder caused increased activity in vegetation samples.
A0095	1/12/1982	Vault		RAS Alarm Response.
A0109	9/21/1982	Vault		Response to RAS alarm at SS Vault.

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[1] EPA/HGL, *Final HSA 6,* p. 165, citation 1:

[1] Vitkus, T. J., Verification Survey of the Old Conservation Yard, Building 064 Side Yard, and Building 028, Santa Susana Field Laboratory, Rockwell International, Ventura County, California, ORISE 93/J-107, October 1993, pp. 5-11.

[2] EPA/HGL, *Final HSA 6,* p. 165, citation 3:

[3] Dahl, F. C. and Tuttle, R. J., *Final Radiological Survey Report of Building 064 Interior*, ETEC Report No. SSWA- ZR-0001, January 14, 1994, pp. 17-19.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0218	6/8/1992	Storage Racks	U	Employee stacking fuel storage racks cut hand.
A0663	8/8/1995	Side Yard	Cs-137	Performing the modified Area IV transient survey in grid R24S25, a hot spot was found.
A0687	9/28/1998	Side Yard	Cs-137	Excavated 6 cubic yard of Cs-137 contaminated soil.

*Isotopes are written as they are presented in the incident database. The HSA research team believes that "MFP" is an acronym for Mixed Fission Products.

- On March 10, 1959 an employee entered the storage vault without a film badge and it was not known how long he was in the vault. The employee was reminded on other occasions to wear his film badge (A0523).[1]

- On February 18. 1963 soil east of the exclusion fence at the SS Vault was found to be contaminated during a routine survey. Three additional surveys revealed an area of 700 square feet of asphalt and soil contaminated with mixed fission products to a maximum of 700 mrad/h at 2 inches. It was deduced that the contamination resulted from a cask containing irradiated Seawolf submarine reactor fuel pins. The cask was received at the vault, stored, transferred to the Hot Lab for inspection, and returned to the vault for storage. After storing the fuel pins for 1.5-2 years it was shipped back to Westinghouse around May, 1962. Sometime during this last storage period, it is believed that the drain plug rusted through, permitting fluid contaminated within the cask to spill onto the asphalt. A soil sample showed 8,340 pCi/g beta-gamma gross radioactivity, including $1x10^6$ dpm/g of Cs-137 and $2x10^5$ dpm/g of Cs-134. Alpha activity was negligible in all samples. Approximately 2,365 gallons of soil and asphalt were removed at the vault to reduce the maximum contamination level to 0.5 mrad/h. Three inches of soil was removed from all the contaminated soil areas and 80 percent of the areas were found to be free of contamination upon resurveying. The remaining areas were excavated up to 1.5 feet. Fill soil was brought in by the maintenance department to return the soil levels to their previous level (A0028).[2]

- On May 3, 1963 an explosion occurred in the north vault of Building 4064. The sources of the explosion were a 1-gallon can containing 8.3 kilograms of uranium carbide (3.7 percent enriched U-235) in the form of fines and pieces, and a 1-gallon can containing 2.5 kilograms of uranium carbide (4.9% enriched U-235) comprising sintered pieces. The fuel in both cans was immersed in Redline 60 oil. The explosion was believed to have been caused by the release of hydrogen gas from degrading uranium carbide. After 20 minutes elapsed, the Atomics International Fire Department entered the vault and smothered the cans with Metal X.

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[1] EPA/HGL, *Final HSA 6,* p. 161, citation 1:

[1] Loba, M. L., Internal Letter, Re: Violation of Health Phys. Practices, March 13, 1959.

[2] EPA/HGL, *Final HSA 6,* p. 161, citations 2 & 3:

[2] Badger, F. H., North American Aviation Internal Letter, re*: Contamination Incident SS Vault Santa Susana*, November 11, 1965.

[3] Moore, J. D., Atomics International Internal Letter, re*: Radioanalysis Report*, February 22, 1963.

According to Atomics International, a smear survey confirmed that contamination had been confined to the interior of the vault, however the Incident Report indicates that contamination was noted some contamination on the grill of the ventilation exhaust. The cans were removed and the vault was decontaminated using kerosene and K-pads. Atomics International planned to remove approximately 10 square feet of asphalt floor tiles where the cans had been located.[1]

- On October 8, 1964 a custodian found black oxidized powder deposited on the inside of a "bird cage" container. Investigation revealed that uranium carbide had oxidized blowing the lid off one 1-gallon can and warping the bottom of the container. The inside of the can was surveyed at 5 x 103 dpm/100 cm^2 alpha. Contamination levels on the concrete dock of the building 4064 increased to 200 dpm / 100 cm^2 alpha from a "clean" level. Evidence suggested that an inert atmosphere had not been sufficiently established in the 1-gallon container (A0468).[2]

- On July 20, 1967 an investigation was performed to identify reasons for increased alpha activity in vegetation samples between Building 4064 and the fire station. It was determined that uranium carbide and uranium oxide powder had been transferred from one 55-gallon drum to another in the Building 4064 storage yard. The drum from which material had been removed was still located in the yard on a piece of plastic sheeting and visible amounts of uranium oxide powder remained. The plastic was folded carefully and disposed of as radioactive waste. No "significant" surface contamination was found in areas other than the plastic sheeting and vegetation samples collected between Building 4064 and the fire station. Personnel were cautioned about procedures for transferring radioactive materials or opening drums of radioactive materials (A0622).[3]

- On January 12, 1982 an alarm went off in Building 4064. Crews arrived at the building to check it out and the all-clear was given within an hour of arriving on the scene. The cause for the alarm was unknown and the alarm was to be checked by maintenance (A0095).[4]

- On September 21, 1982 an alarm went off in Building 4064. Crews arrived at the building to check it out and the all-clear was given within an hour of arriving on the scene. The cause for

[1] EPA/HGL, *Final HSA 6,* p. 161, citation 4:

[4] Coonce, G. L., Atomics International Internal Letter, re*: UC Fire at Building 064*, May 8, 1963.

[2] EPA/HGL, *Final HSA 6,* p. 162, citation 1:

[1] Owen, D. E., Atomics International Internal Letter, re*: Incident Report, Building 064 Vault, 10-8-64*, October 27, 1964.

[3] EPA/HGL, *Final HSA 6,* p. 162, citation 2:

[2] Alexander, R. E., Atomics International, re: Radiation Safety Unit Weekly Newsletter for Period Ending July 22, 1967, August 2, 1967.

[4] EPA/HGL, *Final HSA 6,* p. 162, citation 3:

[3] Bradbury, S. M., Rockwell International Internal Letter, re: Radiological Safety Incident Report, Building 064, 1/12/82, Unknown Date.

the alarm was unknown and the alarm was to be checked by maintenance (A0109).[1]

- On June 8, 1992 an employee was stacking storage racks on a pallet when he cut the palm of his hand. No detectable activity was noted on the employee's hand or the storage racks, despite concern for fixed U-235 contamination under paint on the fuel storage racks (A0218).[2]

- On August 8, 1995 a hot spot of approximately 1 square foot was identified during an Area IV survey in grid number R24S25. The hot spot was measured at 10,000 cpm or 46 µR/h. Per Rockwell's procedure, a 1 meter ambient survey was performed, but it was below the 5 µR/h above background limit for classifying as a hot spot. However, the Building 4064 sideyard was a formally remediated facility, so the discovery was reported to the Area IV survey project manager. The hot spot was roped off and a sample was taken. The sample contained 271 pCi/g of Cs-137. The Cs-137 concentration was too low to be considered an inhalation hazard and the surface radiation was only three times background, so there were no specific safety concerns. According to Rockwell, the discovery of contamination did not warrant a formal occurrence report because building 4064 was not yet released for unrestricted use. The hot spot had been identified in a verification survey by the Oak Ridge Institute for Science and Education (ORISE), but had not been properly communicated to Rockwell. The discovery was cited as an example of the importance of a walk-about surface gamma surveying used in the Area IV characterization survey (A0663).[3] The exact location of this hot spot has not been identified but it appears to be west of Building 4064.

- On September 28, 1998 ORISE discovered an area of elevated soil contamination in the side yard. The area measured approximately 18 feet by 6 feet and was located on the sloping bank between 10th street and the Building 4064 parking lot. A total of 6 cubic yard of soil were excavated until radiation levels reached background levels. ORISE resurveyed the area, verified that radiation levels were normal, and collected two soil samples. Rockwell collected additional samples to confirm that the remediation had been successful (A0687).[4]

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[1] EPA/HGL, *Final HSA 6,* p. 162, citation 4:

> [4] Bradbury, S. M., Rockwell International Internal Letter, re: Radiological Safety Incident Report, Building 064, 9/21/82, September 22, 1982.

[2] EPA/HGL, *Final HSA 6,* p. 162, citation 5:

> [5] Wallace, J. H., Rockwell International Internal Letter, re*: Radiological Safety Report, T064 South Vault, 6/8/92*, June 17, 1992.

[3] EPA/HGL, *Final HSA 6,* p. 163, citation 1:

> [1] McGinnis, E. R., Rockwell International Internal Letter, re: Radiological Incident Report, Soil Contamination Found in T064 Sideyard, 8/8/95, August 25, 1995.

[4] EPA/HGL, *Final HSA 6,* p. 163, citation 2:

> [2] Rutherford, R., Rockwell International Incident Report, re*: Verification Survey,* September 28, 1998.

9.0 Disassembly & Examination of Reactors / Used Reactor Fuel Assemblies

There are two Hot Laboratories documented at SSFL. The Building 4009 SGR Hot Laboratory was not included in the 2006 Site Description. It is described in detail in Section 6.1, "Critical Test Facilities."

As indicated in the 2006 Site Description, reactor test operations often required examination of reactor fuel assemblies and other test specimens to determine how they were performing. Reactors were often removed from their operating locations, and moved to the Building 4020 Hot Lab for examination. Some of the reactors required complete disassembly for the transition. Other, smaller reactors, (like the S8DR after its fuel failure) were moved without complete disassembly. For instance, the S8DR was transitioned to the STIR Facility for "dry runs" before being taken to the Building 4020 Hot Lab for disassembly and analysis.

The Building 4020 Hot Laboratory was used to examine fuel and/or components from the SRE, SER, S2DR, S8ER, S8DR, and the S10FS3 reactors at SSFL, the OMR and SGR criticality test facilities, and the Piqua, Ohio, reactor. It was also used to declad fuel from the SRE, EBR-1, EBR-II, Hallam, Fermi, and Southwest Experimental Fast Oxide reactors. In addition, it may have been used in the examination of the NASA nuclear reactor, the HMRSFR that operated in Building 4012. In addition, the Hot Labs were used to manufacture sealed sources.

The 2006 Site Description indicates that as a result of the work in the Building 4020 Hot Lab, the interior of the Hot Cells and equipment they contain "have been contaminated by small amounts of uranium, plutonium, thorium, and fission and activation products. Some exterior surfaces have become slightly contaminated, as well. The extent of the contamination is approximately 2.2 Ci in the drain system, ventilation and exhaust system, and inside the shielded cells plus traces of contamination on the building walls and surroundings."

The 2006 Site Description only references one incident (a fire, May 19, 1971 - Incident Report #A0052). The 2006 Site Description states that, "No measurable external or internal exposures of radiation were received by personnel involved in the activities before, or during the fire."

The following description of the Building 4020 Hot Laboratory, conducted by EPA as part of the HSA component of the Area IV Radiological Study, documents **129 incidents** associated with the facility that could have resulted in environmental releases and worker exposure.

Section 9.1

Building Number: **4020**
Building Alias: **020 - T020**
Visitor Log Entry Code: **6012 / 6000C / 6001F / T020 / AIHL / RIHL**

Building Name: **Hot Laboratory**
Component Development Hot Cell

Building Function: Research and development, examination, decladding, decontamination, analysis, etc. of fuel and highly radioactive materials. Please see detailed list of Hot Cell uses and description of building processes below.

Notes: According to Incident Report A0027, airflow in the Hot Lab was below design standards in some areas. **Tritium use.** Numerous incidents resulting in worker exposure and airborne releases.

Radionuclides / Constituents of Concern: Building 4020 handled a number of radionuclides including uranium, plutonium, thorium, and promethium. Decay products from U-235, U-238, and Th-232 decay chains include Th-234, Th-228, Ac-228, Ra-226, Pb-214, Bi-214, Pb-212, Bi-212, and Tl- 208. In addition, **H-3**, Sr-90, Cs-137, Na-24, Co-57, Co-60, Eu-152, and Am-243. Solid reactor fuel materials (including but not limited to) U-Mo, UO2, U-ZrH, plutonium-bearing fuels, (in addition to cladding materials: aluminum, sintered aluminum powder, stainless steel, zirconium, Hastelloy alloys, Sodium, and NaK bonded capsules).

9.1.1 Description of Operations & Processes

The Building 4020 Hot Laboratory is among the most detailed in the EPA HSA. Its diverse operations, numerous incidents resulting in releases and worker exposure, and myriad of functions were thoroughly investigated by EPA's research team and explained in detail in the HSA. The below description of building operations and processes is only an abbreviated synopsis of the information contained in the EPA HSA. In addition, EPA felt it was appropriate to include numerous excerpts from employee interviews conducted by EPA and DOE during the Area IV Study and HSA component. The interviews detail job processes and incidents at Building 4020 over several eras of facility operations. They are contained, in their entirety, on the accompanying disk with the EPA HSA report.

Building 4020 was constructed in 1959 as the Component Development Hot Cell used for the remote handling and examination of highly radioactive materials. During initial construction, the facility's radioactive drain was connected to two 500-gallon holdup tanks that were located in the north end of the basement. One tank was designed for high-level waste, and the other for low-level waste. Following an incident whereby these tanks overflowed (no incident report available), the system was modified by installing a 3,000 gallon tank in Building 4468 in approximately 1970, and removing the 500-gallon tanks from Building 4020 in 1977. After the new system was installed, the contents of these sumps were pumped into the Building 4468 holdup tank.[1] Building 4020 was connected to the Area III Sewer Treatment System.

According to the 1984 license renewal application, stack sampling was performed to permit the measurement of particulate radioactive material discharged from the facility. This monitoring was performed quarterly and the results were presented annually in environmental monitoring reports. However, documents indicate that emissions were sampled for entrained particulate radioactive materials by means of continuous stack samplers that were installed at the point of release. In addition, a gas monitor was also installed in the stack to measure radioactive gas discharges and to indicate accidental criticality of low-energy releases occurring within a cell. According to DOE's Environmental Audit (1989) radiological monitoring was inadequate.[2] CORE Advocacy has included a disk containing historical documents, with this Proposed 2016 SSFL Site Description. A folder on the disk contains approximately 30 historical Environmental Monitoring Reports authored by Atomics International, between the 1950's to mid-1980's.

Building 4020 was used for the examination and evaluation of reactor fuels and components, and in irradiation test materials. This included Sodium Reactor Experiment (SRE) fuel assemblies and moderator cans, fuel elements from the Ohio Piqua Nuclear Power Facility and the Organic Moderated Reactor Experiment (OMRE) reactors, and fuel test capsules irradiated at the Materials Testing, Engineering Test, General Electric Testing, (HWOCS) and Hanford reactors.

Irradiated fuel test capsules, based on available documents, appear to have been used in experiments to verify predicted release rates and disposition of fission products from vented fuel elements. They required disassembly at Building 4020, similar to fuel rods, to remove radioactive material. An april 13, 1971 internal letter documents the preparation of Building 4020 for the acceptance and disassembly of an "**URIPS-1P-RTG**" from Aeroget-General Nuclear Company. The fuel for the RTG was documented to be a capsule containing 7,700 Ci of Sr-90.[3]

Building 4020 was also used for the disassembly and examination of Systems for Nuclear Auxiliary Power (SNAP, a DOE-NASA project) Reactor cores, the analysis of irradiated test materials, the manufacture and leak-testing of sealed radioactive sources (primarily Pm-147), and the machining of radioactive Co-60. At an unknown date, the entire SNAP 8 Experimental Reactor core, containing 211 fuel elements, was disassembled and examined at Building 4020.

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[1] EPA/HGL, *Final HSA 5D,* p. 14, citations 4,5,6:

> [4] Boeing, EID-06141, "Hot Laboratory Decontamination and Dismantlement Final Report," November 27, 2001.
>
> [5] Boeing, Document No. RS-00010, *Area 4020 MARSSIM Final Status Survey Report*, October 31, 2000.
>
> [6] Badger, F.H., Rockwell International Internal Letter, *Re: Radiological Occurrence – Bldg T020*, October 3, 1977.

[2] DOE Office of Environmental Audit, "DOE Activities at SSFL," 1989. Page 4-37, Paragraph 4, Re: Radiological Monitoring.

[3] EPA/HGL, *Final HSA 5D,* p. 22, citations 1&2:

> [1] Atomics International, Document No. NAA-SR-9469, *Project Proposals Fiscal Years 1965 and 1966, Sodium Cooled Reactor Development Programs¸* November 2, 1964.
>
> [2] Heine, W.F., North American Rockwell Internal Letter Re: Operational Safety Unit Weekly Highlights – Week Ending 4/9/71, April 13, 1971.

The SNAP 10FS3 reactor, including the vessel, core, primary pump, and piping, was also disassembled and examined at the Hot Lab.

The Hot Lab involved the use of Dowanol, which is a trade name for ethylene glycol n-butyl ether (99%), which was found to be effective for the removal of sodium and NaK from components by reaction. Its use at SSFL for the removal of sodium is documented in documented as early as 1965,[1] and it is reasonable to assume Dowanol was routinely used in all SSFL sodium component cleaning and testing facilities.

Specific operations performed in Building 4020's Hot Cells varied, depending on the program needs and changing program requirements. However, the work was principally categorized as "research and development." The various capabilities of each cell block area was listed in the 1984 license renewal application[2] as follows:

- Cell #1:
    - Preparation of samples of irradiated material for metallography
    - Micro-hardness testing
    - Microscopic measurements
    - Preparation and replication of samples for electromicron microscopy
    - Autoradiography on mounted samples

- Cell #2
    - Materials testing, tensile testing, stress-rupture and creep testing, fatigue testing
    - NaK and sodium distillation
    - Visual examination
    - Density measurements
    - Dimensional measurements
    - Minor component disassembly
    - Fission gas collection
    - Isotope encapsulation
- Cell #3
    - Disassembly cell for irradiated materials
    - Sample preparation
    - Elox equipment
    - Cutoff wheel
    - Waste packaging
    - Visual examination
    - Stereomicroscopic examination
    - Dimensional measurements
    - Cask Unloading

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[1] EPA/HGL, *Final HSA 5D,* p. 23, citation 3:

[3] Atomics International, NAA-SR-MEMO-11605, Weekly Hightlights for S8ER Operations Week Ending August 21, 1965, August 27, 1965.

[2] EPA/HGL, *Final HSA 5D,* p. 23, citation 6:

[6] Rockwell International, ESG-82-33, Health and Safety Sections for Renewal Application of the Special Nuclear Materials License SNM-21, Docket 70-25, Issued to Energy Systems Group of Rockwell International, June 5, 1984.

- • Cell #4
  - Hydrogen analysis (Tritium)
  - Profilometer measurements
  - Annealing studies
  - Permeation testing
  - Major component disassembly and repair
  - Visual examination
  - Stereomicroscopic examination
  - Fuel canning
  - Dimensional measurements
  - Waste packaging
  - Cask unloading and loading
  - Density measurements
  - Gamma spectroscopy
  - Autoradiography on capsule assemblies

The Hot Cells were backed by decontamination rooms for examining high-level radioactive material. The areas surrounding these included office space, an operating gallery, operations support, a mock-up area, and a service gallery. The operations support facilities included a hot storage room (Room 153), air lock (Room 155), hot laboratory (Room 141), manipulator maintenance room (Room 128), and glove box laboratory (Room 139).[1] The EPA HSA provides a detailed description of Building 4020's features, dimensions, and equipment routinely used in each part of the Atomic International / Rockwell International Hot Laboratory (AIHL / RIHL). The facility also included hot and cold change rooms, a photographic laboratory, and office areas.

The preliminary MARSSIM Classification for the Building 4020 is Class 1 because of previous site use, incident reports, and radioactive material use during building operations.

9.1.2 Building 4020 Radiological Incident Reports

There have been several incidents associated with Building 4020 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

9.1.3 Building 4020 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0002	8/26/1959	CDHC		Hot cell door ramp fell, striking an employee's hand
A0001	12/5/1959	CDHC	Mixed Fission Product	Radioactive liquid spilled during vendor pickup.

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[1] EPA/HGL, *Final HSA 5D,* p. 15, citation 3:
[3] Boeing, EID-06141, "Hot Laboratory Decontamination and Dismantlement Final Report," November 27, 2001.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0392	4/14/1960	CDHC DECON 4	Mixed Fission Product	Weekly radiation limits exceeded
A0003	4/18/1960	CDHC	Mixed Fission Product	Irradiated SRE fuel slug placed in an employee's hand
A0011	5/12/1961	CDHC	Mixed Fission Product	Unsafe Handling of B of E Cask
A0505	5/20/1961	CDHC	Mixed Fission Product	Personnel contaminated during waste transfer operations.
A0347 (same incident as A0505 above)	5/21/1961	Service Gallery	Mixed Fission Product	Employee contaminated while loading waste box
A0283	6/2/1961	Cell 3	Mixed Fission Product	Employee exposed to airborne activity when supplied air hose was pinched.
A0012	6/19/1961	CDHC C2 & D2	Mixed Fission Product	Employee attempted to enter very high radiation area.
A0317	5/9/1962	Cell 4	Mixed Fission Product	Irradiated fuel slug burned in Cell 4 releasing radioactive gas.
A0016	5/31/1962	North Pad / Drain	Mixed Fission Product	Portable radioactive liquid tank overflowed on North Pad flowing to surface drainage.
A0018	9/4/1962	Cell 4	Mixed Fission Product	Repair of Fission Gas Analyzer caused high airborne activity and contaminated personnel and lab
A0020	12/5/1962	North Pad / Drain	Mixed Fission Product	Contaminated shoes from controlled area contaminated most of Hot Lab.
A0021	1/25/1963	Cell 3	Mixed Fission Product	Employees hand contaminated when glove tore in Hot Cell.
A0433	5/8/1963	Cell 3	Mixed Fission Product	Waxing mop swung through controlled area contaminated the clean area.
A0022	7/2/1963	Radioactive Storage Yard		Spill of OMRE HB 40 coolant in radioactive storage yard.
A0316	7/8/1963	RIHL & Off Site	Mixed Fission Product	Employee contaminated clothing during cask movement out to storage yard.
A0027	925/1963	Cell 3	Mixed Fission Product	A fire occurred during dissolution of NaK from fuel decladding in Cell 3.
A0024	9/26/1963	DECON / Cell 3	Mixed Fission Product	NaK and alcohol fire during cleaning of fission gas monitor.
A0025	9/26/1963	Cell 3	Mixed Fission Product	Exposure above guidelines during cell cleanup.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0026	10/9/1963	Cell 2	Mixed Fission Product	Uncontrolled furnace left on overnight burning cell equipment.
A0031	3/20/1964	OP Gallery	Mixed Fission Product	Fire suppressing nitrogen purge of Hot Cells generated airborne activity.
A0551	6/8/1964	CDHC Slave Shop	Mixed Fission Product	Unauthorized and unprotected employee contaminated by contaminated equipment.
A0443	6/16/1964	CDHC OP Gallery	Mixed Fission Product	Fuel element elevated in cell causing radiation streaming through slave parts.
A0338	7/10/1964	Service Gallery		Outer and inner doors to airlock open at the same time.
A0554	7/23/1964	CDHC Cell 4	Mixed Fission Product	Contaminated employee was deconned by medical department.
A0354	8/27/1964	OP Gallery	Mixed Fission Product	High airborne activity resulted after loss of exhaust controller
A0415	9/3/1964	CDHC Cell 1	Mixed Fission Product	In-cell work resulted in exposure above guidelines and employee contamination.
A0337	10/15/1964	Service Gallery	Mixed Fission Product	Employee became contaminated while bagging shielding blanket.
A0574	11/18/1964	CDHC Cell 3	Mixed Fission Product	Exit survey from cells revealed speck contamination.
A0033	11/26/1964	North Pad	Mixed Fission Product	Radioactive liquid transfer tank was over-filled and contaminated outside area.
A0034	12/7/1964	Storage Yard		Radioactive material stored in yard creating radiation levels above guidelines.
A0035	5/27/1965	OP Gallery	Mixed Fission Product	High airborne activity during decladding NaK bonded uranium carbide fuel.
A0037	7/16/1965	OP Gallery	Mixed Fission Product	Disintegrated fuel deposited in filter was spread during recovery.
A0441	8/12/1965	AIHL Yard	Mixed Fission Product	Rain water from one way waste cask dumped in clean area contaminating ground.
A0038	9/21/1965	OP Gallery	Mixed Fission Product	Cell purging with nitrogen caused high airborne activity.
A0039	2/2/1966	Metalograph Room	Mixed Fission Product	Extremity exposure above guidelines from picking up irradiated fuel sample.
A0040	2/24/1966	Service Gallery	Mixed Fission Product	Maintenance of contaminated Elox machine resulted in high airborne activity.
A0042	8/16/1966	ALL OF AIHL		Failure of emergency power generator caused increased airborne activity.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0044	12/31/1966	Room 139	Pm147	Fabrication of heat sources caused extremity exposures above guidelines.
A0607	1/28/1967	Service Gallery	Mixed Fission Product	Contamination tracked from slave shop to service gallery and hot shop.
A0613	4/6/1967	AIHL Cell 3	Mixed Fission Product	Fire occurred in Cell 3 during cutting of metallurgical sample.
A0617	5/17/1967	AIHL Glove Box	PM-147	Promethium glove box transfer caused high airborne activity and nasal smears.
A0619	6/10/1967	AIHL Glove Box	Pm-147	Wast removal from the promethium glove boxes caused high airborne activity.
A0046	8/21/1967	RM 139 Glove Box	Pm-147	Extremity exposure above guidelines during fabricated of heat sources.
A0047	10/11/1967	RM 139	PM-147	Ingestion of Pm-147 during cleanup operation.
A0627	10/30/1967	AIHL	Mixed Fission Product	AIHL Radioactive Drain System plugged up and flooded controlled area.
A0050	7/22/1970	Cell 3 AIHL	Mixed Fission Product	Small alcohol fire during disassembly of NaK bonded fuel element
A0051	10/11/1970	OP Gallery AIHL	Ra Th	High airborne alarm after-hours due to increase in natural activity.
A0052	5/19/1971	DECON 4 AIHL	Mixed Fission Product	A major fire resulted during draining of NaK tank in Decon 4.
A0054	7/29/1975	Cell 2 AIHL	Kr-85	SRE fuel slug partially burned releasing radioactive gas and contamination.
A0060	9/30/1977	Basement	Mixed Fission Product	Failure to comply with requirements caused contamination of basement floor.
A0067	4/25/1978	DECON 2	Mixed Fission Product	Employee contaminated with concentrate from sodium digestion.
A0069	5/3/1978	DECON 2 STILL	Mixed Fission Product	A 5-minute alcohol evaporator fire in Decon 2.
A0076	2/9/1979	DECON 2	Mixed Fission Product	Alcohol distillation system spilled contaminating employee.
A0088	8/21/1981	Hot Storage Room	Mixed Fission Product	Bags of radioactive waste were broken during loading, releasing contamination.
A0092	10/20/1981	AIR LOCK	Ta-182	One Rad-Pac pin tossed in radioactive waste.
A0101	3/22/1982	Cell 1	Mixed Fission Product	Zirconium fuel pin cladding fines ignited causing high airborne contamination.
A0104	6/28/1982	D4 and Airlock	Mixed Fission Product / Ta	Working two projects resulted in extremity exposure about guidelines.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0105	7/13/1982	DECON 4 AIHL	Mixed Fission Product	Faulty crimping seal resulted in alpha contamination of employees.
A0325	8/16/1982	Liquid Waste BL		RAS alarm response at RIHL radioactive liquid waste bldg.
A0110	10/11/1982	DECON 4 AIHL	Pu/Mixed Fission Product	Leaking glove box glove caused cross-contamination of two employees.
A0112	12/22/1982	DECON 4 AIHL		Employee experienced a seizure while working in a controlled area.
A0262	4/21/1983	MBA 54	Pu	Incorrect I.D. of fuel rod resulted in grams of Pu in excess of MBA limit
A0120	7/15/1983	Alpha Box D-4	Pu/Mixed Fission Product	Loss of glove seal during change-out on alpha box contaminated employee.
A0119	8/8/1983	Decon 3	Mixed Fission Product	Leaking transfer tube contaminated employee and decon room.
A0118	10/11/1983	Cell 3 Face	Mixed Fission Product	Radioactive liquid siphoned from cell contaminating wide area of building.
A0122	1/30/1984	RIHL	Ta-182	Contaminated electrode was worked on a clean grinder and tracked out of building.
A0124	3/22/1984	Cell 3	Mixed Fission Product	Protective clothing failure allowed caustics to burn and contaminate employee.
A0125	8/20/1984	Cell 3		During in-cell repair an employee bumped his head, drawing blood.
A0126	8/21/1984	DECON / Cell 3	Mixed Fission Product	Employee contaminated smearing low-level tools with high-level contamination.
A0127	10/15/1984	Cell 3	Mixed Fission Product	During remote decon the alcohol caught fire.
A0128	10/28/1984	Slave Shop	Mixed Fission Product	Employee contaminated hands handling bag of radioactive waste.
A0129	12/6/1984	Cell 1	Mixed Fission Product	Failure of protective clothing seal contaminated employee.
A0130	12/10/1984	Cell 1	Mixed Fission Product	Failure of protective clothing seal contaminated employee.
A0131	12/10/1984	Cell 1	Mixed Fission Product	Improper unsuiting contaminated employee.
A0133	12/10/1984	Cell 1	Mixed Fission Product	During decon of Cell 1 extremity exposure exceeded administrative guidelines.
A0134	1/14/1985	Decon 1	Mixed Fission Product	Bag radioactive waste came untaped and contaminated employee’s pants.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0132	1/15/1985	Slave Shop	Mixed Fission Product	Employee cut finger with contaminated screwdriver.
A0135	2/20/1985	SHOP	Mixed Fission Product	Employee cut finger on Cell 4 end door gear shaft during repair.
A0136	3/4/1985	Cell 1	Mixed Fission Product	Contaminated sharp object punctured protective clothing contaminating shoes.
A0137	3/20/1985	Service Gallery	Mixed Fission Product	Contaminated item from cell 1 contaminated personnel and area with opened.
A0139	6/6/1985	SLAVE SHOP	Mixed Fission Product	Decon with acid resulted in burning and contamination of employee.
A0140	8/12/1985	Decon 1	Mixed Fission Product	Contaminated puncture wound occurred during packaging radioactive glass waste.
A0142	10/4/1985	Service Gallery	Mixed Fission Product	Personal clothing worn under protective clothing became contaminated.
A0141	10/17/1985	Cell 3	Mixed Fission Product	Sharp object in cell 3 punctured protective clothing contaminating shoes.
A0147	10/25/1985	Cell 3	Mixed Fission Product	Protective clothing leached contamination onto employee.
A0148	11/4/1985	Cell 3	Mixed Fission Product	Protective clothing leached contamination onto employee.
A0145	11/13/1985	Cell 3	Mixed Fission Product	Protective clothing leached contamination onto personal shoes and socks.
A0143	11/20/1985	Cell 4	Mixed Fission Product	Protective clothing leached contamination onto personal shoes and socks.
A0144	11/21/1985	Cell 3	Mixed Fission Product	Protective clothing leached contamination onto personal shoes and socks.
A0146	11/22/1985	DECON 4 AIHL	Mixed Fission Product	Protective clothing leached contamination onto personal shoes and socks.
A0149	12/10/1985	Hot Storage Room	Mixed Fission Product	Employee pinched hand while loading radioactive waste in box, drawing blood.
A0150	1/14/1986	ALL OF AIHL		A review of recent non-reportable incidents at AIHL/RIHL.
A0151	2/4/1986	Cell 4		Loss of breathing air supply during cell entry.
A0152	2/19/1986	RM 139		Maintenance employee cut finger on radioactive exhaust plenum.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0155	3/4/1986	Service Gallery		Alconox and water solution splashed in eye of employee.
A0156	4/16/1986	Hot Storage Room	Sr-90	Inventory revealed check source missing.
A0165	10/28/1986	Cell 4	U/Mixed Fission Product	Ignition of Fermi saw chips during disassembly in Cell 4.
A0173	3/12/1987	Cell 4		Employee passed out from heat exhaustion in radioactive environment of cell #4.
A0174	7/10/1987	Cell 2	Mixed Fission Product	Employee contaminated wrist during doffing protective clothing.
A0175	7/14/1987	Cell 2	Mixed Fission Product	Protective clothing seal failure resulting in contamination of employee’s neck.
A0177	7/20/1987	Cell 2	Mixed Fission Product	Exist survey revealed neck contamination on employee.
A0178	10/15/1987	Service Gallery	Mixed Fission Product	Waste handling exit survey revealed contaminated pants.
A0181	12/1/1987	Operating Gallery		Employee pinched finger and drew blood while working with a radioactive shield plug.
A0182	12/17/1987	Sump Pump		Employees entered RAAEP area and confined space without permits or approvals.*
A0185	6/13/1988	Basement Alcove		Faulty meter alarmed security guards.
A0190	9/30/1988	Cell 1	Mixed Fission Product	Exit survey revealed contamination on knee and forearms after cell work.
A0192	11/14/1988	Storage Room 153		Employee received puncture would in contaminated area.
A0193	1/4/1989	Cell 1	Mixed Fission Product	Improper seal of protective equipment allowed radioactive inhalation by employee.
A0198	06/6/1989	Cell 1	Mixed Fission Product	Employee exit survey revealed contamination from in-cell operation
A0199	0629/1989	Cell 2 & DECON 1	Mixed Fission Product	Exit survey revealed general point of contact contamination
A0201	10/4/1989	Glove Box RM 139	Pu	Puncture wound in plutonium glove box room
A0587	12/15/1989	RIHL Airlock		Filter failure on vacuum cleaner during scabbling of contaminated concrete.
A0205	4/18/1990	Cell 2	Mixed Fission Product	Contaminated steel chip projectile penetrated wrist cutting radial artery.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0207	7/17/1990	Cell 3	Mixed Fission Product	Ladder slid out from under employee while sledge hammering in cell.
A0210	10/17/1990	Service Gallery	Mixed Fission Product	A dropped duct section missed employees but caused airborne activity.
A0213	12/17/1990	T468 Radioactive Liquid BL		False reading on RAS detector caused alarm.
A0267	8/26/1991	OP Gallery		Contamination barriers blown out into clean area by grit blaster in cell.
A0571	6/17/1993	RIHL basement	Mixed Fission Product	Employee became contaminated during D&D of radioactive exhaust duct.
A0575	9/15/1993	RIHL CELL 3		Dosimeter went off scale during work in high radiation area.
A0662	5/10/1995	Area IV Decon 3		Dumping of vacuum catch-drum without notification.
A0668	4/16/1996	SS T020 Rm 147		Particle on right shoe.
A0675	3/26/1997	Parking Lot		Loss of control of radioactive material.
A0677	7/2/1997	Frisked shoe		Contaminated pipe.
A0679	8/15/1997	Rubber boot		Rubber boot had a hole in it.
A0678	8/15/1997	Left Hand		Contractor removed paper suit without gloves.
A0689	10/a/1997	To20 Parking Lot		Shipment of clean T020 Building debris prior to state confirmatory survey.
A0682	3/20/1998	So. Storage Yard		Unauthorized move of radioactive material.

*****The acronym RAAEP cannot be defined from available documents. On December 17, 1987, an incident occurred at a sump pump and employees entered a confined space without the proper permits or approval (Incident Report A0182). The original incident report is identified as missing from Boeing's incident files. No other details are available on this incident at this time.

9.1.4 Incidents of Known Environmental Releases

• On December 5, 1959 radioactive liquid spilled during vendor pick up and contaminated the vendor's truck. The Coastwise Marine Disposal Company arrived to pick up approximately 2,000 gallons of liquid waste from the hold-up tanks in the basement of Building 4020. The truck was parked adjacent to the north loading dock of the building and the flow of liquid was controlled by a valave near the dock. The van was loaded with 51 empty 55-gallon drums and lids. The wooden floor of the van was covered with a white powder used to solidify liquid waste, but the floor was not watertight. A long plank was resting on top of the drums for walking from the back to the front of the van and a long stick was used for stirring the solidifying agent into the wastewater. The first drum of water was pumped out to the 50-gallon mark and then the solidifying agent was added to demonstrate its capabilities.

When the agent was dumped into the drum, a small amount of radioactive water splattered out into the truck body and flooring and also onto some planks in the back of the open van. The vendor was directed to put some covering down in the back of the open van. A piece of plastic sheeting was provided and the vendors were told not to move off the plastic without removing all protective clothing and leaving it on the plastic sheeting. A bit later, a small amount of water was observed coming out of the van body and running onto the rear wheels of the van. Solidifying agent was immediately thrown on the floor of the van to try and soak up the radioactive water that was trickling down onto the wheels and ground. Pumpin of the water was halted until a satisfactory means of controlling the water inside the van body was devised so that more radioactive water would not be spilled onto the asphalt loading pad. The wastewater transfer was stopped until the degree of contamination could be determined.

Smears were taken of the truck wheels, axle and body and the asphalt area under the truck. Twenty smears were taken and averaged approximately 75 dpm / 100 cm^2 beta gamma. The background radiation intensity had not risen on the survey insrument over normal levels. Pumping operations were discontinued until the truck and area were decontaminated to a level of 40 dpm/100 cm^2 beta gamma, the Atomics International contamination limit for an uncontrolled area. The truck was wiped down and allowed to leave the area after smears showed the beta gamma measurement was less than 30 dpm/100 cm^2 (Incident Report A0001).[1]

The quantity of liquid waste released to the ground surface was not reported in the incident report. Additionally, the report does not describe any cleanup efforts that were made on the asphalt surface. Resulting contamination on the asphalt surface would have flowed across the parking lot and into the drainage ditch.

- On May 9, 1962 a fire occurred in Cell #4 of building 4020. Prior to the fire, an irradiated capsule containing uranium slugs in a stainless steel tube bonded with sodium-potassium allow (NaK) was being disassembled in the Hot Lab. The capsule was separated into two pieces and during decladding of the longer piece in Call 4 the liquid nitrogen supply necessary to maintain the cell atmosphere ran out. Examination of the fuel was discontinued and the fuel slugs were stored under amyl alcohol in a metal tray and covered with a metal plate.

  It was thought that a piece of partially oxidized NaK may have fallen onto the cell floor during the transfer of slugs to the metal tray. When the humidity in the cell increased, the NaK oxidized at a rate that generated sufficient heat to ignite the cell floor covering and the alcohol vapors outside the metal tray. Alcohol inside the tray also evaporated exposing the fuel slugs to air and allowing NaK inside the slugs to oxidize. Three of the nine fuel slugs were destroyed completely. According to the incident report, at the time of the fire, the only volatile radioisotopes remaining in the fuel in significant quantities were krypton-85 (Kr-85) and iodine-131 (I-131). A maximum of 7.8×10^{5} micro curies per cubic centimeter (µCi/cc) of Kr-85 and 1.3×10^{6} µCi/cc of I-131 were estimated to be released through the exhaust stack. The incident report summarized that the release could not have resulted in significant exposure to

[1] EPA/HGL, *Final HSA 5D,* p. 47, citation 1:

[1] Clow, H.E., Atomics International Internal Letter, *Re: Liquid Waste Removal at CDHC*, January 20, 1960.

personnel or surrounding areas (Incident Report A0317).[1]

- On May 31, 1962, a portable radioactive liquid holdup tank was being filled from the radioactive holdup tank inside Building 4020. The operator's attention was diverted by a leaking pipe fitting at the bottom of the portable tank. While the operator was tightening the pipe fitting, the portable tank overflowed and a maximum of 50 gallons of liquid was spilled. Analysis of the liquid remaining in the tank showed an activity level of 2.2×10^{-3} µCi/cc, indicating a total activity of 420 µCi involved in the spill. The portable tank was on a concrete pad surrounded by an asphalt apron that sloped to the roadway. The spilled liquid immediately flowed down slope to the road and then to a drainage ditch, which connected to the "cold sewerage system." The pattern of the spill is shown in a Building 4020 figure included in this report (Figure 2.2.1s).

  Decontamination procedures began immediately. Within minutes of the spill the area was hosed down with fire hoses to prevent any fixation of particulate matter and to dilute liquid already in the drainage ditch. The area was roped off and decontamination of the asphalt began with mops and brushes. Prior to decontamination smears of the asphalt and concrete pad were as high as 50,000 dpm. After a series of scrubbing procedures the area was decontaminated to the point that no detectable removable contamination was found. The area was then surveyed with a portable floor monitor and a 2612 G.M. survey instrument to locate areas of fixed contamination.

  Thirty-seven "hot-spots" approximately 2 inches in diameter were found to have radiation levels in excess of 1 millirad per hour (mrad/hr). Levels ranged from 2 mrad/hr to 130 mrad/hr beta-gamma. These areas were marked with white paint and chipped away. Following chipping, no detectable activity remained. A survey of the drainage ditch with the 2612 G.M. survey instrument found no activity above normal background. Sixty samples were taken from the bed of the drainage ditch from the site of the spill to the sewage treatment facility. Contamination levels ranged from less than 30 dpm to greater than 500 dpm beta-gamma, with an average of approximately 100 dpm beta- gamma contamination. The ditch was sampled from the site of the incident to its entry into the sewage treatment facility. The contamination appeared to be evenly distributed throughout this 400 yard length. Surface soil samples of the ditch showed contamination in the amount of 0.06 µCi/ft^2 (using a factor of 10 for self absorption of the sample). The entire length of the ditch was approximately 1,500 square feet (ft^2), so it was estimated that the total contamination remaining in the ditch was 90 µCi. The incident report notes that removal of the contamination was probably not warranted by the contamination levels, the "narrow, tortuous and deep" nature of the ditch, and the fact that the ditch traversed unoccupied areas. Additional flushing was seen as increasing the rate of contamination in the sewer system. It appears from the incident report that no other cleanup was performed, although recommendations for prevention of similar incidents were made

[1] EPA/HGL, *Final HSA 5D,* p. 48, citation 1:
Remley, M.E., Atomics International, to Levy, J. V., U.S. Atomic Energy Commission, *Re: Fire in the Component Development Hot Cell, May 9*, June 7, 1962.

(Incident Report A0016).[1]

- On July 2, 1963, an area in the radioactive holding area of Building 4020 approximately 15 feet by 3 feet was contaminated to a level of 7.4×10^4 µCi/cc. The incident report did not provide a detailed description of the location of this contamination. The Health and Safety Section requested the area be decontaminated and sealed before the contamination spread to other clean areas. This area was contaminated during a spill of "EB 40" from the Organic Moderated Reactor Experiment (OMRE) cask (Incident Report A0022).[2]

- On July 8, 1963, three Atomics International employees working at Building 4020 were contaminated while moving a cask containing radioactive waste material. The cask was transferred from Cell #1 to a building airlock using a fork lift and special lifting rig. At the airlock the cask was placed in clean plastic bags. The cask was then transferred to a clean fork lift outside the building, without changing the contaminated lifting rig that had been used inside the building. Three employees working outside the building had contact with the contaminated lifting rig. Because the three employees were involved in different stages of the procedure and had continued on to other activities in the day, personnel contamination was discovered over the course of a day. One employee had to have his car and home surveyed as he had gone home before the contaminated lifting rig had been discovered. A spot of contamination was noted on the employee's shirt and his trousers at 0.03 mr/hr and 0.7 mr/hr, respectively; however, it was not felt that contamination had spread outside of Atomics International premises (units may be incorrectly presented in the source document). The lifting rig was decontaminated and personnel surveys indicated no significant external or internal radiation exposure (Incident Report A0316).[3]

- On September 25, 1963, a fire occurred in Cell #3 of Building 4020. The fire occurred during the dissolving of NaK bonding material on fuel cladding using butyl alcohol, a routine operation. Concurrent with the start of the fire, the operating gallery continuous air monitor increased approximately 400 Ci/m beta-gamma. A high volume air sample taken in front of Cell #3 after the fire began indicated 9.4×10^{10} µCi/cc beta-gamma, a factor of 10 higher than a sample taken a short time before the fire. The fire burned a piece of wood, Tygon tubing, butyl alcohol, blotter paper, and the plastic boot that helps keep the contamination levels of the manipulator down. The fire was extinguished within 10 minutes using a nitrogen purge. The airborne concentrations were significant and bioassays of all personnel in the area at the time of the fire indicated a positive and significant intake of mixed fission product. If the cell

[1] EPA/HGL, *Final HSA 5D,* p. 49, citations 1&2:

> [1] Heine, W.F., Atomics International Internal Letter, *Re: Radioactive Spill at CDHC Bldg. 20 Santa Susana*, June 13, 1962.
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> [2] Coonce, G.L., Atomics International Internal Letter, *Re: Contamination Survey*, June 7, 1962.

[2] EPA/HGL, *Final HSA 5D,* p. 49, citation 3:

> [3] Lane, W.D., North American Aviation, Inc. Internal Letter, *Re: Decontamination of R/A Holding Area at CDHC*, July 2, 1963.

[3] EPA/HGL, *Final HSA 5D,* p. 50, citation 1:

> [1] Badger, F.H., North American Aviation Internal Letter, *Re: Investigation of In-Cell Fire at CDHC*, November 4, 1963.

had not recently undergone a major cleanup, the airborne release could have been more serious. During investigation of the incident it was discovered that air flow in the building was below design standards in some areas (Incident Report A0027).[1]

- On November 24, 1964 a radioactive spill resulting from the overflow of a 500-gallon portable liquid holdup tank occurred in the north loading dock area of Building 4020. Transfer of the liquid waste from inside of Building 4020 had stopped when the pump malfunctioned leaving the transfer tank half full. Repairs were made and pumping was restarted at a rate of 30 gallons per minute. The operator, unaware the pump was working at full rate, was approximately 12 feet from the tank when it overflowed. The shutoff valve was immediately closed and a maximum of 25 gallons of liquid was lost at the north loading dock area.

  Analysis of the liquid remaining in the transfer line showed an activity of $2.4x10^{1}$ µCi/cc indicating a total release of $2.3x10^{4}$ µCi/cc was involved in the spill. The radioactive liquid included in Cs-137, zirconium-95 and niobium-95. Approximately 300 $ft.^2$ of cement pad and asphalt were contaminated. The spill area was outlined with spray paint and desiccant was placed in the larger puddles to control runoff. A radiation survey indicated general levels of 10-15 mrad/hr beta-gamma activity and a maximum of 20 mrad/hr beta-gamma at approximately 2 inches above the water on the ground. Preliminary decontamination efforts included scrubbing and vacuum cleaning. The gross contamination of the cement pad was reduced to 1 mrad/hr at the surface and less than 10,000 dpm beta-gamma on a tape smear. Levels on the asphalt, which was covered with a primer coat of paint, were 20 mrad/hr beta-gamma. Final decontamination efforts were completed on December 2, 1964. A final survey showed the cement pad to have 0.3 – 0.5 mrad/hr beta-gamma at the surface, less than 150 dpm beta gamma on tape smear, and less than 30 dpm/cm^2 beta gamma on a normal smear, with three small surface cracks indicating 1.0 mrad/hr. A second coating of primer was applied to the asphalt and a maximum radiation level of 20 mrad/hr beta-gamma was embedded in the asphalt. No removable contamination was evident after the second coat of primer. The contaminated asphalt was not removed. Health and Safety determined that no further decontamination be performed, but the area would be routinely surveyed for future smearable contamination (A0033).[2]

- On May 27, 1965, Cell #3 was under a nitrogen purge to accommodate the decladding of irradiated uranium carbide fuel. The cladding was cut and NaK oozed out. An air monitor at the north end of the operating gallery started to increase, setting off the primary alarm (1,000 Ci/m) and then the upper alarm point of 3,000 Ci/m. The 12-minute air sample indicated $1.5x10^{8}$ µCi/cc. A second air sample taken 30 minutes after the initial alarm was 2.3×10^{9} µCi/cc. Smears taken throughout the area were less than 30 dpm. A third air sample taken fifty minutes after the initial alarm indicated 7.3×10^{10} µCi/cc beta-gamma, immediate count. This sample was recounted 90 minutes later and was $1.4x10^{10}$ µCi/cc beta gamma. The stack monitor indicated two distinct increases in activity. The maximum count rate was 500 Ci/m or

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[1] EPA/HGL, *Final HSA 5D,* p. 49, citation 4:

> [4] Remley, M.E., Atomics International, to Levy, J.V., U.S. Atomic Energy Commission, *Re: Unusual Incident at the Component Development Hot Cell*, July 15, 1963.

[2] EPA/HGL, *Final HSA 5D,* p. 50, citation 2:

> [2] Ericson, G.I., Atomics International Internal Letter, *Re: Radioactive Liquid Spill at CDHC Building 020*, January 12, 1965.

an estimated 6.5 x 10 [8] µCi/cc. The total gaseous release at the stack was estimated to be .012 mCi over a two hour period. No personnel or equipment contamination was detected (A0035).[1]

- On August 12, 1965 rainwater from a one-way waste cask was being dumped in a "non-radioactive outside storage area" at the Hot Lab when an "unusually large" volume of water spilled out of the cask. The incident report did not provide a detailed description of the location of the incident. A survey of the water found it contaminated with 300 µCi of mixed fission product in suspension. The runoff was contained and the area secured. An absorbent was placed on the liquid and contamination was measured up to 20 mrad/hr. After vacuuming the absorbent and scrubbing the area with "Radiac Wash" the contamination was brought down to 0.2 mrad/hr. Contamination was confined to a 3-foot by 10-foot section of asphalt and no personnel contamination resulted from the incident. It was surmised that the cask had been improperly tagged and had possible internal contamination (A0441).[2]

- On October 30, 1967 a radioactive liquid drain system clogged, spreading contaminated water throughout controlled areas of Building 4020. The water was pumped into the RMHF 500-gallon transfer tank, but removable beta contamination levels as high as 1.3×10^6 dpm/100 cm^2 remained. It was reported that all areas were successfully decontaminated (A0627); however, details of the decontamination efforts were not provided.[3]

- On May 19, 1971 there was a fire in Decon #4 during the disposal of 100 gallons of liquid NaK, which contained 100 µCi of mixed fission products. A hole in a tank fill-line caused the release of about 25 gallons of contaminated NaK, which then caught fire. Nearly all contamination was contained in Building 4020. Airborne activity and surface radiological contamination concentrations inside the building from the event range from 2% to 20% of permissible concentration for occupational use and the average concentration released through the stack to the outside of the facility was reportedly about 5% of the permitted concentration for an unrestricted area (A0052).

- On July 29, 1975 a single irradiated SRE fuel slug ignited and partially burned in Cell #2 releasing an estimated 0.77 mCi of Kr-85 gas out of the stack and resulting in the momentary release of airborne radioactivity to the operating gallery. The fire was extinguished in 20 minutes with a nitrogen purge. The incident did not result in any overexposure and did not constitute a reportable incident. The SRE Core I fuel was being prepared for reprocessing by removing all NaK from the fuel slugs.

  The planned NaK distillation proved ineffective on badly damaged fuel and a new system was

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[1] EPA/HGL, *Final HSA 5D,* p. 51, citation 1:

[1] Badger, F.H., Atomics International Internal Letter, *Re: Incident Report*, June 25, 1965.

[2] EPA/HGL, *Final HSA 5D,* p. 51, citation 2:

[2] Badger, F.H., Atomics International Internal Letter, Re: Incident Report, Non-Radioactive Outside Storage Area at AIHL Bldg. 020, SS, 8-12-65, August 16, 1965.

[3] EPA/HGL, *Final HSA 5D,* p. 51, citation 3:

[3] Alexander, R.E., Atomics International Internal Letter, Re: Radiation Safety Unit Weekly Newsletter for Period Ending November 4, 1967, November 10, 1967.

developed in Cell #2 to heat the fuel slugs and sweat the NaK out then dissolve it in alcohol. The slug in question had been soaked in alcohol for several days and ignited when it was heated with a high intensity lamp. The continuous air monitor in the operating gallery stabilized at 6,000 cpm. The stack monitor indicated 700 cpm or 6.5 x 10^{6} µCi/cc going out the stack. Routine analysis of basement air samples indicated 1.87 x 10^{8} µCi/cc beta gamma for a seven day period following the fire. This was a result of airborne activity released to the operating gallery being drawn down the electrical breezeway into up-air dampers in the basement (A0054).[1]

- On October 20, 1981 a "clean" ladder located in an uncontrolled area and scheduled to be loaned out was routinely surveyed and found to be contaminated. The feet of the ladder indicated the highest activity with 30 mrad/hr beta-gamma and 5,000 dpm/100 cm^2 beta-gamma removable contamination. A general contamination level of 1,000 to 2000 dpm/100 cm^2 was reported. No significant alpha activity was detected. The ladder was bagged and placed in a controlled area. All personnel were surveyed and the facility was smeared. No other activity was detected, with the exception of 300 dpm/100cm^2 beta-gamma in Room 139 alongside a file cabinet. Further investigation found the ladder was from the radiologically-controlled service galley area of Building 4020. It had been used in painting Decon #4 in May 1980 and then accounting of the ladder after that time became vague (A0092).[2]

- On December 18, 1981 a survey of the "Rad Pac" loading area of the airlock indicated an abnormally high reading from a low-level waste can. A controlled search of the waste revealed a "Rad Pac" pin entangled in a Kimwipe. The tantalum-182 source pin measured 16.5 mCi of radioactivity. Typically, sources are calibrated individually and stored in numbered holes in a lead brick. Then the specific source pins for the customer are grouped for sealing in capsules and removed to a storage pig. The remaining source pins are removed and placed in a storage vial on a Kimwipe. The vial is closed and placed outside the storage pig. A mechanic missed placing one pin in the vial and it became hidden in a fold of the Kimwipe (A0094).[3]

- On March 22, 1982 zirconium fuel pin fines (fine particles) from grinding of Fermi fuel in Cell #1 reacted violently during an oxidation process and nitrogen purge resulting in high airborne activity in an uncontrolled area of Building 4020. Fermi fuel pins are clad with zirconium. In order to recover the 25% enriched uranium remaining the fuel the zirconium must be removed. Center-less grinding of the fuel was the preferred method. The grindings would be filtered from the coolant and oxidized in a furnace to render the normally unpredictable flammability of the zirconium fines harmless. The wet filter papers with wet fines were stored in a sealed tube until loaded into the furnace. The cell atmosphere would be reduced to less than 5% oxygen by a nitrogen purge. The furnace and fines were put under a vacuum to

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[1] EPA/HGL, *Final HSA 5D,* p. 52, citation 1:

[1] Badger, F.H., Rockwell International Internal Letter, *Re: Fuel Slug Fire – Cell 2, July 29, 1975*, September 29, 1975.

[2] EPA/HGL, *Final HSA 5D,* p. 52, citation 2:

[2] Badger, F.H., Rockwell International Internal Letter, Re: Radiological Safety Incident Report, T020, October 20, 1981, November 19, 1981.

[3] EPA/HGL, *Final HSA 5D,* p. 52, citation 3:

[3] Badger, F.H., Rockwell International Internal Letter, Re: Radiological Safety Incident Report, T020 Airlock, 12/18/81, December 23, 1981.

remove water vapor and then the furnace was turned on to 1,650 degrees Fahrenheit until the fines were oxidized. The oxide would then be placed in a storage can for analysis and disposition.

During the incident, an “O” ring failed and created a loss of vacuum, allowing the “O” ring to burn. The electrical power to the operation was shut down and personnel were evacuated. Initial air samples and smears were normal and personnel returned to work. The oxygen content in Cell #1 was below 5% so the high volume nitrogen purge was switched to low volume and the furnace cool-down air jets were started. A bit later, an air monitor in the operating gallery was checked again and showed a sharp increase in beta-gamma activity (~1,500 cpm). Additionally, the stack monitor showed a 400 cpm increase in particulate activity and a basement air monitor alarmed at ~3,500 cpm. A dilution fan was started and a high volume air sample was taken showing 3x10^{9} µCi/cc. The nitrogen purge rate was changed and the air monitor in the operating gallery stabilized.

Air samples were collected through the building and analyzed. Activities were calculated on the basis of a one hour release. The maximum release occurred in the basement, an unoccupied area, at 1.3x10^{8} µCi/cc. The maximum release in an occupied area was 3.4 x 10-9 µCi/cc at the face of Cell #2. The activity in the stack sample with a one hour base was 1.2 x 10-10 µCi/cc. Analysis of the air samples indicated Cs-137 as the dominant isotope and possible antimony-125 (Sb-125). No other isotopes were identified. Investigation found controllers on the cell purge systems were not working properly and cracks were noted in the radioactive exhaust ducts in the basement. The release of airborne activity was found to be the result of faulty controllers and activation of the furnace air jet cooling system while on a low-volume nitrogen purge. All operations were halted until corrective actions and another safety review of the operations could be conducted (A0101).[1]

- On March 26, 1997 a block with low level contamination was inadvertently not surveyed and released as clean. It was transferred to a radiologically uncontrolled area at the Hot Lab. The contaminated block (300 cpm) was discovered during a state confirmation survey. The block was moved into a radioactive material area and the contamination was reduced to less than 20 dpm/cm2 alpha, less than 100 dpm/cm2 beta, less than 100 cpm above lowest background, and less than 5 µr/hr (units may be incorrectly presented in the source document) above ambient background (A0675).[2]

- On July 2, 1997 a block originally connected to a highly contaminated drain pipe and believed to be filled with concrete slurry was removed, leaking contamination onto the soil and asphalt. The discovery was made after an employee working in the area found contamination on his shoe (800 cpm). The affected area was roped off and highlighted for decontamination. The cause of the incident was determined to be incorrect handling procedures for the block, which

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[1] EPA/HGL, *Final HSA 5D,* p. 53, citations 1 & 2:

[1] Badger, F.H., Rockwell International Internal Letter, Re: Radiological Safety Incident Report, T020 – Cell 1, March 22, 1982, March 29, 1982.

[2] Badger, F.H., Rockwell International Internal Letter, Re: Final Report – Fermi Zirconium Fines Explosion Bldg. 20, April 2, 1982.

[2] EPA/HGL, *Final HSA 5D,* p. 53, citation 3:

[3] Harcombe, R., Boeing Internal Letter, Re: Incident Report, Loss of Control of Radioactive Material, A0675, T020 Parking Lot, 3/26/97, April 9, 1997.

was not originally known to be connected to the contaminated drain pipe (A0677). Additional information regarding the decontamination of this area could not be located by the EPA research team in the documents provided.[1]

- On October 15, 1997 it was discovered that a roll-off of scrap material from Building 4020 was released to an outside contractor without a California Department of Health Services confirmatory survey. The materials in the roll-off had been surveyed clean, the survey documented, and the roll-off released from radiological control by Rocketdyne Health Physics. The state was not given the opportunity to perform a confirmatory survey as required under Rocketdyne's license. A notice of violation was issued. Rocketdyne implemented corrective procedural actions to prevent a recurrence (A0689).[2]

- On March 17, 1998 four unauthorized contract personnel were loading concrete blocks on a flatbed truck from the radioactive materials area at Building 4020. The personnel were not "radiological worker qualified" and thus not authorized for area access. The "Radioactive Materials Area" posting boundary rope had been removed without authorization. A verbal stop-work was issued and personnel were released from the area after being surveyed for radioactive contamination. All contract labor received additional training, and it was determined that the contract workers were allowed through control gates prior to the site supervisor being notified of their arrival (A0682).[3]

[1] EPA/HGL, *Final HSA 5D,* p. 54, citation 1:

> [1] Deschamps, R., Boeing Internal Letter, Re: Incident Report, Contamination Found on Employee's Shoe, A0677, T020, 7/2/97, April 15, 1998.

[2] EPA/HGL, *Final HSA 5D,* p. 54, citation 2:

> [2] Guy, E., Energy Technology Engineering Center, *Occurrence Report, SAN—ETEC-GENL-1997-0001*, January 29, 1998.

[3] EPA/HGL, *Final HSA 5D,* p. 54, citation 3:

> [3] Schaeppi, W., Boeing Internal Letter, Re: Unauthorized Movement of Radioactive Material, March 23, 1998.

10.0 Fabrication, Use and Storage of Radioactive Sources

According to the 2006 Site Profile, SSFL operations required many instruments for detecting and measuring radioactivity. These instruments must be calibrated periodically using known quantities and types of radioactivity called *sources*, which are sealed containers that contain small measured quantities of radioisotopes. Sources are also used for some forms of radiography, irradiation testing, and other applications. Sources were manufactured in the SSFL Hot Laboratory (Building 4020) and used in various facilities at SSFL and elsewhere. Approximately 140,000 Ci of radioactive material (primarily Pm-147) were fabricated into sources at the Hot Laboratory, stored in secured locations and used under carefully controlled conditions.

The HSA research team located more than one location where radiation sources of this type were produced or stored:

Building 4011 - Not Included in 2006 Site Profile
Building 4029 - Included in the 2006 SSFL Site Profile (insufficiently described)
Building 4055 - Included in 2006 SSFL Profile (insufficiently described)

A description of operations and processes associated with Building 4011 is provided in Section 16.0, which contains information on buildings/facilities that were excluded in their entirety from the SSFL Site Profile.

Section 10.1

Building Number: **4029**
Building Alias: **029 / T029**

Building Name: **Radiation Measurements Facility (RMF) - 1962**
Hazardous Waste Materials Facility (HWMF) - 1974

Building Function: **Storage of radioactive source materials**
Storage of hazardous waste materials
Storage of sodium waste (un-permitted RCRA violation)

Radionuclides of Concern: Co-60, Ra-226, Cs-137, Po-Be, Pu-Be

10.1.1 Description of Operations & Processes

Building 4029 was constructed between 1962 and 1965 to store radioactive source materials, including PoBe, PuBe, Co-60, Ra-226 and Cs-137 for instrument calibration.[1] The table below shows the calibration sources used at Building 4029, the source strength, and the date the source strength was measured.

Calibration Sources Used at Building 4029

Source	Source Strength (mCi)	Date
Ra-226*	24.8	1960
Ra-226	132	1960
Ra-226	930	1960
Co-60	Unknown	Not Applicable
PoBe	Unknown	Not Applicable
PuBe	Unknown	Not Applicable
Cs-137	5310	Sept. 1963
Cs-137	5260	Sept. 1963

Source: ETEC Document, 029-AR-0001, “Final D&D Report for Building T029,” March 28, 1996
*A March 1964 incident resulted in the release of Ra-226 from this source capsule at Building 4029.
This incident is discussed in detail below.

Ra-226, Cs-137 and Co-60 were used to calibrate gamma-sensitive instruments while PoBe and PuBe were used to calibrate neutron-sensitive equipment. Based on information contained in the 1006 D&D report, the Ra-226 sources were replaced with two Cs-137 sources and were

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[1] EPA/HGL, *Final HSA 5A,* p. 161, citation 669:
[669] ETEC Document, 029-AR-0001, “Final D&D Report for Building T029,” March 28, 1996.

not used in the facility concurrently. The encapsulated Co-60 source was used in the early 1960’s and was used on a limited basis. It was removed from the facility in about 1965.[1]

PoBe and PuBe neutron sources were reportedly fully encapsulated and stored in a small concrete pit, which was also used to store gamma sources in lead “pigs” when not in use. The neutron storage facility was dismantled in 1964 or 1965. All radioactive source materials were reportedly removed by April 1974 and transferred to another facility. Building 4029 was partially decommissioned at that time.

Beginning in 1974, Building 4029 was incorporated into the Hazardous Waste Management Facility (HWMF) as a storage area along with Building 4133, which served as a treatment facility. The HWMF was for the management of reactive metal waste, including Na, NaK, Li, and LiH_2, and functioned to convert waste metallic sodium into sodium hydroxide.

According to a 1988 DOE memorandum, ten cold traps containing sodium (a reactive hazardous waste) were stored outside the Building 4029-permitted storage area. While it was stated the sodium was contained and would not cause an environmental problem, the storage outside of Building 4029 was a violation of RCRA storage regulations. As a result, ETEC was in the process of developing sawing techniques to cut the taps to that they could be oxidized at the “burn pit.”[2]

In 1996, a D&D report documented the work performed to remove residual radioactive contamination from a relatively inaccessible area of Building 4029. It was released without radiological restrictions in 1997.

Barrels and drums were stored outside Building 4029 for a short period of time in the early 1960’s. In 1989, a storage area was reported to be located near Building 4029 that contained a permitted long-term storage hazardous waste area. Reactive metals including sodium, potassium, sodium potassium, zirconium, and lithium metal were stored in 55-gallon drums. There were also apparently 20 “cold traps” containing reactive sodium metal stored outside

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[1] EPA/HGL, *Final HSA 5A,* p. 162, citation 670, 671, 672:

[670] ETEC Document, GEN-ZR-0006, “Radiological Survey of the Old Calibration Facility – Building T029,” August 19, 1988.

[671] ETEC Document, 029-AR-0001, “Final D&D Report for Building T029,” March 28, 1996.

[672] Rockwell International, Document N001DWP000024, “Radiological Decontamination of Building 029,” July 31, 1989.

[2] EPA/HGL, *Final HSA 5A,* p. 163, citation 677-680:

[677] ETEC Document, GEN-ZR-0006, “Radiological Survey of the Old Calibration Facility – Building T029,” August 19, 1988.

[678] The Boeing Company, *Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1997*, A4CM-ZR-0012, November 23, 1998.

[679] The Boeing Company, Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1998, RD99-115, September 22, 1999.

[680] Scott, Randal, Memorandum Re: Survey Status Report, July 5, 1988.

Building 4029. The area where the traps were stored was not within the permitted hazardous waste storage area. Surveys of the 1960's storage area found no detectable activity.[1]

The preliminary MARSSIM Classification for Building 4029 is Class 1 based on its previous use and the unknown source of the fill material used to backfill excavations during D&D activities.

10.1.2 Building 4029 Radiological Incident Reports

There have been several incidents associated with Building 4029 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

10.1.3 Building 4029 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0029	11/11/1963	SSFL & DS131	CO-60	Investigation of discrepancies in quarterly radioactive byproduct material.
A00032	3/24/1964	Source Well	Ra-226	Leaking calibration source contaminated facility and personnel.
A0367	6/24/1965	Calibration Fac.	Ra-226	Alarm failed when source failed to return to safe storage.
A0577	11/20/1970	Calibration Fac.	Cs-137	Calibration source encapsulation failed during use.

- On November 11, 1963 a health and safety supervisor was notified that six radioactive sources were reported missing from the Quarterly Radioactive By-Product Material Inventory for the third quarter of 1963. The June 30, 1963 inventory was eventually found to be incorrect and all the sources were accounted for, with the exception of the 0.1 mC Co-60 source, which was believed to have been disposed of from the waste disposal shed (Building 131 at Headquarters [DeSoto]) a year earlier. The incident report does not provide any indication that a release occurred as a result of the incident (A0029).[2]

- On March 24, 1964 a leaking calibration source contaminated the building and personnel with 24.8 mCi Ra-226. According to the incident report, the source was one of three containing

[1] EPA/HGL, *Final HSA 5A,* p. 168, citations 705-706:

[705] ETEC Document, GEN-ZR-0006, "Radiological Survey of the Old Calibration Facility – Building T029," August 19, 1988.

[706] Schiffman, Joel, United Stated Department of Energy Environmental Survey Report, June 16, 1989.

[2] EPA/HGL, *Final HSA 5A,* p. 164, citation 689:

[689] Badger, F.H., Internal Letter Re: Investigation of Reported Missing Radioactive Sources, January 8, 1964.

24.8 mCi of Ra-226 as a bromide salt.

On March 24, 1964 the source capsule became detached from the nylon string and fell into the bottom of the source thimble. The 13-foot fall of the source capsule cracked the outer plastic encapsulation surrounding the inner capsule and released some loose Ra-226. The contamination was primarily confined to the source storage well and the source thimble. Three personnel were contaminated with alpha activity on their hands with 2,500 dpm maximum as determined by a portable alpha survey meter. The personnel were evacuated to the Building 4020 (Hot Lab) “hot change room” for decontamination. The area outside the source holder was found to be contaminated with “low-level” removable alpha contamination. Decontamination of the facility reduced fixed and removable contaminatin below detectable levels with one exception at the source storage well at the floor level, at 6 dpm/100 cm^2 alpha.

On March25, 1964 the source was recovered from the source well and was placed in a lead shipping container to await disposition (A0032).[1]

- On June 24, 1965 personnel failed to return a 132 mg Ra-226 source to its well following instrument calibration. Following the departure of the personnel, fire Atomics International employees spent approximately 2,5 hours in the building installing a glove box and connecting it to the building’s absolute filter system. The exposed source was discovered the next day by Health and Safety personnel who were present at the building to conduct a smear survey of a 55-gallon drum containing “a few kg of depleted UC.” The source was returned to the well and the personnel who entered the building during the period of exposure were monitored (A0367).[2]

- On November 20, 1970 the encapsulation of a 4.6 Ci Cs-137 calibration source failed during use and dropped 10 feet to the bottom of the well, resulting in the source getting stuck in the storage well. It was estimated that the external radiation level of the source was 16 R/hr one foot away from the source (A0577).[3]

During a June 1989 DHS inspection of SSFL, DHS reported Rockwell International had received a state permit on December 30, 1983 for a sodium waste storage area at Building 4029. The inspection also stated that, “Rockwell failed to submit a written report to the Department (and EPA) within 15 days after determination of release of the radioactive materials at the sodium storage area (T029).” According to the report, the facility’s Industrial Hygienist “mentioned that they had found radioactive contamination in the sodium storage area.” However, no signs were

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[1] EPA/HGL, *Final HSA 5A,* p. 164, citation 690:

> [690] Busick, D.D., Internal Letter Re: Report of Radioactive Contamination Incident of the Radiation Measurement Facility – Building 029, April 10, 1964.

[2] EPA/HGL, *Final HSA 5A,* p. 165, citation 691:

> [691] Wildanger, A.W., Incident Report Re: Radiation Measurement Facility, A0367, July 9, 1965.

[3] EPA/HGL, *Final HSA 5A,* p. 165, citation 692:

> [692] Owen, R.K., Internal Letter Re: Incident Report – Sealed Source Capsule Failure at T029, December 2, 1970.

posted indicating radioactive contamination.[1] The HSA research team could not locate additional information regarding the contamination referenced by the Industrial Hygienist at Building 4029.

[1] EPA/HGL, *Final HSA 5A,* p. 165, citation 693:

[693] Motiafard, V., State of California, Department of Heath Services, Addendum Report, Rockwell International Corporation Rocketdyne Division, November 30, 1989.

11.0 Preparation of Radioactive Material for Disposal

The 2006 SSFL Site Description indicates that the operation of nuclear reactors and other operations at SSFL (including fuel fabrication, reactor and fuel examination, etc.) generates radioactive waste and other radioactive material that must be disposed. However, the 2006 SSFL Site Description states that no radioactive waste was ever incinerated at the RMHF, and the full description of operations at Building 4664 (Low-Level Radioactive Waste Incinerator) is omitted.

In addition, the 2006 Site Profile implies that no radiological waste disposal occurred on-site, which is incorrect. The disposal of radioactive waste at SSFL is well documented. Radioactive waste was incinerated, buried, burned in open earthen “burn pits,” dumped, and submerged into ponds. In addition, spills and leaks were directed toward various drainage ditches that were directed into the Site Wide Water Reclaim System, which provided Rocketdyne personnel throughout Areas I, II, III and IV with water used to hose down work areas, etc.

The 2006 Site Description provides an incomplete list of the buildings and facilities associated with RMHF, and provides an incomplete, insufficient representation of those that are included. In addition, only two minor incidents at the RMHF are referenced but the HSA provides robust summaries of over 60 incidents involving the RMHF, which are documented in the Incident Database.

The following overview of the RMHF provides additional information, and the excluded locations are described in section 12.0.

11.1 OVERVIEW: Radioactive Materials Handling Facility (RMDF / RMHF)

“The principal source of potential radiation dose to the public from SSFL is the RMDF.”[1]
— United States Department of Energy

The Radioactive Materials Disposal Facility (RMDF) was constructed in 1959. It was originally a support facility for the Systems for Nuclear Auxiliary Power (SNAP) program, the Sodium Reactor Experiment (SRE), and the Hallam Nuclear Power Facility. It was designed to handle the storage, volume reduction, packaging and shipping of SNAP and SRE radioactive waste, and to treat / process / and dispose of waste and radioactive water generated by all Atomics International projects.

Although Boeing has asserted to EPA and provided data contained in the existing SSFL Site Description that asserts no radioactive waste was disposed in the RMHF Incinerator (Building 4664), drawings of the building depict the low-level radioactive waste processing units and equipment. The Incinerator became operational October 5, 1964 and burned low-level radioactive waste at a rate of 100 pounds per hour until it was dismantled in the 1980’s, wherein the incinerator itself was disposed as radioactive waste.[2]

Revelations of Building 4664 Incinerator operations call into question current data applied to dose reconstruction for SSFL employees. Emissions, releases, and airborne activity data relevant to incinerator operations may have been omitted, resulting in an inaccurate characterization of potential worker exposure resulting from operations at Building 4664.

In 1989, DOE’s Office of Environmental Audit conducted a study of DOE operations at SSFL and discovered that, “Lack of a meteorological tower [at SSFL] could result in inaccurate dose assessment in the event of an unscheduled release. Without a meteorological tower providing current wind speed and direction data, it is not possible to accurately predict the area of impact of an unscheduled [or scheduled] release. In addition, annual calculations of the air pathway dose to the population using the AIRDOS-EPA computer model may be in error, since old and inappropriate information from BAP [Burbank Airport] was used. It has been assumed that BAP information was adequate because upper winds above the site are similar to those at BAP. However, data taken from an Area II meteorological tower operated in 1960-1961 showed significant differences.”[3]

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[1] DOE Office of Environmental Audit, *Environmental Survey Preliminary Report: DOE Activities at SSFL,* 1989, p. 4-31 - 4-33.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 136, citations 5, 6, 7, 8:

> [5] Atomics International Drawing, *Low Level Radioactive Waste Facility, Site Plan & Details*, 303-664-C1, Illegible Date.
>
> [6] Atomics International Drawing, *Modification for Low Level Radioactive Waste Equipment*, Bldg. 664 – Plans, Sections & Details, 303-664-S4, January 1966.
>
> [7] Atomics International Drawing, *Low Level Radioactive Waste Facility 664, Flow Diagram, 303-664-P1*, Illegible Date.
>
> [8] Atomics International Drawing, *Low Level Radioactive Waste Facility, Flow Diagram & Details, 303-664-M1*, Date Illegible.

[3] U.S. DOE Office of Environmental Audit, *“Environmental Survey Preliminary Report, U.S. DOE Activities at SSFL,”* 1989.

According to the 1991 Technical Enforcement Report (TER) conducted by EPA,[1] a severe incident occurred at the RMHF in the 1960's. Radioactive wastewater was released to the sanitary sewage RMHF Leach Field. The area was excavated and several feet of bedrock were removed, sealed with asphalt and backfilled with clean soil. In the late 1980's when soil samples were collected from the area, radioactivity was 200 times background. The 1991 TER indicates that the RMHF may have been one of the two primary sources of groundwater contamination at SSFL (other than the SNAP reactor facility).

There were several incidents when the RMHF Leach Field was flooded due to overflow from the flocculation system. In addition, according to a 1992 report on tritium release, the RMHF Leach Field became contaminated as a result of releasing approximately 5,000 gallons of water from the RMHF radioactive water system. It was assumed the major source of radioactive water at that time came from cleanup of the Building 4020 hot cells after examination of fuel assemblies from the first Sodium Reactor Experiment (SRE) core, or from wash water used at the SRE. According to the 1992 report, the RMHF Leach Field is considered a possible source of tritium in groundwater.[2]

The RMHF was a disposal facility and staging area for waste treatment and final disposition. Waste and debris accumulated at the RMHF faster than it could be adequately prepared for shipment or disposal. This section provides a detailed account of building uses and processes, in addition to an internal Rockwell letter (c. 1975) that describes the RMHF's physical condition and provides context in the day-to-day operations at hazards inherent to the workers of this facility.

The RMHF resides on approximately three acres of land and includes a fenced area paved with asphalt, under which contamination reportedly exists due to a radiological incident that occurred in the early 1960's. The paved areas of the RMHF are sloped to carry water away from the buildings to the perimeter channel, which drains west to a retention pond.[3]

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[1] Environmental Protection Agency (EPA) Region IX Draft, *Visual Site Inspection Report for Rockwell International Corporation, Rocketdyne Division, Santa Susana Field Laboratory Technical Enforcement Support at Hazardous Waste Sites,* February, 1991

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 160, citation 2:

. [2] Tuttle, R.J., *Tritium Production and Release to Groundwater at SSFL, RI/RD92-186*, Rockwell International, December 1, 1992, pgs. 4-10–4-11.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 13, citations 1-5:

[1] Interna Correspondence from Horton, P.H. to Nage , W.E., Rockwe Internat ona , *Re: Request for Radioactive Maderail [sic] and Radiation Producing Device User Authorization for RMDF Operations*, December 13, 1989.

[2] The Boe ng Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, p. A-1.

[3] Kartman, A.S., Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.

[4] Carroll, J.W. et al., RMDF Leach Field Decontamination Final Report, ESG-DOE-13385, Rockwell International, September 15, 1982, p. 7.

[5] Correspondence from Gaylord, G.G., Rockwell International, to Liddle, R., U.S. Department of Energy, Re: Assessment Plan for the Radioactive Materials Disposal Facility (RMDF), September 14, 1990.

In general, radioactive wastes handled at the RMHF were residues from chemical and metallurgical laboratory operations, spent reactor fuel from decladding operations, maintenance work on contaminated equipment, and decontamination and decommissioning (D&D) of facilities in which nuclear operations were previously conducted. The RMHF received radioactive water from the Atomics International Hot Lab (4020), the SRE (4143), and any other DOE facilities that generated radioactive water as a part of its operations.

11.1.1 RMHF Buildings / Facilities:

4021	Decontamination / Waste Packaging / Mixed Waste Treatment / Incinerator
4022	Mixed Waste Storage Vault
4034	Offices / Contaminated Laundry Storage
4044	Radiation Safety
4075	Low-Level Waste Storage
*4563	Storage Shed
*4621	Source / Low-Level Waste Storage
*4622	Radioactive Waste Counting Building
*4658	Guard House
*4663	Low-Level Waste Storage
***4664**	**Low-Level Radioactive Waste Incinerator**
4665	Supplies Storage
*4668	Hazardous Materials Storage / Sodium Cleaning Facility
Leach Field	Sanitary Sewer Septic Tank

*Buildings/facilities and operations excluded from the 2006 Site Profile. More information on these locations provided in Section 12.0.

Visitor Log Entry Codes associated with RMHF: 6017, 6000E, 6001R, RMDF, T022, T034

11.1.2 Perspective: 1975 "Plan of Action" for the RMDF/RMHF

The 1975 internal Rockwell document entitled, "Plan of Action for the RMDF"[1] is among the original facility documents referenced by EPA in the Radiological Incident Reports database. The context of the document provides a detailed characterization of the RMHF's appearance and condition, and establishes the precedent of waste handling and storage as documented by a Rockwell International employee.

The document challenges assertions made in the 2006 SSFL Site Description about RMHF operations, general working environment, incidents associated with the facility, and the potential for worker exposure. It should be noted that although the "Plan of Action" was authored in 1975, it describes waste related to Atomics International programs that had ended years before, which had remained haphazardly stored at the RMHF in the holdup yard awaiting final disposition. The document depicts the work environment at the RMHF over the course of several years. The

[1] Internal Correspondence from J.M. Harris to W.R. McCurnin, Re: *Plan of Action for RMDF,* November 18, 1975 (HDMSP00049486.pdf)

RHMF was described by DOE as being the greatest source of radioactive constituents at SSFL.[1]

November 18, 1975
To: W.R. McCurnin **From: J.M. Harris**
731-540 T020 **731-540 T022**

Subject: Plan of Action for RMDF

Upon taking responsibility for the RMDF in mid-July, a large number of contaminated and non-contaminated items existed at the RMDF complex requiring funds for disposition including areas of contaminated asphalt and dirt. This plan documents the existence of these items, the extent to which areas were contaminated, the action taken to date, items requiring disposition, and the proposed plan of action.

Status of RMDF Complex in mid-July "75"

The holdup yard contained 250 drums (30 & 50 gal.), 59 high level pigs, 9 concrete conduits, 10 pallets of miscellaneous materials, 4 transfer casks, 3 pieces of contaminated SRE moderator handling equipment, 50 storage drums (30 ga.), 20 pallets of concrete blocks, and 32 drums for high level waste. There were several areas of contaminated asphalt within the holdup yard and 35 contaminated pallets…

Within the RMDF complex, external to all buildings, and outside the holdup yard, was an accumulation of boxes, barrels, conduits, liquid tanks and other miscellaneous materials including several large rectangular metal containers, six trash dumpsters partially filled with vermiculite and a retort heater with an AEC property tag. There were several areas of contaminated asphalt and dirt at the west end of the complex, and a contaminated area extending along the fence west of the complex between Building 028 and the company's permitter fence.

Contained inside Building 021, within the holdup yard, were 18 small casks containing source materials, miscellaneous samples, a plastic insert for a liquid barrel, remote handling extensions and other items wrapped in plastic. There were three contaminated areas on the floor and shelves of Bldg. 621.

Building 075 contained stored SNAP equipment and packaged material awaiting shipment for burial. Also stored in this building were pallets of contaminated materials from KEWB, ETB and Building 024 waiting to be moved to the devon room of Bldg. 021 for decontamination.

Bldg. 022 contained barrels of sodium in temporary storage and miscellaneous equipment used for handling R/A waste material.

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[1] DOE Office of Environmental Audit, *Environmental Survey Preliminary Report: DOE Activities at SSFL,* 1989, p. 4-31 - 4-33.

<u>Areas of Contaminated Asphalt and Dirt:</u> Some of the items listed above were contaminated internally. At one time contaminated items were wrapped in plastic; however, due to long term storage (three years or more) and exposure to the weather, the integrity of the plastic was violated exposing the internal surfaces. It is presumed that the containers overfilled with rain water carrying contaminated materials onto the outer surfaces of the container, onto the pallets and onto the asphalt where, after repeated cycles (or perhaps only one good rainfall), the contamination spread over the areas shown in the attached map of the RMDF complex. In the path of the spreading contamination were pallets of non-contaminated materials and, at the west end of the holdup yard, there were rows of 30-gallon drums stacked on the asphalt. Most of the drums at the bottom of the stack and all of the pallets downstream of the source of contamination were contaminated. There were at least two separate major spills in the holdup yard, each covering 100 square feet or more, and several smaller spills on the order of 5 square feet or less. Thee remains an area to the south of the yard which has not yet been fully delineated due to the need for removing brush.

At one time, pallets of barrels were stacked at the extreme west end of the complex outside the holdup yard and south of where bldg. 075 is located. It is presumed that one or more contaminated barrels filled with rain water and tipped over, or were full of contaminated water and tipped over, or by some other means spread contamination down the hill to the south for approximately 100 feet by several feet wide as shown on the attached maps. It is also presumed the other spills in that general area were caused by another incident. The full extent of this last spill has not yet been determined due to the need for removing brush along the outside of the perimeter fence and down the ditch to the west of the RMDF complex.

Contamination within Bldg. 621 was confined to three areas. One appeared to be a result of liquid seeping from the barrel liner stored on one of the upper shelves. The second appeared a result of a powdery substance on the floor and the third was of an unknown origin.

There are still two other areas of concern, the pad shown as 644 on the map and the interim storage yard. Pad 664 contains the old evaporator, incinerator and oxidation equipment. Activity from the evaporator is sufficient to prevent detection of contamination near this area; however, preliminary indications show the ditch outside the fence is contaminated to the west of 664.
The interim storage yard is between the RMDF and the SRE. Preliminary surveys of that yard indicate there are areas of contamination on the ground. This area must be cleared of brush and pallets of material must be moved to further delineate the spills.

In summary, there are two well defined separate spills responsible for major efforts in the cleanup of the RMDF holdup yard. There are two separate spills, not fully defined, that require major efforts to cleanup the west end of the RMDF complex. There are two areas that preliminary R/A surveys show to be contaminated but require brush removal to further delineate.

Surveys of the asphalt and dirt in the RMDF complex were 35 mRad/hr or lower with the exception of limited areas at the start of the two major spills in the holdup yard. Details survey results are to be issued by HS and RS identifying all areas of detected contamination and the level of activity.

Action Taken to Date: Since mid-July all of the contaminated and nonn-contaminated items including the contaminated asphalt and dirt have been removed from the holdup yard. Some of the contaminated items were decontaminated and released for unrestricted use or disposed of as scrap. Contaminated pallets, barrels and other miscellaneous items were smashed and put into 19A boxes. Asphalt and dirt were jackhammered out and put into 50 gallon drums. thirteen of the 59 high level pigs were contaminated and/or contained activated material so they were wrapped in plastic, placed on clean pallets and set aside in Building 75 for disposition. The concrete blocks were removed to the SRE for use as shielding, if needed, during the D&D program. Other non-contaminated items were placed outside the holdup yard within the RMDF complex for further disposition. Contaminated areas within Bldg. 621 were decontaminated to as low as practical.

The area of contaminated asphalt and dirt outside the holdup yard at the west end of the complex was jackhammered out and put into 50 gallon drums. Brush was cleared along both sides of the fence down the hill to the west of the complex of Bldg. 028. A radiological survey of the area was made and the result are to be released by HS and RS. About 30 cu. ft. of dirt and rocks were removed from the upper part of the hill when I was directed by the program office to stop all activity and await new direction and funding. While working the upper part of the hill and just prior to receiving the above directive, the bottom of a buried conduit was exposed.

The spill extending down the hill from the center of the complex at the west end required further removal of brush to fully delineate.

Twenty-eight hundred cubic feet of R/A waste materials, generated by D&D of KEWB and ETB, were shipped to land burial in August removing some of the boxes, barrels, tanks and other miscellaneous materials from the RMDF complex. Items in Building. 021 that could be decontaminated were returned to service or put into the salvage yard. Those items that could not be decontaminated were packaged for disposal. All the sodium temporarily stored in Bldg. 022 and at the SRE was permanently stored in Bldg. 665.

Items for Disposition: The following radioactively contaminated items remain at the RMDF complex for disposition. Funds will be available toward the end of the D&D program for the disposal of these items; however, it is recommended that funds be made available now to dispose of these potential sources of contamination. Items are listed in order of priority.

1. **Radioactive spills along fence by T028 and other spills outside the RMDF complex not yet fully identified.**

2. Old evaporator system
3. Thirteen (13) high level pigs (contaminated or containing activated material
4. Conduit buried in the hill by T028
5. Several barrels in T021 contents unknown.
6. Six (6) dumpsters containing vermiculite and unknown contents.
7. 20 19-A boxes of R/A material for disposal (partially funded)
50 50-gallon barrels of R/A asphalt for disposal
19 50 gallon barrels of KEWB and ETB R/A waste for disposal
6 50-gallon barrels of solidified R/A sludge from evaporator in Bldg. 021
8. Barrel of unidentified contents behind Bldg. 075.
9. R/A sources and other materials in Bldg. 621.
10. Heat exchanger from LAD (internally contaminated).
Retort heater AEC No. 165385 (internally contaminated).
Two liquid tanks ~ 200 and 300 gallon (internally contaminated).
11. Old cleaning tans and solar evaporators.
Incinerator system

The following listed non-contaminated items require funds for disposition.

12. Small lathe and miscellaneous items on several pallets.
13. Scrap oxidation system by Bldg. 665.

Plan of Action: If funded, items will be dispositioned as follows: All radioactive spills outside the fence of the RMDF complex (Item 1) will be picked up as they are identified. Delineation of these spills require brush to be removed from the permitter fence.

The evaporator system (Item 2) will be decontaminated to as low as possible, dismantled and disposed of as R/A waste if necessary. The 13 high level pigs (Item 3) will be moved to the devon room, Bldg. 021, and examined for content. Pigs that contain high level material will be packaged for burial and those requiring only decontamination will be decontaminated accordingly. Pigs that cannot be decontaminated will be disposed of as low-level waste.

Remove the conduit buried in the hill by Bldg. 028 (Item 4). Disposition to be determined by its contents.

Barrels of unknown content in Bldg. 021 (Item 5) will be examined for content and disposed of accordingly.

The six dumpsters (Item 6) will be surveyed for radioactive content and disposed of accordingly. The vermiculite will be use for refurbishing shipping containers and the dumpsters when emptied could be used for transporting sealed bags of low-level compressible R/A waste. The items listed in 7 will be weighed, monitored and shipped to a disposal site for burial. The barrel of unidentified contents (Item 8) will be examined for content and disposed of accordingly.

The R/A sources located in Bldg. 621 (Item 9) will be transferred to [REDACTED] at DeSoto per his request. The other materials in Bldg. 621

will be dispositioned based on their potential use. Contaminated items listed as 10 under items for disposition will be packaged and shipped for burial. The cleaning tanks, solar evaporator and incinerator systems (Item 11) will be decontaminated, dismantled and dispositioned accordingly. All non-contaminated items will be stored in appropriate locations. The scrap oxidation plant will be dismantled by a contractor.

Funding and schedule estimates will be made on request.

Jim Harris
Remote Technology

Section 11.2

Building Number: **4021**
Building Alias: **021/T021**
Visitor Log Entry: **6017 / 6000E / 6001R / RMDF / T021**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Decontamination, Packaging, Radioactive Laundry**

Notes: Tritium use and air emissions.

Radionuclides of Concern: Radioactive materials handled in Building 4021 were primarily in the form of items contaminated with mixed fission products and fuels.1 Radionuclides potentially present at the RMHF Building 4021 include: uranium fuel materials (U-234, U-235, U-238), transuranic isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242) and Am-241, fission products Cs-137, Sr-90, Kr-85, and Pm-147, thorium breeder material (Th-228, Th-232), and possible neutron activation products such as Co-60, europium isotopes (Eu-152, Eu-154), **hydrogen-3 (H-3**) **[Tritium]**, iron-55 (Fe-55), nickel isotopes (Ni-59, Ni-63), managense-54 (Mn-54), potassium-40 (K-40), and sodium-22 (Na-22). All radionuclides of concern listed with the exception of Fe-55, Kr-85, Mn-54, and Na-22 (due to relatively short half-lives) are included in the EPA October 2010 Field Sampling Plan for soil sampling in Area IV. However, for the purposes of dose reconstruction these radionuclides should be considered.

11.2.1 Description of Operations & Processes

Building 4021 was constructed in 1959. It was originally built to process low-level radioactive waste. After 1988, it was used as a processing area for wastes associated with D&D activities at the Energy Technology Engineering Center (ETEC).[2] Typical operations at Building 4021 included the removal and concentration of radioactive particulate matter from liquid waste water generated by either the decontamination of equipment in Room 104 or the transfer of radioactive water from the other SSFL facilities to Building 4021. A radioactive waste evaporation system (RWES) provided capabilities to process liquid radioactive waste.[3] Prior to 1980, the radioactive liquid was stored in a 5,000-gallon aboveground holding tank outside Building 4021. Following an overflow of the 5,000-gallon holding tank in 1978 and 1980 (see radiological incident report A0070 and A0080), it was replaced with the 8,000-gallon underground radioactive liquid storage tank in Vault 2 of Building 4022.

The natural gas-powered evaporator was taken offline following a 1966 fire and the flocculation system was used for a period, until the evaporator could be replaced with an electric-powered

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 52, citation 2:

> [2] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, p. A-1.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 25, citation 4:

[4] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, p. A-1.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 20

evaporator. A 1989 report notes that the flocculation tower was built to pretreat radioactively contaminated water to make it easier to filter, but it was made unnecessary by better filters and became inactive.[1]

Based on drawings and reports, the flocculation system may have existed from late 1964 to early 1981, but it appears not to have been used for the entire time period. Atomics International site waste management plans dated in the mid-1970's note the use of the flocculation tower and January 1979 incident reports (Incidents A0077 and A0232) note there was an overflow of the flocculation tower, resulting in contamination.[2]

Building 4021 had its own exhaust and filtration systems to control airborne radiation, arranged from areas of lower contamination to areas of high contamination, before being combined in an exhaust plenum with the air from Building 4022 and exhausted out the 130-foot high stack. According to Rockwell International documents, an emergency blower was not provided at Building 4021 because control of emissions during an emergency could be achieved by shutdown of operations.[3] A separate blower unit was provided for exhaust air from the evaporator and adjacent areas.

The fenced area between Building 4021 and 4022 contained the blowers, filter banks, and compressors for both buildings as well as the shared exhaust stack, and three utility trenches used to support the ventilation ducts. Each trench contained a floor drain to convey surface water away from the area, and to the RMHF northern slope, bypassing the RMHF catch basin.

A 1963 operating specification, presumed to be authored by Atomics International for the RMHF states that automatic air monitoring systems were installed in Buildings 4021 and 4022 to provide continuous air sampling of the decontamination and packaging rooms in Building 4021, and the vault areas below the floor of Building 4022. No information was found concerning air

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 16, citation 2:

> [2] Oldenkamp, R.D. and Mills, J.C., *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, N001ER000017, December 20, 1989, p. 29.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 16, citations 4,5,6,7:

> [4] Atomics International, Site Waste Management Plan, Circa 1972, p. 2.
>
> [5] Atomics International, Management of AEC-Generated Radioactive Wastes at Atomics International, May 31, 1974, pgs. 1-2.
>
> [6] Gardner, F.W. Rockwell International Internal Correspondence, *Re: Release of Radioactivity from RMDF – January 1979*, February 23, 1979.
>
> [7] Gardner, F.W., Rockwell International Internal Letter, *Subject: Radiological Safety Incident Report RMDF*, February 26, 1979.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 17, citations 5,6,1:

> [1] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 63.
>
> [5] U.S. Department of Energy Environment, Safety and Health Office of Environmental Audit, *Environmental Survey Preliminary Report, DOE Activities at Santa Susana Field Laboratories, Ventura California*, February 1989, p. 3- 13.
>
> [6] Chapman, J.A., *Radioactive Materials Disposal Facility Safety Analysis Report*, Rockwell International, June 16, 1986, p. 56.

sampling procedures prior to 1963. The 1963 RMHF operating specification also notes that an automatic continuous stack effluent monitoring system was installed to sample and detect any radioactive, gaseous, or particulate releases to the atmosphere. Any abnormally high radioactive release would cause a buzzer and red light to actuate and remain in the alarm position until actions to remedy the cause and reduce the count rate were accomplished or until the alarm was manually deactivated.[1]

According to an Atomics International disposal document, properly identified and monitored radioactive dry wastes were collected from generator pickup stations by RMHF personnel and transported to RMHF on an established routine schedule, or when requested.[2] The EPA HSA document explains, in detail, how liquid and dry radioactive wastes were processed. A number of internal Rockwell letters were provided to EPA, and depicted annual summaries of waste volumes processed and packaged at Building 4021.

A 1989 EPA report indicated the air emissions from Buildings 4021 and 4022 consisted primarily of surface radioactive particles resulting from decontamination processing, packaging activities in Building 4021, and from store and handling activities in Building 4022. The particulate matter contained uranium, plutonium; cesium-137 (Cs-137), strontium-90 (Sr-90), krypton-85 (Kr-85) and promethium-147 (Pm-147) as mixed fission products; and cobalt-60 (Co-60) and europium-152 (Eu-152) as activation products. The particulate matter in air was controlled through filtration by HEPA filters. The ambient air within Area IV was reportedly monitored daily by continuous collection of air particulate samples using a network of eight air samplers. The samples were counted for alpha and beta radiation following a 120-hour delay to allow for radon and thorium decay. DOE monitored the stacks serving Buildings 4021 and 4022. The DOE survey report indicated that emissions from the RMHF Buildings 4021 and 4022 were higher than the equivalent ambient air emissions shown in the Rockwell International annual monitoring report data for 1981-1987.

11.2.2 1990 Air Emissions from RMHF According to Rockwell International

Radionuclide	Quantity (Ci)
Americium-241 (Am-241)	1.0 x 10
Cesium-137 (Cs-137)	3.3 x 10
Cobalt-60 (Co-60)	4.9 x 10
Tritium (H-3)	1.6 x 10
Plutonium-239 (Pu-239)	2.5 x 10
Strontium-90 (Sr-90)	2.9 x 10

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 18, citation 7:

[7] Operating Specification Radioactive Materials Disposal Unit, November 7, 1963, p. 4.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 22, citation 7:

[7] Unknown Author, *Disposal of Radioactive Materials at Atomics International*, Unknown Date, p. 8.

According to a 1991 DOE Tiger Team finding, stack emissions had not undergone formal evaluation in accordance with established National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations.[1] Additionally, although the samplers at the RMHF had the required continuous radiation monitors to detect sudden increases in radiation during accident situations, deficiencies in the radionuclide particulate sampling systems (which were not in use until 1970) prevented the samplers from meeting NESHAP requirements.

Examples of noted stack sampling deficiencies included suitability of sampling locations, number of sampling points, and sampler design. Moreover, the HSA indicates that the samplers at the RMHF were not originally designed to monitor the large range of particulates, which could be present as a result of HEPA filter problems, deposition inside the stack, or corrosion buildup in the stack. Due to design flaws, the radioactive particulate emission release rates that were supplied for modeling purposes by Rockwell International were determined from air filter samples, which were collected in a manner that may not have been representative of actual emissions. DOE's Tiger Team observed that the changing and handling of the filter samples revealed that a loss of particulate matter may have occurred, and thus air emission modeling may not have been accurate.[2]

According to DOE, "The principal source of potential radiation dose to the public from SSFL is the RMDF." A representative of DOE also stated that, "Airborne dose assessment at this facility [RMHF] may be imprecise … because of AIRDOS computer monitoring difficulties."[3]

In 1989, DOE Office of Environmental Audit indicated that air sampling and monitoring practices at SSFL were insufficient for the duration of site operations. Given documented onsite burning of radioactive waste and the presence of the RMHF incinerator, current estimations of airborne activity and emissions as they relate to internal and environmental ambient exposure may be inaccurate and even grossly underestimated, and therefore inappropriate for use in dose reconstruction.

EPA's HSA report provides detailed information on various surveys for radioactivity associated with the RMHF. For instance, in 1987 the Monthly Comprehensive Smear Surveys indicated that quarterly reviews noted high radiation levels measured by location film badges in the decontamination and packaging rooms, although gradual reductions had reportedly occurred in past quarterly surveys.

In 1988, DOE indicated that even though improvement had been made to reduce radiation exposure rates, because of changing operations involving radioactive materials handling at the RMHF, exposure rates may have exceeded the DOE guideline of 100 millirems per year for continuous exposure at the Area IV property boundary north of the RMHF. The guideline was intended to prevent members of the public from unknowingly receiving excessive exposure as a result of DOE operations. According to the report, long-term exposure to a member of the public

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[1] DOE, *Tiger Team Assessment, Energy Technology Engineering Center,* April, 1991

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 28, citation 1:

> [1] U.S. Department of Energy, *Tiger Team Assessment Energy Technology Engineering Center, DOE/ EH-0175,* April 1991, pgs. 3-12–3-15.

[3] DOE Office of Environmental Audit, *Environmental Survey Preliminary Report: DOE Activities at SSFL,* 1989, p. 4-31 - 4-33.

was unlikely due to the rugged terrain along the north boundary and daily security patrols. However, no reference was made to concerns about potential worker exposure.[1]

In 2007, Boeing performed radiological surveys on Buildings within the RMHF complex, including Building 4022. The original survey for Building 4022 called for multiple survey units but because of relatively high levels of radiation (up to 140 micro roentgens per hour) primarily on the west side of the building and likely due to radiation levels from Building 4021, Boeing decided that the building could not be satisfactorily surveyed as originally proposed.

The preliminary MARSSIM classification for the Building 4021 is Class 1, due to its former use, radiological incidents, and previous radiological investigations. As of 2011, Building 4021 was still standing but no longer in use. According to Boeing and the EPA HSA, the inside floor and walls were contaminated and under fixative paint, the upstream HEPA ventilation ducting in Building 4021 and between Building 4021 and 4022 was highly contaminated, and areas under the floor drain lines were highly contaminated.[2]

11.2.3 Building 4021 Radiological Incident Reports

There have been several incidents associated with Building 4021 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

11.2.4 Building 4021 Radiological Incident Report Summary, Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0348	3/16/60	Decon RM	Mixed Fission	A Boiling Decon Solution Foamed Over and Spread Contamination in Decon Rm
A0336	12/21/60	Decon RM		Glove Box and Be Contaminated Cutoff Wheel Separation Caused Floor Contamination
A0017	6/12/62	RMDF Decon Rm	Mixed Fission	SRE Sodium Pipe for Decon Exhibited High Dose Rates and Airborne Activity
A0019	10/30/62	Decon Rm T021	Mixed Fission	Employee Failed to Wear Prescribed Respiratory Equipment
A0408	6/10/64	Bdg 21 Decon	Mixed Fission	RMDF Decon RM Moderator Can Cleaning Resulted in Sodium Fire and Explosion
A0448	12/22/64	North of T021	Mixed Fission	Heat Exchanger Bell Leaked Water onto Ground While Being Moved
A0297	11/11/66	T021 Evaporator	Mixed Fission	Filters Plugged and Collapsed When “Water” Evaporator Pan Caught Fire
A0387	6/26/68	Decon Rm		Fire Started During Primary Sodium Draining from a Hallam Throttle Valve
A0388	10/31/78	Evaporator RM		RMDF Evaporator Fire in Building 4021

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 46, citation 2:

> [2] Weiner, L.A. and Barisas, S., *Status Report of the DOE Activities at the Santa Susana Field Laboratories Site Environmental Survey*, U.S. Department of Energy, June 30, 1988, p. 10.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 43

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0070	5/22/78	R/A Tank Area	Mixed Fission	Sump Pump Failure Allowed R/A Liquid to Overflow into Yard
A0558	10/13/78	R/A Decon Rm		Employee Contaminated Previous Cut
A0559	10/10/79	RMDF Decon Rm	Mixed Fission	Splashed R/A Water Contaminated Employee and Subsequently His Film Badge
A0080	1/9/80	RMDF & Drainage	Mixed Fission	Water Hose Broke Overfilling R/A Waste Tank and Drained to 28 Pond
A0243	2/29/80	T021 Sump Pump		Employee Became Contaminated Working on R/A Sump Pump
A0566	12/4/81	RMDF Decon Rm	Mixed Fission	Bucket Overfilled with R/A Liquid Spilling into Drum
A0180	11/9/1987	Decon RM 021	Mixed Fission	Waste Packaging Generated High Airborne Activity When tem Was Dropped
A0179	11/18/87	Decon Rm 021	Mixed Fission	Escorted Worker Entered Contaminated Area Before He Could Be Stopped
A0208	8/9/90	Decon RM 021	Mixed Fission	Contaminated Power Tool Cut Finger During Size Reducing R/A Waste
A02011	11/15/90	Decon Rm 021	Ce 144	Exit Survey Revealed Contamination on Employee Shorts
A0266	2/14/91	Exhaust Fan		R/A Exhaust Blower Failure Caused Alarm
A0580	8/6/93	RMDF Laundry RM		Employee Worked in Controlled Area Without Permission
A0655	10/12/94	RMDF T021 PK RM	Cs 137	Cs 137 & Co 60 Contamination of Personnel Shoes
A0680	10/3/97	Lower Park Lot		State Found 4 Blocks Over the Limit 100 120 Cpm Fixed Contamination
A0671	1/10/97	DeCon Room		Fixed R/A Contamination on ndividual s Personal Shoe

- On June 10, 1964 personnel were attempting to disassemble a moderator can for disposal. There was a reaction of the sodium that caused an explosion and fire. Contaminated smoke resulted in an average beta gamma contamination level of 4.5 x 10^6 dpm / 100 cm^2 . The incident report indicated that sodium sparks were blown approximately 25 feet, searing plastic on the floor and red-line clothing worn by personnel. The fire was extinguished with calcium carbonate. Personnel received contamination in the nose (60 dpm beta gamma) as a result of opening the door of the decontamination room immediately after the explosion and inhaling the smoke. After the smoke had cleared from the room, personnel drove a fork lift into the room to push the moderator can back into the storage can. The incident report indicated that the moderator can covered with sodium had a radiation level on a section of the can of 50 rad/ hr, including mixed fission products. The incident report did not provide additional information to indicate whether there were any releases of contaminated air to the atmosphere, whether the surfaces in the decontamination room became contaminated and required decontamination, or how the moderator can was handled after being placed in the storage can

(A0408).[1]

- On July 21, 1964 while washing out an empty moderator storage can, a sodium reaction caused an explosion and fire. The explosion and fire were reported to have been confined to the inside of the storage can and were smothered with calcium carbonate. Continuous air monitoring reportedly indicated no increase in airborne contamination during the incident. The incident report stated that an air sample taken 75 minutes following the incident indicated airborne concentrations of 3.2 x 10 ^{11} µC/cc alpha and 1.2 x 10-^{10} µC/cc beta gamma. Nose swipes of the personnel involved indicated no detectable contamination (A0413).[2]

- On December 22, 1964 a component from the SRE was taken to Building 4021 for decontamination. The incident report and the Boeing Incidents Database identified the component as a "heat exchanger bell." According to the incident report, while transferring the component from a storage area to the decontamination room, rain water contained under plastic covering spilled on the pad and asphalt in back of the decontamination room resulting in the contamination of the pad, asphalt, forklift, and a pallet. The maximum contamination measured was 7,000 dpm / 100 cm^2 with a radiation level of 6 mrad/hr from the asphalt. A 2005 historical site assessment indicated a maximum contamination level of 2000 dpm / 100 cm^2 for this incident, and it is unclear from the source document whether the level of contamination was 2,000 dpm / 100 cm^2 or 7,000 dpm / 100 cm^2. At the time of the incident report, the asphalt and the pad were being cleaned "without significant progress." The incident report did not elaborate on how the area was being cleaned or if the area had been successfully cleaned. The forklift was cleaned to 30 dpm / 100 cm^2 and the pallet was discarded as contaminated waste, although the incident report did not provide information to indicate how or to where the pallet was discarded.

  Investigation of the incident had determined that the plastic covering for the SRE component was contaminated to a level of 2,000 dpm. In addition, the single plastic covering had a number of rips and tears from which the contamination was spread by the entrance of rain water. The incident report noted that it was unknown whether or not the item was in the reported condition upon receipt to the RMHF or if it was damaged at the RMHF. It could not be determined from the incident report where the item was stored prior to decontamination as the incident report identifies the area only as a "storage area." Given that rain water had infiltrated the plastic covering of the SRE component, it is assumed this storage area was located exterior to Building 4021 (A0448).[3]

- On November 11, 1966 a water evaporator pan caught fire. Upon arrival to the building, smoke was observed to be emanating from Building 4021 through all the openings, including

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 37, citation 1:

> [1] Young, L.N., Atomics International Internal Correspondence, Re: Incident Report Building 21-Decontamination Room, June 6, 1964, June 17, 1964.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 37, citation 2:

> [2] Young, L.N., Atomics International Internal Correspondence, *Re: Incident Report, Building 021, Decontamination Room, July 21, 1964*, July 22, 1964.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 39, citation 1:

> [1] Young, L.N., Atomics International Internal Correspondence, Re: Incident Report, North Side – Building 021, December 22, 1964, January 18, 1965.

doors, ventilators, and stack. A portable air sampler was placed in the smoke just outside building 4021, and the Rocketdyne weather station was contacted to obtain wind direction information. This information was not available, however, because the Rocketdyne anemometer was inoperative at the time. Visual inspection observed the smoke to be moving in a southeasterly direction and it was recommended that ventilation be turned off in Buildings 4036 and 4037. [There is no mention in the incident report that employees working outside at neighboring areas were warned of the risks associated with this incident]. Rocketdyne personnel monitored the smoke, office areas and building walls with a GM portable survey instrument and detected no radiation levels above "normal background," as reported by Rocketdyne.

The fire was contained approximately 10 minutes following the initial alarm. A fireman entered the attic of Building 4021 to inspect ductwork of the building and reported no unusual conditions except for residual smoke. An employee reported to the scene to perform radiation and contamination surveys of all equipment and trucks in the area.

Investigation of the incident determined that the fire occurred in the east evaporator in the packaging room of Building 4021. The fire was caused by the "apparent ignition by radiant heaters of wax floating on the liquid undergoing evaporation." All firemen were checked for contamination and it was determined that contamination was limited to shoes at levels of up to 1 mrad/hr. These were decontaminated and returned. Some personnel had hand contamination of up to .54 mrad/hr, which was successfully decontaminated to less than 30 dpm / 100 cm^2 betta gamma. Bioassay samples indicated no evidence of inhalation of radioactive material. Environmental sampling, including air sampling showed concentrations of $6x10^{10}$ µCi/cc betta gamma. Fire trucks, "MSA equipment," fire bottles, and office areas were also surveyed and had measurements ranging from less than 50 dpm / 100 cm^2 to less than 500 dpm / 100 cm^2 beta gamma.

The incident report concluded that all areas, vehicles, and equipment were successfully decontaminated to less than 30 dpm / 100 cm^2 beta gamma. The report also summarized that no internal or external personnel exposure resulted and "no significant release of radioactive materials occurred" (A0297).[1]

- On June 26, 1968 a sodium fire occurred at the RMHF. According to the incident report, a Hallam reactor primary system throttle sodium valve (Valve #303) was being em ptied of sodium in front of the south roll-up door of Room 105 of Building 4021, when the sodium caught fire. The heating and draining process consistent of wrapping the valve with strip heaters, heating the valve under controlled conditions, and allowing the liquid sodium to drain into a pan containing calcium carbonate.

  During the course of draining Valve #303, small fires occurred as the sodium drained into the pan. Two technicians extinguished the fires with calcium carbonate; however, the small fires merged into one large fire in the pan and could not be controlled with calcium carbonate. The volume of the sodium that had been drained into the pan was estimated to be approximately 15 gallons. Control of the fire was achieved with an Ansul Net-L-X extinguisher and calcium

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 39, citation 2:

[2] Clow, H.E., Atomics International Internal Correspondence, *Subject: Fire Alarm, Bldg. 021*, November 15, 1966.

carbonate. Upon receiving “HSRS” approval, staff removed the pan containing the sodium and fire-fighting chemicals to the “dangerous chemicals disposal pit for burning.”[1]

The incident report indicated that two high-volume air samples were taken during the fire and included a five-minute sample and a 30-minute sample. Both samples were placed in the path of the smoke cloud. According to Atomics International, each sample showed a concentration of approximately 2.6x10^{10} µCi/cc. The samples were recounted after 48 hours and were reported to have a count rate of less than background. The regulatory limit for occupational exposure in 1968 was reported to be 9x10^{9} µCi/cc.[2]

Additionally, the ventilation systems in Buildings 4036/4037 and 4027 were shut down since the smoke cloud was moving in the direction of those buildings. Nasal smears and clothing surveys were made of all personnel involved in controlling the fire. In addition, smear and radiation surveys were made of the areas located in the path of the smoke cloud and of the general fire area. The incident report reported the measurements to be at background. The regulatory limit for insoluable sodium-22 was reported to be 3x10^{10} µCi/cc at the time of the incident (A0387).[3]

- A fire occurred in the evaporator area of Building 4021 on October 31, 1974. The evaporator system in the building consisted of an angle iron frame, a stainless steel tank, a tank cover, and two independently controlled gas burners. Limited information is available regarding the actual fire; however, a summary of the damage indicated that the fire damaged the high voltage ignition wire on each burner and the flame detectors. In addition, the aluminum

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 40, citations 2-4:

[2] Mooers, A.R., Atomics International Internal Correspondence, *Subject: Sodium Fire at the RMDF*, July 10, 1968.

[3] Tschaeche, A.N., Atomics International Internal Correspondence, *Subject: Sodium Fire at SS-021 on June 26, 1968*, July 2, 1968.

[4] Corning, F.E., Memorandum, *Sodium Fire, Building #022, Santa Susana*, June 26, 1968. The building number is incorrectly identified on this June 26, 1968 memorandum subject line. The content of the memorandum indicates the fire occurred on the south side of Building 4021.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 40, citations 5-7:

[5] Mooers, A.R., Atomics International Internal Correspondence, *Subject: Sodium Fire at the RMDF*, July 10, 1968.

[6] Tschaeche, A.N., Atomics International Internal Correspondence, *Subject: Sodium Fire at SS-021 on June 26, 1968*, July 2, 1968.

[7] Corning, F.E., Memorandum, *Sodium Fire, Building #022, Santa Susana*, June 26, 1968. The building number is incorrectly identified on this June 26, 1968 memorandum subject line. The content of the memorandum indicates the fire occurred on the south side of Building 4021.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 40, citations 8-10:

[8] Mooers, A.R., Atomics International Internal Correspondence, *Subject: Sodium Fire at the RMDF*, July 10, 1968.

[9] Tschaeche, A.N., Atomics International Internal Correspondence, *Subject: Sodium Fire at SS-021 on June 26, 1968*, July 2, 1968.

[10] Corning, F.E., Memorandum, *Sodium Fire, Building #022, Santa Susana*, June 26, 1968. The building number is incorrectly identified on this June 26, 1968 memorandum subject line. The content of the memorandum indicates the fire occurred on the south side of Building 4021.

removable section of the tank cover melted and the ignition transformer on one burner was damaged by the water that was used to hose down the area following the fire. Additional information regarding the type of cause of the fire could not be located in available documents reviewed by the EPA research team (A0388).[1]

- On May 22, 1978 a sump pump at Building 4021 stopped working and contaminated liquid flowed out of a 5,000-gallon radioactive liquid holdup tank. Approximately 40 to 50 gallons of water contaminated with mixed fission products ran through a break in the asphalt dike contaminating asphalt and eight tires from a trailer parked on the asphalt. The contaminated water ran about 40 yards west and south of the dike and ranged from 2 feet to 10 feet in width. The wet area was covered with Pell-A-Cell absorbent, which was later picked up with shovels and put into 55-gallon drums. Foam was also applied and vacuumed up for further cleanup.

  Smear samples were taken of the foamed-and-vacuumed area the following day. Five smears showed contamination ranging from 108 dpm/100 cm^2 to 356 dpm/100 cm^2. These smears were all within an area of 15 feet from the holdup tank enclosure fence. This area was foamed and vacuumed again. Fifteen additional smears were taken of this area and the results were all less than 100 dpm / 100 cm^2.

  As indicated above, the tires of a trailer parked in the contaminated area also became contaminated. Contamination ranged from 59 dpm/100 cm^2 to 601 dpm/100 cm^2. The tires were reported to have been cleaned to less than 50 dpm/100 cm^2 and the trailer was removed from the area. The trailer was reported to have belonged to an “outside contractor.”

  An additional survey was performed using a PUG with a shielded Eberline HP-210 probe, and direct readings observed by the instrument ranged from 20,000 cpm to 45,000 cpm.[2] Background readings in this area were approximately 4,000 cpm. As a result of the high readings, on May 30 1978 [over a week after the original incident] the contaminated areas were foamed with “Ammoniated Turco Meteor All Purpose Water Emulsion Cleaner” and scrubbed with a stiff bristle brush and vacuumed. Reading with the PUG and HP-210 probe showed no significant change, and on June 1, 1978 the contaminated area was covered with “Midwest’s Z-40 Floor and Road Seal Emulsion” to fix any possible loose contamination. The incident report did not indicate any additional surveys and did not provide any figures to show the extent of contamination and the location of the trailer. Apparently, the incident report did not mention the potential personnel contamination of those involved in the incident of subsequent cleanup efforts (A0070).[3]

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 41, citation 1:

> [1] Gutierrez, E.P., Rockwell International Internal Letter, *Subject: Evaporator Fire Incident, Bldg. 021*, November 8, 1974.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 41, citation 2:

> [2] A PUG is a radiation survey instrument made by Technical Associates, which has been developing radiation detection equipment since 1946.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 41, citation 3:

> [3] Bradbury, S.M, Rockwell International Internal Correspondence, Re: Sump Overflow in the 5,000-Gal Holdup Tank Enclosure at the RMDF, June 7, 1978.

A follow up to the incident noted that during the “Great Rain of ’78” there was great difficulty in handling the amounts of contaminated water generated at several facilities. The 5,000-gallon radioactive liquid storage tank was surrounded by a security fence and low berm, but was unprotected from the weather. Rain poured off the building 4021 roof and fell directly into the holdup sump and was automatically pumped to the holdup tank.

To prevent rainwater from filling the holdup tank, the berm was broken to allow the water to drain out. However, because the berm and sump pit were the only protection against release of water from overflow and leakage, a work order to repair the berm was issued soon after the end of the rains. The work order was not completed in time to prevent the incident. The berm and sump pit, when empty, provided retention capacity for about 2,000 to 3,000 gallons of water. The 5,000-gallon holdup tank usually contained 3,000 to 5,000 gallons of water. Thus, the area did not provide enough protection against total release of the holdup contents. The radiation exposure rate at the fence around the tank averaged 50 mR/hr, but because of the large size of the tank, radiation exposure extends “significantly” beyond the enclosure. The incident followup letter notees that these problems and potential hazards could be eliminated by construction of a concrete block wall enclosing the tank with a weather-tight roof. It also states that there have been ‘many bad experiences with contaminated water at Santa Susana,” and the facility must be upgraded to prevent future incidents. [At the time this letter was generated, SSFL had operated for 30 years; the RMHF Building 4021 had operated for nearly 20 years].[1]

- On January 9, 1980 a water hose broke and caused the 5,000-gallon radioactive liquid storage tank to overflow at Building 4021 and drain to the RMHF 4614 Holdup Pond. The leak was discovered by RMHF personnel located outside the RMHF perimter fence who noticed liquid running out the top of the storage tank. The source was found to be coming from the decontamination room of Building 4021 and the water was shut off. According to the incident report, the excess water was a result of an employee neglecting to turn off the water hose at the valve.

  The hose was used with a spray nozzle for rinsing during decontamination operations in the decontamination room of Building 4021. The incident report stated that although the nozzle was shut off, the excess pressure caused the hose to break, causing the tank to fill and overflow. This incident resulted in the release of approximately 100 gallons of liquid containing .01 µCi of mixed fission products and caused the contamination of approximately 2,500 square feet of asphalt paving and an accumulation of about 3,000 gallons of contaminated liquid with 100 gallons being released. According to the incident report, the loss occurred because the asphalt berm that should have contained the contaminated spill leaked and permitted the contaminated liquid to spread over a sizable area.

  Heavy rain prior to the spill and during the cleanup operations resulted in a significant increase in the decontamination effort. Runoff from the rainfall contributed to a major increase in the amount of contaminated water that was collected first in the RMHF “radioactive pond” and then transferred to holdup tanks in the RMHF. The incident report indicated that the tank that overflowed and released the contamination liquid was taken out of service and that all

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 42, citation 1:

> [1] Internal Correspondence from Tuttle, R.J. to Breese, L.S. and Walter, J.H., Rockwell International, *Re: RMDF Liquid R/A Waste Holdup Tank*, July 27, 1978.

future radioactive water was being stored in an underground tank with complete retention of any overflow or spill. The incident report did not provide information to indicate how the affected areas were cleaned or to what levels they were cleaned (A0080).[1]

- In 1986, during the third week of the third quarter electric power to the HEPA filtered exhaust blower for the decontamination and packaging rooms was inadvertently left off after a test and the exhaust system was inoperative for an unknown period of time. Air sampling data showed that radioactive contamination migrated across the decontamination room and into the packaging room.[2]

- On October 3, 1997 four concrete blocks in the lower RMHF parking lot were discovered to have small areas, less than 1 foot square, of fixed contamination ranging from 100 to 800 cpm. The concrete blocks were decontaminated, resurveyed, and released without radiological restrictions (A0680).[3]

As of July 27, 2011 Boeing notes that there is no storage of radioactive waste in Building 4021. However, the inside floor and walls are contaminated and under fixative paint, the upstream HEPA ventilation ducting in Building 4021 and between Building 4021 and Building 4022 is highly contaminated, and areas under the floor drain lines are highly contaminated.

The EPA provides a detailed chronology of radiological investigations that are associated with each building and facility. However, given the nature and severity of RMHF contamination, NIOSH and ABRWH are encouraged to review the EPA HSA 7-1 NBZ document pertaining to the Area IV Study in its entirety, with particular attention on the RMHF given consistently high radiation measurements throughout the buildings and facilities associated with the RMHF, Rockwell International's definitions of "acceptable" readings, and clear indications of worker exposure risk.

EPA found it to be significant that a 1993 internal letter between Rockwell staff notes that there is suspected significant contamination beneath the asphalt-covered RMHF area. This letter states that such contamination was not included in a site characterization plan because the complex will be remediated after the RMHF ceases operation. However, as noted, in 2011 that had yet to occur.[4]

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 42, citation 2:

> [2] Bradbury, S.M., Rockwell International Internal Correspondence, *Re: Radiological Safety Incident Report, RMDF, January 9, 1980*, April 9, 1980.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 43, citation 1:

> [1] Internal Correspondence from Moore, J.D. to Remley, M.E., Rockwell International, Re: Quarterly Review of the RMDF for Radiation Safety, Third Calendar Quarter, 1986, December 15, 1986.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 43, citation 2:

[2] Deschamps, R., The Boeing Company Internal Correspondence, *Re: Incident Report No. A0680*, October 20, 1997.

[4] EPA/HGL, *Final HSA 7-3-NBZ,* p. 47, citation 5:

> [5] Internal Correspondence from Author, D.W., to Hoffman, N.J., *Re: SSFL Area IV Site Characterization Plan*, June 17, 1993.

Section 11.3

Building Number: **4022**
Building Alias: **022/T022**
Visitor Log Entry: **6017 / 6000E / 6001R / RMDF / T022**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Vault Storage / Waste Compactor**

Note: Tritium use and air emissions.

Radionuclides of Concern: Radioactive materials handled in Building 4022 were primarily in the form of fuels. Radionuclides potentially present at the RMHF include: uranium fuel materials (U-234, U-235, U-238), transuranic isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242) and americium-241 (Am-241), fission products Cs-137 and Sr-90, thorium breeder material (Th-228, Th-232), and possible neutron activation products such as cobalt-60 (Co-60), europium isotopes (Eu-152, Eu-154), **hydrogen-3 (H-3)**, iron-55 (Fe-55), nickel isotopes (Ni-59, Ni-63), managense-54 (Mn-54), potassium-40 (K-40), and sodium-22 (Na-22). All radionuclides of concern listed with the exception of Fe-55, Mn-54, and Na-22 (due to relatively short half-lives) are included in the EPA 2010 Field Sampling Plan for soil sampling in Area IV.[1] However, for the purposes of dose reconstruction, these radionuclides should be considered.

11.3.1 Description of Operations & Processes

Building 4022 was constructed in 1959 as part of the RMHF complex, which was a support facility to SNAP, the SRE, and the Hallam Nuclear Power Facility (storage, volume reduction, packaging, shipping of SNAP / SRE radioactive waste). Building 4022 was used for the dry storage of used and unused nuclear fuel. During ETEC operations, the building vaults were used to store containerized wastes from decontamination and decommissioning activities.

There were seven below-grade storage vaults constructed with reinforced concrete and air-cooling systems, which ranged in size and were used for the storage of mixed waste and low-level radioactive waste.[2] By 1980, an 8,000-gallon radioactive liquid storage tank was located in

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 76, citation 3:
3. The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis,* June 18, 2007, p. A-2.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 56, citations 9, 10, 11, 12:

[9] The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-2.

[10] Internal Correspondence from Seward, F.A. to Nagel, W.E., Rockwell International, *Re: Request for Radioactive Material and Radiation Producing Device User Authorization for RMDF Operation*, December 10, 1985.

[11] Haley and Aldrich, Inc., *Closure Plan for the Radioactive Materials Handling Facility (RMHF),* October 2006, p. 3-2.

[12] Daniel, Mann, Johnson & Mendenhall, *Calculations for R/A Waste & Fuel Storage Facility, Santa Susana, California, AEC Contract AT(11-1)-632*, August 1958.

Vault 2 of Building 4022, replacing the aboveground tank outside Building 4021 following overflow of that tank (please see Building 4021 Radiological Incident Report).

Storage of the SRE Core I at Building 4022 began in 1959 and SRE Core II was stored beginning in 1964. Both cores were stored in 3.5-inch diameter by 166-inch long canisters with threaded closures. Core I contained 2.8 percent uranium-235 (U-235). Core II had different assemblies with approximately 92-93 percent U-235 enrichment.[1] The EPA-HSA contains a comprehensive chronology of fuel stored in the RMHF vault.[2]

In addition to the 8,000-gallon radioactive liquid storage tank in Vault 2, two 5,000-gallon storage tanks were located in the vault. According to EPA's discussions with Boeing personnel, these two tanks were secondary tanks brought from the SRE (Building 4143) to collect water, primarily rain water, during the RMHF Leach Field cleanup.[3]

Building 4022 had its own exhaust and filtration systems to control airborne radiation. The building had no windows. During fuel transfer operations, all of the doors were closed. The ventilation for the above-grade working area of Building 4022 was brought about by natural convection from the work floor to the vents on the roof. In the event of a blower failure, an emergency diesel generator provided power for the emergency backup blower, with a filter bank. Each filter bank had a set of 10 pre filters and 10 HEPA filters. After filtering, air from Building 4022 was combined in an exhaust plenum with air from Building 4021, and exhausted out the 3-foot-in-diameter 130-foot high stack.

A 1989 EPA report indicated the air emissions from Buildings 4021 and 4022 consisted primarily of surface radioactive particles resulting from decontamination processing, packaging activities in Building 4021, and from store and handling activities in Building 4022. The particulate matter contained uranium, plutonium; cesium-137 (Cs-137), strontium-90 (Sr-90), krypton-85 (Kr-85) and promethium-147 (Pm-147) as mixed fission products; and cobalt-60 (Co-60) and europium-152 (Eu-152) as activation products. The particulate matter in air was controlled through filtration by HEPA filters. The ambient air within Area IV was reportedly monitored daily by continuous collection of air particulate samples using a network of eight air samplers. The samples were counted for alpha and beta radiation following a 120-hour delay to allow for radon and thorium decay.

DOE monitored the stacks serving Buildings 4021 and 4022. The DOE survey report indicated that emissions from the RMHF Buildings 4021 and 4022 were higher than the equivalent ambient air emissions shown in the Rockwell International annual monitoring report data for 1981-1987.

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 61, citation 5:

> Correspondence from Remley, M.E., Atomics International Division of Rockwell International, to Page, R.G., U.S. Atomic Energy Commission, *Re: Physical Protection of Special Nuclear Materials Docket 70-25*, August 16, 1974.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 62

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 57, citation 3:

> [3] Correspondence from Chell, M., MWH, to Waite, P., The Boeing Company, *Re: Questions for Paul Waite Regarding RHMF [sic] Site History (Discussion took place via email during March, 2009),* March 16, 2009.

EPA's HSA references a 1991 DOE Tiger Team finding that stack emissions had not undergone formal evaluation in accordance with established National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations.[1] Additionally, the HSA indicates that although the samplers at the RMHF had the required continuous radiation monitors to detect sudden increases in radiation during accident situations, deficiencies in the radionuclide particulate sampling systems (which were not in use until 1970) prevented the samplers from meeting NESHAP requirements.

Examples of noted stack sampling deficiencies included suitability of sampling locations, number of sampling points, and sampler design. Moreover, the HSA indicates that the samplers at the RMHF were not originally designed to monitor the large range of particulates, which could be present as a result of HEPA filter problems, deposition inside the stack, or corrosion buildup in the stack. Due to design flaws, the radioactive particulate emission release rates that were supplied for modeling purposes by Rockwell International were determined from air filter samples, which were collected in a manner that may not have been representative of actual emissions. DOE's Tiger Team observed that the changing and handling of the filter samples revealed that a loss of particulate matter may have occurred, and thus air emission modeling may not have been accurate.[2]

According to DOE, "The principal source of potential radiation dose to the public from SSFL is the RMDF." A representative of DOE also stated that, "Airborne dose assessment at this facility [RMHF] may be imprecise … because of AIRDOS computer monitoring difficulties."[3]

In 1989, DOE Office of Environmental Audit indicated that air sampling and monitoring practices at SSFL were insufficient for the duration of site operations. Given documented onsite burning of radioactive waste and the presence of the RMHF incinerator, current estimations of airborne activity and emissions as they relate to internal and environmental ambient exposure may be inaccurate and even grossly underestimated, and therefore inappropriate for use in dose reconstruction.

EPA's HSA report provides detailed information on various surveys for radioactivity associated with the RMHF. For instance, in 1987 the Monthly Comprehensive Smear Surveys indicated that quarterly reviews noted high radiation levels measured by location film badges in the decontamination and packaging rooms, although gradual reductions had reportedly occurred in past quarterly surveys.

In 1988, DOE indicated that even though improvement had been made to reduce radiation exposure rates, because of changing operations involving radioactive materials handling at the RMHF, exposure rates may have exceeded the DOE guideline of 100 millirems per year for continuous exposure at the Area IV property boundary north of the RMHF. The guideline was intended to prevent members of the public from unknowingly receiving excessive exposure as a

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[1] DOE, *Tiger Team Assessment, Energy Technology Engineering Center,* April, 1991

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 28, citation 1:

> [1] U.S. Department of Energy, *Tiger Team Assessment Energy Technology Engineering Center, DOE/EH-0175,* April 1991, pgs. 3-12–3-15.

[3] DOE Office of Environmental Audit, *Environmental Survey Preliminary Report: DOE Activities at SSFL,* 1989, p. 4-31 - 4-33.

result of DOE operations. According to the report, long-term exposure to a member of the public was unlikely due to the rugged terrain along the north boundary and daily security patrols. However, no reference was made to concerns about potential worker exposure.[1]

As of 2011, Building 4022 was still standing. Boeing noted that there was no storage of radioactive waste in Building 4022. However, the underground vaults of Building 4022 still had low levels of contamination and the HEPA ventilation ducting between Building 4021 and Building 4022 was highly contaminated.

According to the HSA, the Radiological Contamination Potential based on the preliminary MARSSIM classification for the Building 4022 area was Class 1, due to the facility's former use as a radioactive materials storage facility, documented radiological incidents, and previous investigations.

11.3.2 Building 4022 Radiological Incident Reports

There have been several incidents associated with Building 4022 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

11.3.3 Building 4022 Radiological Incident Report Summary, Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0588	12/29/65	RMDF Yard		Drums of Contaminated Sodium Exploded in Rain Storm and Burned
A0631	5/9/69	RMDF Vault Pit		Employee Fell 12 Feet to Bottom of Sump Pit
A0589	5/19/77	RMDF High Bay	Mixed Fission	SRE Piping Caught Fire in the Sodium Melt Vessel at RMDF
A0078	4/5/79	High Bay	Sr/Cs	Recovery of Jammed Fuel Element Can in Hallam Transfer Cask
A0314	8/14/79	Gate to T022		Waste Truck Load Leaked R/A Liquid
A0239	10/29/79	Substation 783		R/A Exhaust Lost When Raccoon Shorted Out Substation and Generator Failed
A0086	5/28/81	High Bay	MFP	High Level R/A Liquid Ran Out of NAC Cask onto Floor Blocks
A0567	7/23/81	RMDF High Bay		HP Contaminated Finger While Smearing "Clean" Tools
A0259	11/24/1981	Vault 7 Waste	Mixed Fission	Absorbed High Level NAC Waste Open to Atmosphere
A0326	6/30/82	High Bay		RAS Alarm Response nappropriately Cancelled Because of Known Cause

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 46, citation 2:

[2] Weiner, L.A. and Barisas, S., *Status Report of the DOE Activities at the Santa Susana Field Laboratories Site Environmental Survey*, U.S. Department of Energy, June 30, 1988, p. 10.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0115	3/23/83	High Bay		RAS Alarm Caused by High Radiation During Fuel Transfer
A0116	3/30/83	High Bay		Response to RAS Alarm
A0158	6/11/86	High Bay	Mixed Fission	Off Scale Dosimeter During BM Cask Work
A0159	6/13/86	High Bay	Mixed Fission	Employee Placed Unprotected Hand on Contaminated Cask
A0161	6/25/1986	High Bay	Mixed Fission	Employee Contaminated Shoe During Decon of NAC Cask
A0166/ A0167	12/22/86	High Bay	Cs/Co	R/A Water Sprayed Employee During Fuel Cask Unloading / R/A Water Drained from Transfer Cask Contaminating Employee and Floor
A0168	1/6/87	High Bay		Employees Shoes Found to be Contaminated
A0171	1/7/87	High Bay	Mixed Fission	Employee Contaminated During Routine Survey of Tools and Equipment
A0170	1/15/87	All RMDF		Review of R/A ncident at RMDF
A0172	10/2/90	DeCon Rm 021	Mixed Fission	Employees Became Contaminated While Unloading R/A Cable for Decon
A0209	2/21/97	High Bay Door Tent		Fixed R/A Contamination on Left Wrist and Personal Pants
A0674	3/25/97	High Bay		Discreet Particle on Employee s Right Shoe

- A health physics logbook entry for the RMHF dated December 29, 1965 describes several loud explosions thought to be sonic booms by personnel in the RMHF Office building 4034. The explosions turned out to be coming from a sodium drum in a shipment of radioactive waste awaiting pickup. An emergency team of three firemen responded first followed by the health physics emergency team. Smoke from the fire was reported to blow away from the RMHF to an unpopulated area.

  The logbook entry notes that weather conditions at the time (high winds and heavy rain) made normal operating procedures, including air sampling and smearing, difficult. an exclusion zone was established and equipment and personnel were monitored prior to leaving the area. One fireman's uniform was found to have contamination at 90 dpm. All other uniforms were at background, below .1 mrad/hr and 30 dpm. A water sample taken from rain runoff indicated 1x10-5 µCi/cc. A handwritten note obtained from Boeing indicates that on December 29, 1965, drums of contaminated sodium exploded in a rain storm and "burned." The note indicated there was a fire, liquid spill, outside contamination, and airborne release to the environment. A formal incident report for this incident could not be located in available documents (A0588).[1]

- On May 19, 1977 the "Sodium Melt Vessel lid" was removed in preparation for removing the SRE piping from the vessel. Approximately 20 minutes following the removal of the lid, it was reported that smoke was detected coming from the vessel. An employee took the dry chemicals fire extinguisher and unloaded it into the vessel and the employees present evacuated the building. Two employees wearing self-contained breathing apparatus

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 71, citation 2:

[2] Unknown Author, Handwritten Note: 588, 12-29-65, RMDF Yard, Unknown Date.

equipment entered the building to put the lid back on the melt vessel to extinguish the fire.

Air samples were reported to have resulted in an immediate count of 2.3x10-10 µCi/cc and a 1-hour delay count of 2.0 x 10-10 µCi/cc. Nasal smears of the employees present during the incident were reported to have been negative. Following the incident, the vault area was damp mopped and allowed to dry. The incident report indicated that the cause of the fire was either excess alcohol or deficient argon gas purge. It was also indicated that the RMDF air stack sampler was removed and analyzed and found to be “negative.” On May 20, 1977 130 smears taken in the vault area indicated for smears with a maximum count of 75 dpm. These areas were reported to have been cleaned and the building was released. The incident report did not indicate the background levels of the building (A0589).[1]

- On August 14, 1979 an outside vendor, Heavy Transport, Inc., truck-trailer was loaded with approximately 44,000 pounds of low-level radioactive waste destined for Beatty, Nevada for burial. The shipment contained six 8-food long boxes with the remainder of the waste in 55-gallon drums. The truck-trailer was moved outside the immediate RMHF facility area to a low-background area for a final U.S. Department of Transportation radiation survey. The trailer was parked on the left side of the facility access road and was tilted slightly toward the outside edge of the roadway. Soon after moving the vehicle, liquid was observed dripping from the trailer to asphalt apron. A shipping box leaked approximately 1 pint of radioactive liquid containing cesium-137 (Cs-137) and strontium-90 (Sr-90) on the asphalt outside the RMHF and on the trailer. An immediate survey found readings of about 85 mrad/hr on the asphalt and 125 mrad/hr on the trailer. According to the incident report, “protective measures were taken to contain and control the area and liquid escaping from that location.” This included the placement of a bucket to catch what was suspected to be alcohol and a rope barrier was established to control access to the spill area.

  Alcohol splattered onto a rear tire and a mud flange, which were covered by personnel using green tape. The truck and trailer were moved back into the controlled area to unload the leaking shipping box. The incident report indicated that plastic was used to catch additional leakage and to cover the road to protect uncontaminated tires. One employee contaminated a white lab coat to about 700 cpm, which resulted in the lab coat being placed in a radioactive waste receptacle for disposal.

  Upon removal of the shipping containers, it was determined that alcohol dripped through the wooden floor and contaminated part of the undercarriage of the trailer. Personnel were assigned to clean this radioactive material, which took approximately three days to reduce all detectable activity to 200 cpm or less. This included the installation of new wooden slats and the painting of all bare metal surfaces as necessary. The incident report did not indicate how the asphalt apron along the RMHF access road was decontamination (A0314).[2]

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 71, citation 3:

> [3] Bradbury, S.M., Rockwell International Internal Letter, *Subject: Fire in the Sodium Melt Vessel in Building 022*, May 23, 1977.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 72, citation 1:

> [1] Owens, D.E., Rockwell International Internal Correspondence, Re: Radiological Safety Incident Report, RMDF, August 14, 1979, A0314, August 20, 1979.

- On May 28, 1981 in the Building 4022 high bay, personnel were rotating “the N.A.C. cask” 180 degrees on the longitudinal axis from the normal transport position. The cask was then lowered to the horizontal position. This was to allow the opening of a drain plug that normally faced down in transport. The incident report indicated that as the cask approached horizontal, liquid ran out the top vent line hole and the cover port located “135 degrees below top dead center.” The liquid was reported to have run down the cask support member to the belly pan and through holes in the corrugated metal pan to the uncovered vault floor blocks. Personnel spread absorbent towels over the spill and placed a bucket under the belly pan to catch the liquid draining from the belly pan. The cask was elevated to stop the flow of liquid.

  The contents of the tank were reported to have been approximately 1-year old mixed fission products from a failed power reactor fuel element that was suspended in liquid. The dose rate from the major accumulation of liquid in the bucket used to catch the liquid was 25 rad/hr beta gamma at 4 inches above the bucket. One spot on the floor indicated 25 rad/h were 17 R/hr at 2 inches. It was estimated that 50 gallons of liquid were located in the cask. The incident report did not indicate what volume spilled

  The available incident report indicated that additional summaries were provided on the back; however the research team only received one page of the incident report. As a result, information regarding the contamination and cleanup of the incident could not be summarized by the EPA research team (A086).[1]

- A 1985 second quarter radiation safety review for RMHF Building 4022 indicated that fixed-location dosimeters were placed at eight locations around the RMHF perimeter fence. Results from the initial monitoring period showed a maximum exposure of 810 mrem at the northwest perimeter fence. This result is above the annual limit of 500 mrem/yr for radiation exposure in uncontrolled areas.[2]

- A 1986 first quarter radiation safety review for the RMHF again showed a high exposure (1,140 mrem) at the northwest perimeter fence. It was noted that the possibility of exposure to the general public was unlikely, due to the terrain north of the RMHF fence line and the continuous remote surveillance of the area. Apparently, the possibility of exposure to employees in the area was not referenced in the report.[3]

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 72, citation 2:

> [2] Badger, F.H., Rockwell International Internal Letter, Subject: Radiological Safety Incident Report, T022 – High Bay, May 28, 1981, June 9, 1981.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 73, citation 1:

> [1] Internal Correspondence from Moore, J.D. to Remley, M.E., Rockwell International, Re: Quarterly Review of the RMDF (T022) for Radiation Safety, Second Calendar Quarter, 1985, September 18, 1985.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 73, citation 2:

> [2] Internal Correspondence from Moore, J.D. to Remley, M.E., Rockwell International, Re: Quarterly Review of the RMDF for Radiation Safety, First Calendar Quarter, 1986, June 23, 1986.

Section 11.4

Building Number: **4034**
Building Alias: **034/T034**
Visitor Log Entry: **6017 / 6000E / 6001R / RMDF / T034**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Shipping / Receiving**

Note: **Designated "Non-Radiological."**
Workers may not have been adequately monitored.
Main entry/exit point at RMHF; "Authorized Use Location"
Radioactive Materials / Laundry / Receiving / Processing

Notes: Several incidents at 4021 & 4022, detailed in the Incident Reports Database, describe incidents that resulted in the ventilation systems of Building 4034 being turned off to avoid personnel exposure and possible contaminant migration from RMHF 4034. In addition, tritium is listed among the radionuclides of concern associated with this location.

Radionuclides of Concern: EPA's research team found no evidence that nuclear or radioactive materials were known to have been stored or handled in Building 4034. However, because Building 4034 is located southeast of the Building 4022 RMHF storage vault, contamination could have migrated from Building 4022 to Building 4044. Radionuclides associated with potential migration from Building 4022 include: uranium fuel materials (U-234, U-235, U-238), transuranic isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242), and americium-241 (Am-241), fission products cesium-137 (Cs-137) and strontium-90 (Sr-90), thorium breeder material (Th-228, Th-232), and possible neutron activation products such as cobalt-60 (Co-60), europium isotopes (Eu-152, Eu-154), **hydrogen-3 (H-3)**, iron-55 (Fe-55), nickel isotopes (Ni-59, Ni-63), managense-54 (Mn-54), potassium-40 (K-40), and sodium-22 (Na-22).

11.4.1 Description of Operations and Processes:

According to the EPA HSA, Building 4034 was constructed in 1961 for intended use as an Office Building. Building 4034 served as the main office and point of entry for RMHF, and was among those buildings listed as "authorized use locations" for the receiving, processing, packaging and shipping of radioactive wastes and materials generated by Atomics International activities: receiving processing, packaging and shipping of radioactive laundry; receiving and processing liquid radioactive wastes; storage of radioactive materials and maintaining facilities equipment and material. Buildings 4021, 4022, 4044, 4075, and 4621 were also listed as authorized use locations with the authorized users being based out of Building 4034.[1]

Because use authorization applications list the location of the principle user, most use authorizations identified for the RMHF complex indicate that the principle user was located at

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 82, citation 1:

. [1] Kneff, D.W. and R.D. Meyer, *Radioactive Materials Handling Facility (RMHF) Demolition Program Management Plan, PMP-00008*, The Boeing Company, January 30, 2004, pgs. 10-11, 19.

the RMHF Building 4034. However, because Building 4034 may be considered an administrative building, it may be referenced in Boeing Employment Summaries and Document Acquisitions Requests (DARs) as a “non-radiological” work location, where an assigned employee may not have been monitored for radiation exposure or assumed to have been at risk. However, given the documented facility use and operations, such an assertion could result in an underestimation of the health risks associated with Building 4034.

The preliminary MARSSIM classification for the Building 4034 area is Class I, due to its proximity to RMHF Building 4022 and the potential for contaminant migration.

Section 11.5

Building Number: **4044**
Building Alias: **044/T044**
Visitor Log Entry: **6017 / T022 / T034 / 6000E / 6001R**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Clean Shop**
Radiation Safety Office
Health Physics Instrumentation
Technician Support Area
Break Room
Storage

Notes: **Possible Tritium Contamination.**
Possible "Non-Radiological" designation.
Workers may not have been adequately monitored for radiation exposure.

Radionuclides of Concern: As the health physics office, Building 4044 was used to count removable contamination measurements and store calibration sources. A 1989 quarterly radioisotope inventory for Building 4044 found sources containing the following radionuclides: Bi-210, Pb-210, Pu-239, Sr-90, Tc-99, and Th-230. An historical photo (c. 1990) shows two small containers labeled "Radioactive Material" and "Radioactive Material - Contaminated Waste" under a desk in Building 4044.[1] The radiological incident associated with this building (described below) notes that mixed fission products were handled in Building 4044.

In addition, because Building 4044 is located just east of the Building 4022 RMHF storage vault, contamination could have migrated from Building 4022 to Building 4044. Radionuclides associated with potential contaminant migration from RMHF Building 4022, according to EPA, include: U-234, U-235, U-238, Pu-238, Pu-239, Pu- 240, Pu-241, Pu-242, Am-241, Cs-137, Sr-90, Th-228, Th-232, Co-60, Eu-152, Eu-154, **H-3**, Fe-55, Ni-59, Ni-63, Mn-54, K-40, and Na-22.

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 89, citation 6:
[6] Rockwell International, *Photograph of SSFL Building 44 RMDF Clean Shop*, circa 1990, HDMSP00048945.

11.5.1 Description of Operations & Processes

Building 4044 was constructed in the mid-1960's as the RMDF Clean Shop.[1] The building contained a radiation safety office with health physics instrumentation and a technician support area / break room. Building 4044 contained radiation counters for radioactive surveillance of the RMHF. The health physics office had been used as a counting area for removable contamination measurements, storage, and use of calibration sources. Radioactive waste was generated as part of operations at Building 4044.[2]

As of July 27, 2011, according to Boeing, there were 10 assorted micro-curie level check sources in use at the Health Physics Laboratory in Building 4044, containing cesium-137 (Cs-137), strontium-90 (Sr-90), technetium-99 (Tc-99), thorium-230 (Th-230), and uranium-238 (U-238).[3] As of 2012, Building 4044 was still active as a break room and health physics office for the RMHF.

The preliminary MARSSIM classification for Building 4044 is Class I, due to its use as a health physics counting office and proximity to Building 4022, the RMHF storage vault.

11.5.2 Building 4044 Radiological Incident Reports

There has been one incident associated with Building 4044 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing.

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 86, citations 1, 2, 3:

> [1] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis*, June 18, 2007, p. A-4.
>
> [2] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
>
> *[3] Kartman, A.S., Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.*

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 86, citations 1-3:

> [1] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis*, June 18, 2007, p. A-4.
>
> [2] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.
>
> *[3] Kartman, A.S., Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.*

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 87, citations 3-4:

> [3] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-13.
>
> [4] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008.

11.5.3
Building 4044 Radiological Incident Report Summary Based on Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0082	7/24/80	RMDF	Mixed Fission	Radioactive Waste Container Emptied Into Clean Waste Gondola.

- On July 24, 1980 it was discovered that a 5-gallon radioactive waste container from the counting room of Building 4044 was inadvertently emptied into a regular trash gondola on July 23, 1980. Upon discovering the error, the trash gondola was returned to the RMHF Building 4022 and had the entire contents placed into a proper radioactive waste disposal container. The incident report did not indicate the location of the trash gondola prior to being transported back to the RMHF Building 4022 (A0082).[1]

The EPA HSA provides a chronology of radiological investigations associated with this facility. Use Authorization 106 pertained to radioactive waste and contaminated materials generated at other authorized facilities. Use Authorization 106M, issued February 12, 1992 noted that operation of the RMHF included receiving, processing, packaging, and shipping radioactive wastes and materials generated by Rocketdyne activities; receiving, processing, packaging and shipping radioactive laundry; receiving and processing liquid radioactive wastes; storing radioactive materials; and maintaining facilities equipment and material. Buildings 4021, 4022, 4044, 4075 and 4621 were listed as authorized use locations with the authorized users based out of Building 4034.

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 86, citations 1-3:

[2] Owen, R.K., Rockwell International Internal Correspondence, *Re: Radiological Safety Incident Report, RMDF, July 24, 1980*, August 20, 1980.

Section 11.6

Building Number: **4075**
Building Alias: **075/T075**
Visitor Log Entry: **6017 / T022 / T034 / 6000E / 6001R**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Contaminated Equipment Storage Building**
Staging Area for Radioactive Waste Shipments

Radionuclides of Concern: Possible radionuclides of concern include uranium, plutonium, thorium, and mixed fission products. The incident database described isotopes of cobalt and europium as being part of the radioactive waste that was released.[1]

11.6.1 Description of Operations & Processes

Building 4075 was constructed in 1971 as the Contaminated Equipment Storage Building and stored low specific activity packaged waste and was primarily used for staging of waste shipments.

There were no exhaust filter systems or additional contamination control safeguards implemented at this building. Building 4075 had no air conditioning, water supply or natural gas connection. EPA's 2009 site visit noted that Building 4075 was "designed so that the floor drain was located in the topographic low point of the building, so any spilled chemicals would flow to the drain." The drain was controlled by a valve and drained via subsurface pipeline into the storm water culvert, which eventually directed drainage to the Site-Wide Water Reclaim System that transported water throughout all areas of SSFL, for use by personnel. Building 4075 was considered a Resource Conservation and Recovery Act (RCRA) permitted building for the support and storage of radioactive wastes (low level, mixed, and transuranic wastes) pending shipment.

According to the HSA, an Atomics International site waste management plan dated circa 1972 and an updated plan dated May 1974 provided information regarding the waste disposal activities at SSFL. According to the waste management plan, which was prepared for the management of AEC contract wastes, provided the following summary:

"Temporary storage of low-level radioactive waste is performed in Buildings 621, 663 and 075. Low-level waste and contaminated equipment are temporarily stored in Buildings 075, 621, and 663, and in the fenced storage area surrounding Building 621. These buildings are steel buildings, which are designed to provide protection from the elements and security for the

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 100

stored items. Contamination control is provided by stringent packaging requirements, so exhaust filter systems and additional contamination control safeguards are unnecessary." [1]

The HSA references a November 1975 Rockwell letter, which notes that at the time Building 4075 contained stored Systems for Nuclear Auxiliary Power (SNAP) equipment and packaged material awaiting shipment for burial. The SNAP program ended in 1973. It is unknown exactly when the SNAP materials were transported to the RMHF for storage, or how long they were present before the 1975 Rockwell letter was issued. The 1975 Rockwell letter states that while the SNAP waste was inside the building awaiting transport to a DOE disposal site, steel billet stored at the RMHF complex could be used to form a bay inside Building 4075 and lead shielding currently stored at the RMHF could be hung on the walls to provide more adequate shielding. The additional shielding was requested expeditiously to bring radiation levels into acceptable DOE limits at the time.[2]

The generation of the 1975 Rockwell request regarding additional shielding to store SNAP materials suggests that similar improvisation may have been required or requested on occasion, depending on materials stored at this location. This presents concerns over assumptions of safe working conditions and data that may be applied during dose reconstructions for SSFL employees, which may reflect underestimated dose.

Although the building was designated as a "low-level" storage facility, the HSA references an August 15, 1988 site visit report noting solid radioactive materials were stored inside Building 4075 in drums or large metal containers, or were "temporarily" stored in the RMHF yard during staging procedures. On the day of the site visit, the yard contained portions of approximately 300 drums of cobalt-60 (Co-60) contaminated sand from the Building 4059 (SNAP) area. Drums stored in the yard were destined for Hanford, Washington for disposal.[3] Aerial photos taken in 1976 depict a disturbed area on the hillside north of Building 4075, suggesting a radiological burial or disposal location.[4]

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 93, citations 1&2:

> [1] Atomics International, *Site Waste Management Plan*, Circa 1972, p. 2.
>
> [2] Atomics International, *Management of AEC-Generated Radioactive Wastes at Atomics International*, May 31, 1974, pgs. 1-2.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 94, citation 3:

> [3] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 94, citation 5:

> [5] Lavagnino, G., *ETEC Meeting and Site Visit*, U.S. Department of Energy, August 17, 1988.

[4] EPA/HGL, *Final HSA 7-3-NBZ,* p. 99, citations 2&3:

> [2] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, March 2008, p. 2-4.
>
> [3] MWH, *RCRA Facility Investigation Work Plan Addendum Second Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California*, October 2008, p. HDMSP00015875.

According to the HSA, the preliminary MARSSIM classification for the Building 4075 area is Class 1, due to its former use and a documented release of radiological material.

11.6.2 Building 4075 Radiological Incident Reports

There has been one documented incident associated with Building 4075 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing.

11.6.3
Building 4075 Radiological Incident Report Summary Based on Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0188	8/15/1988	Radioactive Storage 075	Co/Eu	Fork Truck Operator Punctured 55 Gal Drum of R/A Waste.

• On August 15, 1988 a forklift driver punctured two drums containing radioactive sand that originated from Building 4059. approximately 40 grams of sand spilled onto a 200 square centimeter area of the drum pallet and floor. One-half gram of the sand had a beta gamma reading of 24,000 dpm. The spilt sand was vacuumed up into a radioactive vacuum cleaner, and the punctures were sealed with duct tape. The drums were transported to Building 4021 (decontamination room) and the remaining sand was transferred to new drums. Post cleanup surveys found no detectable contamination (A0188).[1]

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 96, citations 2&3:

[2] McGinnis, E.R., Rockwell International Internal Correspondence, *Re: Radiological Safety Incident Report, RMDF- T075, August 15, 1988*, August 23, 1988.

[3] Moore, J.D., Rockwell International Internal Correspondence, *Re: Quarterly Review of the Radioactive Materials Disposal Facility (RMDF) for Radiation Safety, Third Calendar Quarter, 1988*, December 22, 1988.

Section 11.7

Building Number: **4654**
Building Alias: **654/T654**
Visitor Log Entry: **6017 / T022 / T034 / 6000E / 6001R**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Interim Radioactive Waste Storage Facility (ISF)**
Sodium Reactor Experiment (SRE) Support & Storage
Organic Moderated Reactor Experiment (OMRE) Waste Storage
Systems for Nuclear Auxiliary Power (SNAP) Waste Storage

Radionuclides of Concern: The primary radionuclides of concern for Building 4654 are uranium and mixed fission and activation products.[1]

11.7.1 Description of Operations & Processes

Building 4654 was constructed in 1958 as the Interim Storage Facility (ISF) to support the Sodium Reactor Experiment (SRE). The ISF was designed to store dummy and spent fuel elements, shipping and storage casks, and hot waste generated at the SRE. After the SRE stopped operating, Building 4654 was used to store waste from the Organic Moderated Reactor Experiment (OMRE) and the Systems for Nuclear Auxiliary Power (SNAP) program. While the EPA HSA indicates that Building 4654 was taken out of service between 1964-1984, it is noteworthy that the SNAP program's years of research and development were 1960's through the late 1970's. Low-level radiation was released from the storage of containers at this facility.[2]

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 193, citation 2:

> [2] Vitkus, T.J., *Verification Survey of the Interim Storage Facility (T654), Santa Susana Field Laboratory, Rockwell International*, Ventura County, California, ORISE 97-1900, Oak Ridge Institute for Science and Education, November 1997, p. 7.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 184, citations 1-8:

> [1] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, pgs. 1, 3.
>
> [2] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 5.
>
> [3] Dahl, Farley, C., *Building T654 Supplemental Final Radiological Survey Report, SSWS-AR-0011*, The Boeing Company, January 20, 1999, p. 3.
>
> [4] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports*, June 2009, pg. B.2-7.
>
> [5] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 5.
>
> [6] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports*, June 2009, pg. B.2-7.
>
> [7] Johnson, R.P. and Speed, D.L., *Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507*, Rockwell International, Rocketdyne Division, March 15, 1985, p. 1.
>
> [8] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, p. 12.

Building 4654 was open to the environment, which provided the potential for surface water to seep into the storage tubes and to possibly corrode the steel pipes. This building design increased the potential for contaminated water to leak into the subsurface below the storage tubes.

A 1964 inspection tour of SSFL fuel storage areas notes that one of the SRE Core I fuel elements removed from the Building 4654 storage pits contained in an unleaded tube, which separated just as it was being fitted into the RMHF storage thimble. It was recommended that the tube be weld-sealed for contamination control. The inspection report notes that the Building 4654 storage area was also temporarily being used to store classified scrap materials.[1]

11.7.2 1995 ORISE Verification Survey

In 1995, the Oak Ridge Institute for Science and Education (ORISE) performed independent verification of Rocketdyne's final status survey of Building 4654 following 1984-1985 D&D efforts. ORISE determined that exposure rates at Building 4654 ranged from 10 to 15 μR/h. According to ORISE, background rates ranged from 12 to 16 μR/h with an average of 14 μR/h. The NRC exposure rate limit is 5 μR/h above background.

ORISE conducted a document review and independent measurement and sampling. ORISE found deficiencies in Rocketdyne's final status documentation. Deficiencies included inadequate final status survey methods, no discussion of specific contaminants, inconsistent specification of all applicable guidelines and presentation of data that may be compared to the guidelines, absence of quantitative laboratory data, and inconsistent presentation of adequate figures documenting remediated areas and measurement and sampling locations.[2]

11.7.3 Building 4654 Radiological Incident Reports

There have been a couple of incidents associated with Building 4654 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 185, citation 1:

> [1] Internal Correspondence from Matten, K.L. to Fuel Committee Members, Atomics International, *Re: Inspection Tour of Santa Susana Fuel Storage Areas*, April 23, 1964.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 185, citations 5,6,1:

> [5] Vitkus, T.J. and Bright, T.L., *Verification Survey of the Interim Storage Facility; Buildings T030, T641, and T013; an Area Northwest of Buildings T019, T013, T012, and T059; and a Storage Yard West of Buildings T626 and T038, Santa Susana Field Laboratory, Rockwell International, Ventura County, California, ORISE 96/C-4*, Oak Ridge Institute for Science and Education, February 1996, pgs. 5-15.
>
> [6] Shah, Satish, N., *Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364*, The Boeing Company, May 20, 1999, pgs. 11, 14.
>
> [1] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California,* June 2009, p. 3-12*.*

The preliminary MARSSIM classification for the Building 4654 area is Class 1, due to the building design, its former use, radiological incidents, and previous investigations.

11.7.4 Building 4654 Radiological Incident Report Summary, Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0014	1/23/1962	T654 R/A STORAG	Mixed Fission	Loss of Containment of R/A Equipment Stored Outside
A0079	7/5/79	654 R/A YARD	Mixed Fission	Contamination Found on Pavement and Outside Storage Yard Fence

- On January 23, 1962 a radiation survey of Building 4654 was conducted and revealed contamination had spread from the inside of the fenced area to the asphalt outside the fence. At that time, the contamination level outside the fenced area of Building 4654 was between 2 and 3 mrad/hr. The contamination on exposed equipment surfaces inside the fence was as high as 17 rad/hr. This information was written in the SRE operations logbook. The incident report indicated that no action was taken to decontaminate the area or prevent further spread of contamination. On February 13, 1962 a similar survey was conducted and indicated an increased spread of contamination due to rain. The contamination on the pavement was between 2 and 17 mrad/hr outside the enclosure. Exposed equipment surfaces inside the enclosure showed loss or displacement of 5 rad/hr of contamination as the maximum detectable level was 12/rad hr. Four soil samples were taken along the drainage pathways. Soil contamination ranged from 20-30 µCi/g. Additional information regarding any cleanup of the area, or whether contamination continued to spread, was not provided in the incident summary (A0014).[1]

- During a preliminary survey of the storage yard on July 5, 1979 contaminated shipping casks stored in the area were found to be emitting high levels of radiation. These high levels were noted in the northeast corner of the fenced area. An area of asphalt measured greater than 50,000 dpm. A smear of a 3-gallon shipping cask found radioactive contamination of 12,000 dpm and an instrument survey indicated 35 mrad/hr at the cask. Some of the other casks surveyed indicated radioactive intensities of 40 mrad/hr. A preliminary survey of the soil outside the fenced area indicated possible soil contamination along the northeast fence line along the east side ranging from 200 to 400 cpm. The incident report did not include information to indicate any clean up operations of the area (A0079).[2]

- Seals and packing on some casks and equipment stored at the ISF deteriorated from exposure to the elements to such an extent that low-level contamination was released. This

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 186, citation 1:

> [1] *Badger, F.H., Atomics International Internal Letter, Re: Spread of Contamination in Area # 654, February 18, 1962.*

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 186, citation 3:

> [3] *Owen, R.K., Handwritten Note Re: SRE Interim Storage Yard, July 5, 1979.*

release contaminated the asphalt surface near the casks and soil just outsisde the ISF fence. The casks and other sources of potential contamination were sent to an offsite disposal facility. Radioactive core components placed in the storage tubes contaminated the internal storage cells. The exact location where the casks and equipment were stored inside the ISF fenced storage area is unknown.[1]

- During D&D excavation activities the hydraulic hammer mounted on the end of the backhoe punctured storage tube 7. The area was surveyed for contamination but none was found.[2]

11.7.5 Radiological Investigations

The EPA HSA contains a detailed chronology of radiological investigations and decontamination procedures associated with Building 4654. Of note is that 1995 ORISE Verification Survey following Rocketdyne's 1984-1985 D&D efforts. ORISE found deficiencies in Rocketdyne's final status documentation, which included inadequate final status survey methods, no discussion of specific contaminants, inconsistent specification of all applicable guidelines and prsentation of data that may be compared to the guidelines, absence of quantitative laboratory data, and inconsistent presentation of adequate figures documented remediated areas and measurement and sampling locations.

In addition, ORISE determined that Rocketdyne's surface scans for alpha, beta, and gamma activity did not identify any locations of residual contamination. Exposure rates for the ISF ranged from 10-15 μR/h. According to ORISE, background rates ranged from 12 to 16 μR/h with an average of 14 μR/h. The NRC exposure rate limit is 5 μR/h above background.

ORISE was unable to verify the radiological status of the ISF because of document deficiencies and recommended additional surveys. A supplemental survey plan was developed by Rocketdyne for a cooperative soil sampling effort with ORISE.[3] Several subsequent investigations of the location were performed. On Febuary 1, 2005 DOE released Building 4664 for unrestricted use.

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 186, citation 4:

> *[4] Johnson, R.P. and Speed, D.L., Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507, Rockwell International, Rocketdyne Division, March 15, 1985, p. 1.*

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 186, citation 5:

> *[5] Johnson, R.P. and Speed, D.L., Interim Storage Facility Decommissioning Final Report, ESG-DOE-13507, Rockwell International, Rocketdyne Division, March 15, 1985, pgs. 9, 13.*

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 190, citations 5,6,1:

> [5] Vitkus, T.J. and Bright, T.L., Verification Survey of the Interim Storage Facility; Buildings T030, T641, and T013; an Area Northwest of Buildings T019, T013, T012, and T059; and a Storage Yard West of Buildings T626 and T038, Santa Susana Field Laboratory, Rockwell International, Ventura County, California, ORISE 96/C-4, Oak Ridge Institute for Science and Education, February 1996, pgs. 5-15.
>
> [6] Shah, Satish, N., Final Report Decontamination & Decommissioning of Interim Storage Facility 4654, EID-04364, The Boeing Company, May 20, 1999, pgs. 11, 14
>
> [1] MWH, Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, June 2009, p. 3-12.

Section 11.8

Building Number: **4665**
Building Alias: **665/T665**
Visitor Log Entry: **6017 / T022 / T034 / 6000E / 6001R**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Oxidation Facility**
Equipment Storage
Longterm Sodium Storage (SRE)
General & Hazardous Materials Storage

Radionuclides of Concern: Radioactive waste and material may have been stored or handled at this facility. The most probable radionuclides of concern are isotopes of uranium, plutonium, thorium, and mixed fission products.

11.8.1 Description of Operations & Releases:

Building 4665 was constructed in 1964 as the Oxidation Facility, and was connected to Building 4664 via a water line. Building 4665 was used as an oxidation facility and equipment storage area for the RMHF. It was used for long-term storage of sodium that had previously been temporarily stored in Building 4022 and at the Sodium Reactor Experiment (SRE, Building 4143).[1] An undated fire preplan report notes that Building 4665 was also used for the storage of paper, plastics, paints, filters, and lighting.[2]

A November 1996 building reconnaissance report states that the building had a minor crack in its floor and was used for the storage of hazardous materials. Equipment and supplies were noted throughout the building. The report states that less than 300 gallons of hazardous material was in the building storage racks at the time.[3]

The preliminary MARSSUM classification for the Building 4665 area is Class 1, due to its potential for contamination by storing items previously stored in Building 4022, the RMHF storage vault, as well as its proximity to Building 4022. According to Boeing, there are no accidental releases or incident reports associated with Building 4665.

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 146, citations 1, 2, 12:

[1] Carroll, J.W. et al., *RMDF Leach Field Decontamination Final Report, ESG-DOE-13385*, Rockwell International, September 15, 1982, p. 11.

[2] Atomics International Drawing, *Radioactive Scrap Oxidation Facility, Building 665, Santa Susana Field*

[12] *The Boeing Company, Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007, p. A-5.*

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 147, citation 3:

[3] Unknown Author, *RMDF Fire Preplans – Structures*, Unknown date.

[3] 3 EPA/HGL, *Final HSA 7-3-NBZ,* p. 147, citation 4:

[4] Unknown Author, *Building Reconnaissance Report*, Building 665, November 8, 1996.

Section 11.9

Building Number: **Leach Field Area**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Notes: Possible source of Tritium in Groundwater.

Radionuclides of Concern: Radionuclides of concern detected in the RMHF Leach Field include Cs-137, Sr-90, and Y-90.[1] Other radionuclides of concern likely associated with the RMHF Leach Field are those associated with Building 4021, primarily mixed fission products and fuels.[2] uranium fuel materials (U- 234, U-235, U-238), transuranic isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241, Pu- 242) and americium-241 (Am-241), fission products Cs-137, Sr-90, krypton-85 (Kr-85), and promethium-147 (Pm-147), thorium breeder material (Th-228, Th-232), and possible neutron activation products such as cobalt-60 (Co-60), europium isotopes (Eu-152, Eu-154), **hydrogen-3 (H-3)**, iron-55 (Fe-55), nickel isotopes (Ni-59, Ni-63), managense-54 (Mn-54), potassium-40 (K- 40), sodium-22 (Na-22), Fe-55, Kr-85, and Mn-54.

11.9.1 Description of Operations & Releases:

The RMHF Leach Field area comprises the RMHF Leach Field and the land surrounding it north of the RMHF fence line and near the northern edge of the Area IV boundary. The RMHF Leach Field was constructed in early 1959 as an irregular-shaped excavation that was backfilled with 4 feet of gravel, covered with a paper barrier, and then covered with native soil to the original grade. The Leach Field was the gravity-fed disposal point for a 1,500-gallon septic tank sanitary waste system that accepted waste from the Building 4021 lavatories, shower, and toilets. A second connection to the RMHF Leach Field, bypassing the septic tank, was made from the radioactive water processing system at the waste holdup tank, located on the west side of Building 4021. Liquid waste from the radioactive holdup tank was reportedly discharged to the leach field only after sample analysis indicated radioactive contamination was within “acceptable limits.”[3] The term, “acceptable limits” is an unknown context, and likely does not apply to current standards or with the December 2010 Administrative Order on Consent (AOC) regarding environmental cleanup at SSFL.

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 167, citation 3 & 4:

> [3] Rockwell International, *Radioactive Materials Disposal Facility Leach Field Environmental Evaluation Report, DOE-SF-3*, February 23, 1982, p. 8.
>
> [4] Collins, J., *Final Radiological Inspection of the RMDF Leach Field for Release for Unrestricted Use, N704TP990010*, Rockwell International, August 13, 1980, p.11.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 167, citation 5:

> [5] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, p. A-1.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 157, citations 3,4,5:

Th RMHF Leach Field was used from early 1959 through late 1961 for the disposal of sanitary waste associated with Building 4021. Sanitary waste was subsequently accepted at the Area III sewage treatment plant. The RMHF septic system was abandoned in place.

11.9.2 Former Radiological Burial or Disposal Locations

The June 2009 Resource Conservation and Recovery Act Facility Investigation (RCRA RFI) report depicts a large potential debris area north and east of the RMHF Leach Field, and calls this area the Western Drainage Debris area. The report associates it with Building 4133; however the debris area appears to be closer to the RMHF Leach Field than Building 4133. The debris noted as concrete, scrap, metal, and empty drums may be associated with Building 4133, but the location of the debris area depicted is nearer the RMHF Leach Field.[1]

The preliminary MARSSIM classification for the RMHF Leach Field area is Class 1, due to its former use and the radiological contamination found in the RMHF Leach Field.

11.9.3 Leach Field Radiological Incident Report Summary, Data Provided by Boeing

There have been a couple of incidents associated with Building 4654 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0056 / A0064	11/3/1976	RMDF Leach Field	Mixed Fission	Contaminated leach field discovered during RMDF North Slope Recovery
A0079	2/14/1978	RMDF Leach Field	Mixed Fission	Leach Field during decontamination flooded with rain water.

- According to the 1982 RMDF Leach Field decontamination final report, prior to the connection of Building 4021 to the central sanitary sewer in late 1961, a valve to the emergency overflow of the radioactive water processing system was left partially open and allowed an unknown amount of contaminated water to enter the leach field system. Further investigation indicated that the distribution box flooded and leaked near its upper surface when the radioactive materials were introduced. The radioactive materials percolated northeasterly as well as down the north leach line and into the gravel bed.

  Historical information regarding this release of contaminated water to the leach field could not be located by the EPA research team. According to a 1992 report on tritium release, the RMHF Leach Field became contaminated as a result of releasing approximately 5,000 gallons of water from the RMHF radioactive water system.

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 167, citation 2:

> [2] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.

It was assumed the major source of radioactive water at that time came from cleanup of the building 4020 (Hot Lab) hot cells after examination of fuel assemblies from the first Sodium Reactor Experiment (SRE) core or from wash water used at the SRE. The 1992 Rockwell report author estimates 0.1 curies (Ci) of Cs0137 and .017 Ci of tritium were released to the leach field, although the values are arbitrary as they try to account for losses to evaporation. According to the 1992 report, the RMHF Leach Field is considered a possible source of tritium in groundwater.[1]

- On November 3, 1976 RMHF Leach Field connected to Building 4021 was found to be contaminated at levels up to 200 mrad/hr. To date the EPA research team has not located the incident report documenting this incident.

- On February 14, 1978 the RMHF Leach Field was found to have contaminated water draining from it as a result of heavy rains in February. These rains caused mud slides blocking some of the drainage paths around the leach field resulting in flooding of the field. This was compounded by flow of surface water directly into the gravel bed of the leach field through exploratory wells that had been drilled during 1976. The drainage water was reported to be contaminated with strontium-90 (Sr-90) at a level of 4×10^{5} microcuries per milliliter (µCi/mL) gross beta activity although other contaminants were possible. The point of drainage was dammed by use of sandbags and a sump was dug to retain additional drainage. Soil was removed from the surface of drainage channels downstream of the leach field to remove the contamination deposited by the runoff. A “large number” of water and soil samples were taken and analyzed from the point of drainage downstream to the “site boundary and beyond.” The

  results showed that surface water runoff samples ranged from a maximum of 4.6×10^{5} µCi/mL beta in the drainage from the leach field to 1.0×10^{7} µCi/mL beta approximately 0.25 miles past the Area IV boundary line. Soil radioactivity ranged from a maximum of 1,880 picocuries per gram (pCi/g) beta at the leach field to normal background of approximately 24 pCi/g beta near the Area IV boundary line.

  Based on estimates, the U.S. Environmental Protection Agency (EPA) finds it significant that the incident report indicated that the release from the leach field was estimated to not exceed 3.2 millicuries (mCi). It was recommended the leach field be decontaminated in 1978. The incident report did not provide a figure showing the extent of contamination (A0056, A0064).[2]

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 160, citation 2:

> [2] Tuttle, R.J., *Tritium Production and Release to Groundwater at SSFL, RI/RD92-186*, Rockwell International, December 1, 1992, pgs. 4-10–4-11.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 161, citation 1:

> [1] Tuttle, R.J., Rockwell International Internal Correspondence, *Re: Contaminated Runoff from RMDF Leach Field*, March 2, 1978.

12.0 RMHF: Additional Locations / Operations

Several important buildings and facilities associated with RMHF were left out of the 2006 Site Description and Site Profile. As a result, all associated data relevant to potential environmental releases and worker exposures associated with these locations has been similarly excluded.

The RMHF was a major contributor to onsite ambient radiation exposure and airborne emissions. One of the most important facilities excluded from the 2006 Site Profile is the Building 4664 Low-Level Radioactive Waste Incinerator. According to Boeing, this facility was never used to incinerate radioactive waste. However, the EPA HSA research team located historical documents showing Building 4664's construction for the purpose of burning low-level radioactive waste; that it functioned in such a capacity for nearly 20 years; and that upon its decommissioning it was disposed as radioactive waste.

While the exclusion of many important buildings, operations, releases and incidents from a Site Profile results in a vastly diminished perception of site operations and worker exposure, as well as compromises the environmental dose estimations applied to workers on site, the exclusion of the Building 4664 Low-Level Radioactive Waste Incinerator alone has likely had a substantive impact on the validity of all environmental data submitted for SSFL.

Section 12.1

Building Number:	**4622**
Building Alias:	**622/T622**
Visitor Log Entry:	**6017 / T022 / T034 / 6000E / 6001R**
Building Name:	**Radioactive Materials Handling Facility (RMHF)** **Entry Point** **Guard Shack**
Building Function:	**Health Physics Counting Area / RA Waste Counting**

Radionuclides of Concern: Given numerous references to Building 4622 as a building used for radioactive counting and the EPA research team's inability to locate any more specific information on radionuclides of concern, it is presumed that waste handled at other RMHF complex buildings had the potential to be sampled and counted at Building 4622. Thus, this building area presents the same concerns for radionuclides that are reflected in the rest of the RMHF complex.

12.1.1 Description of Operations & Processes

Building 4622 appears to have been constructed in or before 1959, and has been identified as the Radioactive Waste Counting Building, and an Entry Building for the RMHF complex.1 A July 3, 1962 Atomics International letter identifies Building 4622 as a "guard shack." According to the letter, when the RMHF was activated, Building 4622 was equipped with a portal monitor and a hand-and-foot counter to check all personnel in and out of the RMHF area. However, background activity levels rendered the equipment useless and it was replaced with portable equipment better suited for monitoring personnel.2 Historical documents indicate Building 4622 was considered an entry building, and also used as a storage location for visitor film badges and the control badge. It was reported on April 19th, 1965 that Building 4022 had been used for the recent open-air transfer of 20 Sodium Reactor Experiment (SRE) moderator cans in the vault of that building. As a result of the proximity of Building 4622 to Building 4022, background radiation in Building 4622 was raised from 005 "mr/hr" to approximately .2 "mr/hr" over a period of approximately 120 hours, resulting in elevated film badge readings for the month of April.[3]

According to a 2005 HSA and a Resource Conservation and Recovery Act (RCRA) facility investigation work plan, Building 4622 was used as a health physics counting area. Samples of

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 122, citation 2:

> [2] Shoemaker, *Operating Specification Radioactive Materials Disposal Unit*, February 24, 1964.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 122, citation 5:

> [5] Schlapp, F.W., Atomics International Internal Letter, Subject: *Radiation Monitoring Equipment in Dormant Storage*, July 3, 1962.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 122, citation 7:

> [7] Young, L.N., Atomics International Internal Letter, Subject: *Overexposure of April Film Badges at Building 622, April 19, 1965.*

waste contained at the RMHF were taken to Building 4622 for radioactive counting. EPA's research team could not locate historical documents to confirm these building operations. However, it should be noted that industrial planning maps for SSFL identify Building 4622 as a Radioactive Waste Counting Building from March 1962 through March 1975. The building is no longer present on industrial maps, beginning in July 1977. The 2005 RCRA HSA indicates that Building 4622 was demolished in approximately 1976.

The preliminary MARSSIM classification for the Building 4622 area is Class 1, due to its possible use as a radioactive waste counting building and the limited information and investigation material available for this building.

Section 12.2

Building Number: **4563**
Building Alias: **563/T563**
Visitor Log Entry: **6017 / T022 / T034 / 6000E / 6001R**

Building Name: **Radioactive Materials Handling Facility (RMHF) Storage Yard**

Building Function: **Waste Storage**

Radionuclides of Concern: The most probable radionuclides of concern are uranium, plutonium, thorium, and mixed fission products.[1]

12.2.1 Description of Operations & Processes:

Building 4563 was constructed in 1958, but at that time it was an uncovered, asphalt and concrete paved storage yard. It served as a storage area for containerized radioactive waste pending shipment to a disposal facility. According to the HSA, on average, fewer than 40 waste containers were stored in this yard pending shipment. No radiological incident reports were found.[2] Use Authorizations dated 1970 indicate this location was used for the storage of irradiated stainless steel from the Systems Nuclear Auxiliary Power 8 Development Reactor (SNAP8-DR) shield assembly, at the the storage yard.

The HSA indicates that the preliminary MARSSIM classification for the Building 4563 area is Class 1, due to its former use as a storage yard and the lack of previous investigations.

The EPA HSA research team did not locate any radiological incident reports associated with this location.

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 106 citation 2:

> [2] Cabrera Services, Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California, October 2007, p. 4

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 103

Section 12.3

Building Number: **4621**
Building Alias: **621/T621**
Visitor Log Entry: **6017 / T022 / T034 / 6000E / 6001R**

Building Name **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Radioactive Accountable Waste Storage Building**

Radionuclides of Concern: Building 4621 stored radioactive materials primarily in the form of mixed fission products from various waste sites.[1] A radioactive waste packaging document indicated that a container stored at Building 4621 included radioisotopes Co-60, Cs-137, strontium-90 (Sr-90), and thorium-232 (Th-232). Internal Rockwell letters regarding use authorizations indicate the following sources have been stored in Building 4621: Am-241, Co-60, Cs-137, iridium-192 (Ir-192), plutonium-beryllium (PuBe), and “Th-170” [sic, possibly Tm-170].” A 1992 semi-annual leak test and a 1995 radioactive materials license renewal provided the following inventory of sources at Building 4621: Am-241, bismuth-210 (Bi-210), Cf-252, Cs-137, chromium-51 (Cr-51), cobalt isotopes (Co-56, Co-57, Co-58, and Co-60), Ir- 192, lead-210 (Pb-210), Kr-85, manganese isotopes (Mn-52, and Mn-54), Ra-226, Sr-90, and thulium-170 (Tm-170).5,6, Cf-252, Co- 56, Co-57, Co-58, Cr-51, Ir-192, Kr-85, Mn-52, Mn-54, and Tm-170.

12.3.1 Description of Operations & Processes

Building 4621 was constructed in the mid-1960’s as the Radioactive Accountable Waste Storage Building, designated for the storage of containerized low-to-intermediate level radioactive waste.[2] Dry and liquid mixed waste materials were stored in 55-gallon drums. According to an Atomics International site waste management plan dated circa 1972, exhaust filter systems and additional contamination control safeguards were considered unnecessary for this facility, based on the assumption that stringent packaging requirements were sufficient.[3]

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 118, citation 6:

. [6] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, p. A-2.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 109, citations 1, 2, 3:

[1] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis, June 18, 2007*, pgs. A-2 – A-3.

[2] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.

[3] Correspondence from Seward, F.A. to Nagel, W.E., *Re: Request for Radioactive Material and Radiation Producing Devise User Authorization for RMDF Operation*, December 10, 1985.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 93, citations 1&2:

[1] Atomics International, *Site Waste Management Plan*, Circa 1972, p. 2.

[2] Atomics International, *Management of AEC-Generated Radioactive Wastes at Atomics International*, May 31, 1974, pgs. 1-2.

According to the HSA, as of 2011 Building 4621 was still standing and the mixed-waste storage yard was still active.[1]

The preliminary MARSSIM classification for the Building 4621 area is Class 1, due to its former use as a mixed waste storage area and the numerous spills of radiological material in the area.

12.3.2 Building 4621 Radiological Incident Reports

There have been several incidents associated with Building 4621 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

12.3.3 Building 4621 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0553	9/4/1975	621 Yard	Ra226	During Tour of RMDF A Lost Source was Discovered
A0055	6/2/75	RMDF & Adjacent	Mixed Fission	Nine Spills Have Been Identified @ RMDF Complex
A0570	8/18/85	RMDF T-621		A False High Radiation Alarm Occurred And Was Responded To.
A0341	4/7/89	T621 RAS		Response to False RAS Alarm

- On September 4, 1975, a 132 millicurie (mCi) radium-226 (Ra-226) source was discovered lying on the ground between Building 4621 and Building 4075. The source was not in a shielded container and was not labeled or tagged and had two feet of string attached. Following its discovery, the source was properly marked and stored in a secure condition. According to the incident report, personnel assigned to the RMHF had been instructed to clean out building 4621. Personnel removed all sources stored within the building to the open yard. While moving items, personnel dropped the spherical container and spilled the encapsulated source on the ground. The incident report did not indicate how long the source remained unnoticed. The incident report indicated that no significant exposure or spread of

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 112, citations 2 & 3:

[2] *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume I – Text, Tables, and Figures,* MWH, June 2009, p. 3-9.

[3] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008.

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 111, citations 1 & 2:

[1] Badger, F.H., Rockwell International Internal Letter, *Subject: Lost Source Discovery*, September 9, 1975.

[2] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys, Santa Susana Field Laboratory, Ventura County, California*, October 2007, p. 5.

contamination resulted from the incident (A0053).[1]

- An October 17, 1975, Rockwell letter discusses nine significant radioactive spill areas and numerous spot areas at the RMHF complex. Figure 2.7e presents the map of these areas, many of which were located in the western storage yard areas of the RMHF complex. The activity associated with the spills ranged from 0.5 to 3,500 millirads per hour. The spills were assumed to have occurred between 1972 and 1975 and to have followed the water course. One spill was a result of an empty high-level waste cask containing 15 rad per hour on the inside of the cask in the storage yard. The cask filled with rain water and flooded contaminated water out. Six similar casks were found. Additionally, three barrels of radioactive materials stored in "the backyard" tipped over and leaked or rotted out and leaked causing three other areas of contamination.As of October 17, 1975, all spills in the storage yard and two spills outside the storage yard were decontaminated or removed. Cleanup on another spill had begun and two other areas were identified for cleanup, but had not yet been delineated (A0055).[2]

- A November 18, 1975 Rockwell letter follows up on the October 17, 1975 letter discussed above and describes the current status of the RMHF complex. The letter notes that there were three contaminated areas on the floor and shelves in Building 4621. One area appeared to be a result of liquid seeping from a barrel liner stored on one of the upper shelves. The second area appeared to be the result of a powdery substance on the floor. A third area of contamination was of an unknown origin.

  The November 18, 1975 letter also describes the holdup yard as containing significant radiological sources including approximately 250 drums (30 and 50 gallons), 59 high level pigs, 50 liquid storage drums (30 gallon), 32 drums of high level waste, 20 pallets of concrete block, 9 concrete conduits, 10 pallets of miscellaneous materials, 4 transfer casks, and 3 pieces of contaminated Sodium Reactor Experiment (SRE) moderator handling equipment. Several areas of contaminated asphalt and approximately 35 contaminated pallets were noted in the holdup yard. The U.S. Environmental Protection Agency (EPA) finds it significant that the November 1975 letter notes that there were at least two separate major spills in the Building 4621 holdup yard, each covering approximately 100 square feet or more and several smaller spills of about 5 square feet or less.

  Additionally, external to all buildings and the holdup yard proper, an accumulation of boxes, barrels, conduits, liquid tanks, large rectangular metal containers, trash dumpsters, and other miscellaneous materials was noted.

  Several areas of contaminated asphalt and dirt were identified at the west end of the RMHF perimeter. The areas of contamination described in this letter appear to be the same areas

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 111, citations 4:

[4] *Internal Correspondence from Badger, F.H. to McCurnin, Jr., W.R., Rockwell International, Re: Radioactive Spills in RMDF, October 17, 1975.*

described above in the October 17, 1975 letter. Contamination of dirt and asphalt was thought to be the result of long-term, outdoor storage. Contaminated items were generally wrapped in plastic and stored in the storage yard, but after three or more years of storage and exposure to weather, the integrity of the plastic wrapping was compromised exposing contaminated surfaces. Rain water could then carry contamination onto outer surfaces of containers and along drainage pathways of the RMHF complex. Rows of 30-gallon drums stacked on the asphalt at the west end of the RMHF perimeter and pallets of non-contaminated material presumably became contaminated in this manner. According to the November 1975 letter, since mid-July all of the contaminated and non- contaminated items were removed from Building 4621 holdup yard. Items that could be decontaminated were and items that could not be decontaminated were packaged for disposal. Asphalt and dirt were jack hammered out and put into 50-gallon drums. Concrete blocks were moved to the SRE for use as shielding during decontamination and decommissioning operations, if necessary. Contaminated items within Building 4621were "decontaminated to as low as practical." The letter recommends that funds be made available soon to dispose of all the contaminated items found at the RMHF complex.[1] [2]

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 112, citations 1-4:

> *[1] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, Re: Plan of Action for RMDF, November 18, 1975.*
>
> *[2] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, Re: Plan of Action f for RMDF, November 18, 1975.*
>
> *[3] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, Re: Plan of Action for RMDF, November 18, 1975.*
>
> *[4] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, Re: Plan of Action for RMDF, November 18, 1975.*

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 113, citation 1:

> *[1] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, Re: Plan of Action for RMDF, November 18, 1975.*

Section 12.4

Building Number: **4658**
Building Alias: **658/T658**
Visitor Log Entry: **6017 / T022 / T034 / 6000E / 6001R**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Guard Shack / Entrance / Exit**

Building 4658 was originally constructed in 1959 for use as the Guard Shack. In 1981 or 1982, the entrance to the RMHF complex was reconfigured. New fencing, a new entrance gate, and a new guard shack were installed.

12.4.1 Building 4658 Radionuclides of Concern

Although no radionuclides of concern could be identified specific to Building 4658, the building was located at the entry point for all incoming and outgoing fuel and waste shipments. Therefore, EPA determined that radionuclides at other RMHF facilities should also be sampled at this location. EPA determined that sampling beneath the concrete foundation of Building 4658 should be sampled because the area served as a storage location for radioactive materials, but had only received limited investigation. EPA determined the aboveground pipeline near Building 4658 should be investigated because the contents of the pipeline were unknown, and pooling locations had been observed around pipeline supports. Surface drainage areas were also sampled, and investigated for residual contamination.

According to the preliminary MARSSIM classification, Building 4658 area is a Class 1 due to its proximity to other buildings at the RMHF complex that handled radioactive material.

Section 12.5

Building Number: **4663**
Building Alias: **663/T663**
Visitor Log Entry: **6017 / T022 / T034 / 6000E / 6001R**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Storage Area**

Radionuclides of Concern: The most probable contaminants of concern associated with any possible radioactive material storage at Building 4663 were isotopes of uranium, plutonium, and thorium, and mixed fission products.[1]

12.5.1 Description of Operations & Processes

Building 4663 was constructed in the late 1950's or early 1960's as a Storage Area that may have been used for the storage of radioactive materials.[2] A 1964 inspection tour of SSFL fuel storage areas notes that "the accumulation of 'loaded' filters in storage building 663 is becoming a problem. These filters are being 'loaded' at a rate of up to 20/week. Each filter may contain a meaningful quantity of uranium when one is machining fuels containing fully enriched uranium."[3]

The Atomics International Reactor Fuels Committee discussed this accumulation of "loaded" ventilation system filters in Building 4663. According to the committee, these filters were being 'loaded' at a rate of about 48 absolute filters per month (containing approximately 107 grams of uranium per absolute filter) in the "FEM and FED" machining operations. The Committee thought that the uranium content of these filters could present problems, both with regard to potential criticality (following certain types of accidents, e.g., fires), and overall accountability economics. However, according to the Committee, at the time, the RMHF had no way of recovering these fuel values from the filter media.[4]

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 134, citation 1:

> [1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-39.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 130, citations 4 & 5:

> [4] Sapere Consulting, Inc. and The Boeing Company, Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries, May 2005, p. I-39.
>
> [5] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 130, citation 6:

> [6] Internal Correspondence from Matten, K.L. to Fuel Committee Members, Atomics International, *Re: Inspection Tour of Santa Susana Fuel Storage Areas*, April 23, 1964.

[4] EPA/HGL, *Final HSA 7-3-NBZ,* p. 130, citation 7:

> [7] Internal Correspondence from Reactor Fuels Committee to Balent, R. et al., Atomics International, *Re: Tour and Inspection of AI Fuel Storage Facility – Minutes of Meeting of May 4, 1964*, May 14, 1964.

According to the HSA, an Atomics International site waste management plan dated circa 1972 and an updated plan dated May 1974 provided information regarding the waste disposal activities at SSFL. According to the waste management plan, which was prepared for the management of AEC contract wastes, provided the following summary:

“Temporary storage of low-level radioactive waste is performed in Buildings 621, 663 and 075. Low-level waste and contaminated equipment are temporarily stored in Buildings 075, 621, and 663, and in the fenced storage area surrounding Building 621. These buildings are steel buildings, which are designed to provide protection from the elements and security for the stored items. Contamination control is provided by stringent packaging requirements, so exhaust filter systems and additional contamination control safeguards are unnecessary.” [1]

The preliminary MARSSIM classification for the Building 4663 area is Class 1, due to its former use as a radioactive storage facility, a radiological incident and nearby spills, and its proximity to other facilities handling and storing radioactive waste.

12.5.2 Building 4663 Radiological Incident Reports

There has been one incident associated with Building 4663 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

12.5.3 Building 4663 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0616	5/21/67	RMDF Storage Yard	UC	A Drum of U Metal Vented By Bullet Holes Caught Fire Upon Opening

- On May 21, 1967, a 55-gallon drum containing uranium metal under calcium carbonate powder was found burning in the RMHF storage yard. Violent venting through a hole in the drum indicated a likely explosion. Three rifle shots were fired into the drum to relieve the pressure, and the drum was then moved by forklift to a steel rack. The fire “extinguished itself” and the drum was left outside to cool overnight. The drum was then moved to Building 4021 the following morning and was opened. Three of the 1-gallon cans within the drum began burning and the fire was extinguished with G-1 powder. The drum was left in Building 4021 until final disposition. According to the report, air samples, nasal swabs and contamination surveyed indicated that no significant release of radioactive materials or contamination of

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 93, citations 1&2:

[1] Atomics International, *Site Waste Management Plan*, Circa 1972, p. 2.

[2] Atomics International, *Management of AEC-Generated Radioactive Wastes at Atomics International*, May 31, 1974, pgs. 1-2.

personnel occurred as a result of the fire (A0616).[1]

- An October 17, 1975, internal letter discusses nine significant radioactive spill areas and numerous spot areas identified at the RMDF complex. Figure 2.10b presents the map of these areas, most of which were located in the western storage yard areas of the RMDF complex. The activity associated with the spills ranged from 0.5 to 3,500 millirads per hour. The spills were assumed to have occurred between 1972 and 1975 and to have followed the water course. One spill was a result of a supposedly empty high level waste cask in the storage yard that filled with rain water and flooded contaminated water out. Six similar casks were found. Three barrels of radioactive materials stored in the backyard tipped over and leaked or rotted out and leaked causing three other areas. As of October 17, 1975, all spills in the storage yard and two spills outside the storage yard were decontaminated or removed. Cleanup on another spill had begun and two other areas were identified for cleanup, but had not yet been delineated.[2]

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 132, citation 1:

> [1] Unknown Author to Remley, M.E., Atomics International Internal Correspondence, *Re: Radiation Safety Unit Weekly Newsletter for Period Ending May 27, 1967*, June 1, 1967.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 132, citation 2:

> [2] Internal Correspondence from Badger, F.H. to McCurnin, Jr., W.R., Rockwell International, *Re: Radioactive Spills in RMDF*, October 17, 1975.

Section 12.6

Building Number: **4664**
Building Alias: **664/T664**
Visitor Log Entry: **6017 / T022 / T034 / 6000E / 6001R**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Low-Level Radioactive Waste Incinerator**
Flocculation
Evaporator
Low-Level Radioactive Waste Processing

Radionuclides of Concern: The most probable contaminants of concern are isotopes of uranium, plutonium, and thorium, and mixed fission products.

12.6.1 Description of Operations & Processes

Building 4664 was constructed in 1964. Boeing indicated to EPA and in the existing SSFL Site Profile that this location was not used to incinerate radioactive waste. According to Boeing, the incinerator was a "test installation" that proved unsuccessful in the incineration of non-radioactive wastes, and it was dismantled.

Atomics International's "Site Plans and Details" documents generated in 1964 include drawings of the "Low-Level Radioactive Waste Facility" at Building 4664 and depict the low-level radioactive waste processing units and equipment on an uncovered equipment pad, which included the clarification unit, evaporator unit, incinerator unit, flocculation unit, exhaust stack, bag filter, cooling tower, and associated tanks, pumps, trench, and piping.[1]

A September 1964 internal letter regarding the segregation of radioactive wastes indicates that the **RMHF acquired incineration equipment to burn low-level and toxic contaminated dry wastes that were generated by programs at Atomics International.** The letter also indicates that the equipment was to be operational after October 5, 1964, to burn contaminated wood, plastics, paper, rags, leather and other burnables containing less than 10% moisture, at a rate of

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 136, citations 5, 6, 7, 8:

[5] Atomics International Drawing, *Low Level Radioactive Waste Facility, Site Plan & Details*, 303-664-C1, Illegible Date.

[6] Atomics International Drawing, *Modification for Low Level Radioactive Waste Equipment*, Bldg. 664 – Plans, Sections & Details, 303-664-S4, January 1966.

[7] Atomics International Drawing, *Low Level Radioactive Waste Facility 664, Flow Diagram, 303-664-P1*, Illegible Date.

[8] Atomics International Drawing, *Low Level Radioactive Waste Facility, Flow Diagram & Details, 303-664-M1*, Date Illegible.

100 pounds per hour.[1]

A 1967 test report for the Building 4664 incinerator notes that an acceptance test was successful in that cellulose waste was safely incinerated at the designed rate of 100 pounds per hour. Metallic objects were not reduced as successfully as paper products. No information regarding management of the incinerator ash was located. The test report also notes that the concrete trench, designed to receive any contaminated spill, is not waterproofed and seeped water at a slow rate.

In 1982, Building 4664 incinerator and support equipment were removed. **The incinerator was disposed as radioactive waste. The concrete pad that previously supported the flocculation tower was scabbled to reduce the contamination to less than 500 counts per minute.** About 800 square feet of contaminated asphalt and soil was removed and disposed as radioactive waste. A September 24, 1982 letter noted that work continued to clean the concrete pad and the area between the pad and the fence.[2]

Given the evidence of low-level radioactive waste incineration at the RMHF and its exclusion from the Site Profile, it is likely all data associated with airborne particulate emissions or other releases at this location have also been excluded. As a result, estimations of worker dose due to ambient and environmental exposures are called into question.

Building 4664 was used as a processing facility for low-level radioactive waste at the RMHF, and as the former flocculation and incinerator area. The natural gas-powered evaporator was taken offline following a 1966 fire and the flocculation system was used for a period, until the evaporator could be replaced with an electric-powered evaporator. A 1989 report notes that the

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 137, citations 1-4:

> [1] Sapere Consulting, Inc. and The Boeing Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. I-41.
>
> [2] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC) Santa Susana Field Laboratory, Ventura County, California*, March 2008.
>
> [3] Rockwell International, *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, *N001ER000017*, December 1989, Rev. C May 30, 1991, p. 29.
>
> [4] Internal Correspondence from Schlapp, F.W. to All P.E.s, R.E., and Supervision, Atomics International, *Re: Segregation of Radioactive (R/A) Wastes*, September 18, 1964.
>
> [5] Ibid. 122119551

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 138, citations 5, 6, 7:

> [5] Internal Correspondence from Page, J.P. to Roberts, W.J., Rockwell International, *Re: Engineering Development & Text Highlites – Week Ending 9/24/82*, September, 27, 1982.
>
> [6] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports, Appendix C, Radioactive Materials Handling Facility RFI Site (SWMU 7.6 and Area IV AOC),* June 2009, p. C.2-12*.*
>
> [7] Internal Correspondence from McCurnin, W.R. to Walter, J.H., *Re: Highlights – Week Ending 09-24-82*, September 24, 1982.

flocculation tower was built to pretreat radioactively contaminated water to make it easier to filter, but it was made unnecessary by better filters and became inactive.[1]

Based on drawings and reports, the flocculation system may have existed from late 1964 to early 1981, but it appears not to have been used for the entire time period. Atomics International site waste management plans dated in the mid-1970's note the use of the flocculation tower and January 1979 incident reports (Incidents A0077 and A0232) note there was an overflow of the flocculation tower, resulting in contamination.[2]

The preliminary MARSSIM classification for the Building 4664 area is Class 1, due to its former use as a low-level radioactive waste processing facility, radiological incidents, and lack of previous investigation.

12.6.2 Building 4664 Radiological Incident Reports

There have been three incidents associated with Building 4664 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing.

12.6.3 Building 4664 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0362	2/10/65	T664 Flocculation Tower	Mixed Fission	R/A Liquid Processing System Tygon Hose Separated Spilling onto Pavement
A0489	5/13/65	Bldg. 22 Area	Mixed Fission	Flocculating Tower Overflowed Spilling R/A Water on Equipment, Pad and Soil
A0615	5/21/67	RMDF Truck	UC	A Drum of UC Sludge Exploded on a Truck Outside
A0077/ a0232	1/17/1979	Floc Tower Area	Mixed Fission	R/A Water from Flocculation Tower Contaminated Drainage Ditch and Pond.

- On February 10, 1965, the evaporator system backed up. While attempting to remove a stoppage by reverse flow provided by the circulating pump of the flocculation system,

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 16, citation 2:

[2] Oldenkamp, R.D. and Mills, J.C., *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, N001ER000017, December 20, 1989, p. 29.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 16, citations 4,5,6,7:

[4] Atomics International, Site Waste Management Plan, Circa 1972, p. 2.

[5] Atomics International, Management of AEC-Generated Radioactive Wastes at Atomics International, May 31, 1974, pgs. 1-2.

[6] Gardner, F.W. Rockwell International Internal Correspondence, *Re: Release of Radioactivity from RMDF – January 1979*, February 23, 1979.

[7] Gardner, F.W., Rockwell International Internal Letter, *Subject: Radiological Safety Incident Report RMDF*, February 26, 1979.

excessive pressure buildup occurred and blew the flexible hose from its connection, releasing approximately 5 gallons of radioactive contaminated liquid onto the asphalt. The asphalt was contaminated to a maximum level of 2,000 dpm/100cm^2. Other components of the system were also contaminated to a maximum level of 2,000 dpm/100cm^2. Decontamination of the area was performed with hydrochloric acid and a scrub brush (A0362).

- On May 13, 1965 while filling the flocculation tower with treated liquid for separating the sludge from liquid “suitable for processing in the evaporator system,” the operator’s attention was diverted and he failed to see the level indicator light on. The flocculation tower overflowed, spilling approximately 10 gallons of “chemically treated contaminated liquid” onto the tank and the tank equipment, the cement pad, and the surrounding soil. The incident report stated that smears indicated no contamination to the employee; however, the incident report did not indicate whether the surrounding area had been contaminated or whether the area was cleaned up (A0489).[1]

- On May 21, 1967, one of eighteen 55-gallon drums of uranium carbide sludge and other unspecified sludges exploded on a truck outside the RMHF incinerator, contaminating asphalt and evaporator equipment. The drum contained three 1-gallon cans of uranium carbide sludge that had been removed from the scrubber at Building 4005. Vermiculite and uranium contamination was blown into the evaporator and incinerator area, areas of asphalt, and over the north boundary fence. Contamination levels ranged from 300 to 5,000 dpm/100 cm^2. Initial cleanup of the area was performed with a vacuum cleaner and the evaporator and incinerator equipment was scrubbed down. The area was then “hosed down.” The truck was decontaminated in the decontamination room and the drums were placed in the packaging room where the six drums containing sludge material were kept until final disposition. The other twelve drums containing uranium carbide were decontaminated and shipped to Building 4064 for storage. The incident report did not include additional information regarding the decontamination procedures or the level to which the area was decontaminated. While the report indicated that area was “hosed down,” additional information was not provided to indicate whether the area was still ontaminated or whether the runoff was collected or allowed to enter the surrounding drainage channels (A0615).[2]

- A November 18, 1975 Rockwell letter describes an “area of concern” at the Building 4664 pad. The letter nots the equipment pad contained the “old evaporator, incinerator, and oxidation equipment.” Although activity from the evaporator was sufficient to prevent the detection of contamination near the area, the letter states that preliminary indications show the ditch outside the fence is contaminated to the west of Building 4664. No other details are provided in the letter to indicate what may have caused the contamination, how or when it occurred, or

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 139, citation 2:

> [2] Young, L.M., Atomics International Internal Correspondence, *Re: Incident Report Building 022, May 13, 1965*, May 18, 1965.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 140, citation 1:

> [1] Unknown Author to Remley, M.E., Atomics International Internal Correspondence, *Re: Radiation Safety Unit Weekly Newsletter for Period Ending May 27, 1967*, June 1, 1967.

what further steps were taken to characterize and remediate the contaminated area.[1]

- On January 17, 1979, radioactive water from the Building 4664 flocculation tower was leaked onto paving and rinsed into the RMHF 4614 Holdup Pond contaminating the drainage ditch and pond. It was estimated that approximately 2 gallons of contaminated water containing approximately 5×10^{2} microcuries per milliliter (µCi/mL) of mixed fission products leaked from the tank. The incident report indicated that initially the flocculation tower pad and runoff ditch contained contamination levels of 25,000 counts per minute (cpm) with hot spots of 35,000 cpm. There was no information about any cleanup or removal actions. However, an asphalt sealant was applied on January 31, 1979, and levels reduced to 20 to 50 percent of the original values with an additional reduction of approximately 20 percent following the "runoff of the sealant." (A0077, A0232).[2]

- On October 23, 1979, approximately 1 gallon of radioactive liquid representing waste from both the Sodium Reactor Experiment and Hot Lab was released into a catch basin under the "Building 4021" flocculation tower. The catch basin was "cleaned to about the same contamination level as usual," which was less than 1,000 dpm/100 cm^2 of beta- gamma activity. The incident report noted it was not practical to remove more activity at the time due to the deteriorated condition of the metal floor.[3]

The EPA HSA provides a detailed chronology of radiological investigations and decontamination and cleanup of releases associated with Building 4664. No Radiological Use Authorizations were found.

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 140, citation 2:

[2] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 140, citations 3 & 4:

[3] Gardner, F.W. Rockwell International Internal Correspondence, *Re: Release of Radioactivity from RMDF – January 1979*, February 23, 1979.

[4] Gardner, F.W., Rockwell International Internal Letter, *Subject: Radiological Safety Incident Report RMDF*, February 26, 1979.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 140, citations 5:

[5] Internal Correspondence from Owens, D.E. to Radiation & Nuclear Safety Energy Systems Group, Rockwell International, *Re: Radiological Safety Incident Report, RMDF, October 23, 1979*, dated October 29, 1979.

Section 12.7

Building Number: **4668**
Building Alias: **668/T668**
Visitor Log Entry: **6017 / T022 / T034 / 6000E / 6001R**

Building Name: **Radioactive Materials Handling Facility (RMHF)**

Building Function: **Storage & Sodium Cleaning**

Radionuclides of Concern: Although designated a "non-radioactive" chemical storage facility, radioactive material was apparently stored under the Building 4688 structure. The most probable radionuclides of concern are isotopes of uranium, plutonium, and thorium, and mixed fission products.[1]

12.7.1 Description of Operations & Processes

Building 4688 was originally constructed northeast of Building 4003 (located in the Sodium Reactor Experiment [SRE] complex area) in approximately 1962. It was moved to the RMHF in approximately 1967 to serve as a storage structure.[2]

Building 4688 was used for storage and likely supported sodium cleaning activities. The building was used primarily as protection against the rain and sun. A 1993 report states that Building 4688 was a hazardous materials storage shed that stored chemicals in small containers of one gallon or less, including acetone, alcohols, solvents, laboratory reagents, paints, oils and gasoline. A large storage container with unknown contents is visible in the Building 4688 area in historical photographs from 1961-1989.

A November 18, 1975 Rockwell letter describes an "interim storage yard" between the RMHF complex and the SRE, and reflects areas of contamination on the ground. The letter notes the area must be cleared of brush and pallets of material must be moved to further delineate spill areas.[3]

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 154, citation 2:

> [2] Kartman, A.S., *Aerial Photographic Analysis of Santa Susana Field Laboratory – Area IV, Ventura County , California, Volume 1 & 2*, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Sciences Division, March 2010.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 152, citations 1 & 2:

> [1] The Boeing Company, *Radioactive Materials Handling Facility Decontamination and Decommissioning Engineering Evaluation/Cost Analysis*, June 18, 2007, p. A-6.
>
> [2] Santa Susana Area IV, *Atomics International/Energy Systems Group Planning Maps*, March 1962–November 1992.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 153, citations 2 & 3:

> [2] Internal Correspondence from Harris, J.M. to McCurnin, W.R., Rockwell International, *Re: Plan of Action for RMDF*, November 18, 1975.
>
> [3] Internal Correspondence from Badger, F.H. to McCurnin, Jr., W.R., Rockwell International, *Re: Radioactive Spills in RMDF*, October 17, 1975.

In 2007, Boeing performed a radiological survey on Building 4688 and other buildings within the RMHF complex. Some survey data was collected from Building 4688 roof surfaces, and spot checks of the building revealed significant levels of beta-emitting residual radioactivity on several of the support columns. Boeing directed the survey activities be discontinued. Limited investigation of the building roof concluded that additional survey data would be needed to determine suitability for release.[1]
Indications that waste had been dumped near and around building 4688 were identified in February 2008.[2] In 2009, EPA's site visit noted that the Building 4688 area was then used for equipment, hazardous waste, and chemical storage. Three locked storage cabinets located under the Building 4688 awning stored hazardous waste and chemicals, and were inspected weekly.

The preliminary MARSSIM classification for the Building 4688 area is Class 1, due to the drum storage in the area and Building 4688's proximity to RMHF Building 4022, which stored radioactive materials, and limited previous investigations.

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 153, citation 4:

> [4] Cabrera Services, *Final Combined Summary Report: Radioactive Materials Handling Facility Building Surveys*, October 2007, pgs. 19, 40.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 154, citation 1:

> [1] MWH, *RCRA Facility Investigation Work Plan Addendum Amendment, Radioactive Materials Handling Facility RFI Site* (SWMU 7.6 and Area IV AOC), Santa Susana Field Laboratory, Ventura County, California, March 2008, p. 2-4.

13.0 Research on Reprocessing Used Reactor Fuel

The 2006 Site Description excluded operations and processes associated with facilities used to research and reprocess used reactor fuel.

Section 13.1

Building Number: **4003**
Building Alias: **003/T003**

Building Name: **Engineering Test Building (ETB) "Hot Cave"**

Building Function: **Fuel Element Assembly (SRE)**
Molten Uranium Research
Fuel Decladding
Irradiation Experiments
SNAP Fuel Analysis & Corrosion Tests

Other Related Buildings: **Substation Building 4693**
Support Building 4825

Notes: Tritium

Radionuclides of Concern: Uranium, thorium, transuranic elements, mixed fission products, and activation products. Possible radionuclides include natural and enriched uranium (U-238, U-234, U-235, U-236), isotopes of plutonium (Pu-239, Pu-240, Pu-241, Pu-242), americium-241 (Am-241), thorium-228 (Th-228), Th-232, Th-234, activation products **(tritium (H-3),** carbon -14 (C-14), sodium-22 (Na-22), Na-24, chromium-51 (Cr-51), manganese-54 (Mn-54), nickel-59 (Ni-59), Ni-63, iron-59 (Fe-59), cobalt-60 (Co-60)) and fission products (krypton-85 (Kr-85), strontium-89 (Sr-89), Sr-90, antimony-125 (Sb-125), iodine-129 (I-129), I-131, cesium-134 (Cs-134), Cs-137, cerium-144 (Ce-144), barium (lanthanum)-140 (Ba (La)-140), niobium-95 (Nb-95), ruthenium-103 (Ru-103), Ru-106, xenon-133 (Xn-133), Xe-135, promethium-147 (Pm-147), samarium-151 (Sm-151), europium-152 (Eu-152), radium-226 (Ra-226), actinium-228 (Ac- 228).

13.1.1 Description of Operations & Processes

Building 4003 was constructed in 1957.[1] It was known as the Engineering Test Building (ETB) and the "Hot Cave." Between 1957-1964 it was used to assemble fuel elements for the SRE. In this operation, uranium and thorium metal slugs were loaded into metal tubes, the remaining tube space was filled with sodium and the tubes were sealed. The Hot Cave portion of the building was designed and constructed to investigate the chemistry of molten uranium, and to study the separation of fission products and plutonium from uranium systems.

The HSA provides aerial photographs and a detailed description of building features and specifications. Building 4003 contained offices, a change room, several laboratories, a Freon

[1] EPA/HGL, *Final HSA 6,* p.12, citation 1:
[1]ETEC website at: www.etec.energy.gov/History/Major-Operations/SRE.html

compressor, a concrete pit, a tank pit, a sump, an expansion tank, a boiler, and a cooling tower.[1] It should be noted that because Building 4003 contained offices, employees that may have been assigned to the offices may have been considered "non-radiological" employees. However, given the operations at the facility, such a designation may grossly misrepresent their exposure risks.

Building 4003 also contained an exhaust system that included nine fume hoods, valves, ducts, blowers, filters, filter plenum chambers, and a stack. In addition, Building 4003 contained two radioactive waste sinks connected to 5-gallon bottles, and a highly shielded area designed for remote manipulation of radioactive materials, known as the "Hot Cave." The Hot Cave contained identical east and west "hot cells," a pair of mechanical manipulators for each of the two cells, a transfer tunnel, liquid waste lines, east and west cell "small" radioactive liquid waste holdup tanks located below the Hot Cave, and a hot cell exhaust system with HEPA filters and two blowers located on the roof of Building 4003.

The west hot cell of the Hot Cave was used primarily for kilogram-scale processing experiments involving chemical reactions of irradiated reactor fuels at temperatures up to 1,800˚ C. The east hot cell was used primarily for mechanical operations, such as decladding, component disassembly, and inspection. The transfer tunnel was used for sample handling, waste removal, inter-cave transfer, and the storage of kilocurie sources.[2] According to DOE, later activities involved bench-scale research into reprocessing of used (or irradiated) fuel assemblies. The research involved the removal of fission products from used fuel.[3]

Building 4003 was also used for the analysis of Systems for Nuclear Auxiliary Power (SNAP) fuel burn-up samples and the evaluation of irradiation experiments. Use of the Hot Cave ended when the SNAP program was terminated in 1973.

The 2006 Site Profile indicates that "some traces of radioactivity were later found in the drain line, which was removed." However, according to Atomics International (1973), the inner surfaces of the Hot Cave were found to be "grossly" contaminated with mixed fission products. According to the HSA, containment of this high-level contamination required continuous operation of the radioactive exhaust system as well as filtering and sampling activities. Radioactive contamination was found to be on the internal surfaces of the hot cells, in the liquid waste lines, the liquid waste holdup tanks, the radioactive exhaust system ducting and on filter

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[1] EPA/HGL, *Final HSA 6,* p.12, citations 3 & 4:

> [3] Montgomery Watson Harza, Table 1, List of Historical Document Map Features at SRE, August 1, 2003.
>
> [4] Rockwell internal letter from C. D. Bingham to W. F. Heine, Re: Application to Perform Radiochemical Operations in Building 003A (ETB Annex), December 10, 1970.

[2] EPA/HGL, *Final HSA 6,* p.13, citation 10:

> [10] Strausberg, S., Gardner, W. J., Guon, J., Luebben, T. E., and Mills, T. H., *Modified Hot Cave Facility for Reprocessing Experiments*, Atomics International Report No. NAA-SR-2687, June 30, 1958, p.3.

[3] EPA/HGL, *Final HSA 6,* p.14, citation 1:

> [1] ETEC website at: www.etec.energy.gov/History/Major-Operations/SRE.html.

plenums. In 1974, the building 4003 facilities were declared “excess” and a facilities dismantling plan was prepared.[1]

Atomics International informed the AEC that the alpha-emitting radionuclides present were from enriched uranium; some transuranics may also have been present. The beta-gamma emitting radionuclides resulted from fission products and stainless steel activation products.[2] Atomics International commenced D&D in January 1975 and ended in June 1975. Dismantling of the Hot Cave was completed in April 1975.

After 1961, Building 4003 was connected to a site-wide (Areas I, II, III, IV) sewage treatment system. In 1982, the sewer lines were found to be radioactively contaminated.[3] The sewage treatment plant began in the 1950’s to collect sanitary waste from Areas II, III, and IV. In addition to sanitary waste, the treatment plant received cooling tower discharges from non-chromated cooling tower systems and treated groundwater from various site groundwater recovery systems. The treated discharge was allowed to flow into the R-2A Discharge Pond in Area II. As part of the Site Wide Water Reclaim System, the Area II R-2A Pond serviced the Coca Rocket Engine Test Stands and Saturn V personnel. In July, 1982 Rockwell reported enriched uranium was identified in the sewer sump outside Building 4003 in the range of 23-32 µg/g. Rockwell concluded that ANL would object to the unrestricted use of Building 4003 but asserted that cleanup was impractical and almost impossible.[4]

The HSA provides a detailed chronology of radiological investigations and D&D activities associated with the Building 4003 area. The preliminary MARSSIM classification for the Building 4003 area is Class 1, due to its former use as an SRE support building and its proximity to SRE Building 4143.

13.1.2 Building 4003 Radiological Incident Reports

There have been several incidents associated with Building 4003 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

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[1] EPA/HGL, *Final HSA 6,* p.14, citation 2:

> [2] Graves, A. W., *Facilities Dismantling Plan for Building (D+D) T003 Hot Cave*, Atomics International Report No. FDP-704-990-001, October 10, 1974, p. 2.

[2] EPA/HGL, *Final HSA 6,* p.14, citation 3:

> [3] Atomics International letter from W. F. Heine to R. L. Westby, U.S. Atomic Energy Commission, re: *Contamination Limits for Release of KEWB and Building 003 for Unrestricted Use*, November 21, 1974.

[3] EPA/HGL, *Final HSA 6,* p.22, citation 1:

> [1] Letter from B. D. Sujata, The Boeing Company, to J. Evans, County of Ventura, re: *Information Regarding Permit – Septic Tank and Leach Field*, October 23, 2001.

[4] EPA/HGL, *Final HSA 6,* p.14, citation 4:

> [4] Rockwell International Telephone Conversation Record from W. Smith to B. F. Ureda, Re: *Building 003 Contamination*, July 2, 1982.

13.1.3 Building 4003 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0530	10/7/1959	ETB Maybe		Employee contaminated his hands when he failed to wear prescribed protective clothing.
A0423	12/22/1959	ETB	MFP	Contractor removed R/A exhaust stack without health physics cognizance.
A0549	7/22/1960	ETB Rm 160		Employee cut hand in controlled area.
A0295	2/1/1965	ETB & D004		Varied work location & late return of film badge resulted in exceeding guidelines. Employee exposure: 2,000 mrem gamma and 640 mrem beta
A0438	9/15/1969	ETB Hot Cell	MFP	Multiple projects resulted in employee exposure above guidelines. Employee exposure: 6,065 mrem
A0048	9/2/1969	ETB Chem Labs		ETB Lab equipment and floor found contaminated.

*Isotopes are written as they are presented in the incident database. The research team believes that MFP is an acronym for mixed fission products.

- On October 7, 1959, an employee performed maintenance on a radioactive contaminated sodium line with his bare hands. The employee was aware the line was contaminated. Both of his hands became contaminated to a level of 1.5 mrad/h. After 35 minutes of cleaning, the employee's hands were successfully decontaminated (A0530).[1]

- On December 22, 1959 contract personnel were working on the exhaust stack of the radioactive vent systems at the ETB without the knowledge of the health physics department, without the proper permit, and without film badges. The contract crew was unaware the exhaust system was radioactive. No personnel contamination was discovered. Work was immediately stopped until the proper permit was filled out and film badges assigned (A0423).[2]

- On July 22, 1960 an employee cut his hand during a drilling operation. No activity was found above background on his hand (A0549).[3]

[1] EPA/HGL, *Final HSA 6,* p.16, citation 2:

[2] Bell, C. E., Internal Letter, re: Violation of Health Phys. Practices, October 8, 1959.

[2] EPA/HGL, *Final HSA 6,* p.16, citation 3:

[3] Lang, J. C., Atomics International Internal Letter, re*: Notice of Rule Infraction*, December 31, 1959.

[3] EPA/HGL, *Final HSA 6,* p.17, citation 1:

[1] Illegible Author, Atomics International Internal Letter, re: Radiological Safety Incident Report, Room 160 ETB Annex, July 22, 1960, July 27, 1960.

- In October 1965, a missing film badge belonging to a chemist was found. The badge had been missing since January 1965 and when processed, indicated an exposure 2,000 mrem gamma and 640 mrem beta. When added to the chemist's February and March exposures, the quarterly total exposure was 2,600 mrem gamma and 1,870 mrem beta. Review of the chemist's duties in January suggested that he did in fact receive the exposure indicated on the film badge, despite the possibility of other factors affecting the reading. The chemist's lifetime accumulated exposure through September 1965 was 28.4 rem, below the permissible exposure of 65 rem at that time (A0295).[1]

- On September 15, 1969 film badges worn by an employee over the course of a calendar quarter were evaluated and the combined exposure from the badges was 6,065 mrem. This overexposure was found to be the result of multiple different operations at the ETB (A0438).[2]

- On September 2, 1969 a smear survey was requested for the upstairs laboratory at the ETB because contamination had been found on the floor. The contamination was first noted on an employee's shoe (200 cpm). The employee smeared the stairs and found up areas of contamination up to 1,000 dpm/100 cm^2. This prompted him to smear the floor where he was setting up equipment. Repetitive smears of the floor brought forth "hotter" and "hotter" results. The employee eventually roped off the area and requested further surveying of the lab. Additional smear surveys found gross contamination on the bench top and covered sink. A couple of spots read up to 1.5 rad/h. This material was easily removable. Parts of two ring stands on the work bench indicated 0.5 rad/h and were bagged up. Another "hot" area of the lab was located on an adjacent bench top where a survey detected 30,000 cpm. Smear surveys taken on September 4 and 5 1969 found contamination greater than 150,000 dpm/ 100 cm^2 (the counter detectibility limit) on the outside of a furnace, a balance, and a hot plate in the hood. The hot plate was measured to be 330 mrad/h. Also found in the hood, behind two lead bricks, was a bottle of liquid waste from earlier equipment, which read 5 rad/h. According to the incident report, the "episode was somewhat mysterious." It appears that there may have been two sources of contamination because gamma activity was missing from one set of smears. It was unknown whether a chemical or physical process had removed gamma emitters, such as cesium, from this area. As of September 8, 1969, the lab had been fairly well decontaminated and most items outside the hood were less than 100 dpm / 100 cm^2 beta-gamma (A0048).[3]

As part of the dismantling operations, Atomics International opened the west cell and conducted a radioactivity survey; the cell was found to contain significantly higher levels of radioactivity than the east cell. The west cell contained test analysis equipment and experimental residue. Miscellaneous waste was removed including three trays (7 rad/h) and two 1-gallon paint cans

[1] EPA/HGL, *Final HSA 6,* p.16, citation 2:

> [2] Correspondence from Remley, M. E., Atomics International, to Levy, J., U.S. Atomic Energy Commission, *Re: Apparent Type B Radiation Exposure*, November 5, 1965.

[2] EPA/HGL, *Final HSA 6,* p.16, citation 3:

> [3] Bresson, J. F., North American Aviation Internal Letter, re: Film Badge Exposure – Contamination at the ETC, SS003, Bresson to Heine, 9/13/69, October 15, 1969.

[3] EPA/HGL, *Final HSA 6,* p.16, citation 4:

> [4] Bresson, J. F., North American Rockwell Corporation Internal Letter, re*: Contamination at the ETC, S003*, September 15, 1969.

(approximately 25 rad/h). These items were sent to the RMHF (Radioactive Materials Handling Facility) for disposal. Five prefilters (250 mrad/h) from the lower section of the cell and a 30-gallon bag of solid waste (2 rad/h) were then removed and the cell was vacuum cleaned again to remove most loose contamination. The roof shield blocks and associated manipulators were removed while the openings in the roof were covered with plastic sheeting to contain loose contamination. The remaining items in the cell were then removed. These included a Lucite enclosure, a shelf, a table, and 90 gallons of solid radioactive waste. Dry uranyl salt solution (25 rad/h at 10 cm) were removed from the floor. A container of SNAP burnup samples was located in the transfer tunnel between two cells. Using tongs, this container was transferred to a 5-gallon can and then into a lead cask, which was then transferred to RMHF.[1]

The HSA provides a detailed chronology of radiological investigations and decontamination / cleanup procedures, including Atomics International's excavation of the Hot Cave.

[1] EPA/HGL, *Final HSA 6,* p.17, citation 3:

[3] Ureda, B. F., Building 003Decontamination and Disposition Final Report, AI-ERDA-13158, February 25, 1976, pp. 13-15.

14.0 Operation of Particle Accelerators

Two particle accelerators were used at SSFL; one in Building 4030 (described in this section) and one in Building 4009 (excluded from the 2006 Site Description. Please see Section 7.1 pertaining to Building 4009 and the OMR/SGR Reactors).

There are other ways to generate artificial radioactivity besides nuclear fission. One way is to bombard a target material with atomic particles accelerated to high speeds by means of a particle accelerator. A common form of particle accelerator is a Van de Graaf generator, which uses a high-voltage electrostatic field to accelerate atomic particles to high speeds (high energy levels). Collisions of these particles with a target material (such as aluminum or tritium) can generate small amounts of radioactivity. Atomics International operated a Van de Graaf generator in Building 4030, bombarding tritium targets with deuterons to produce neutrons.

A second Van de Graaf generator was operated in Building 4009 (OMR/SGR). It should be noted that, while the 2006 SSFL Site Description references a second particle accelerator at SSFL, it briefly associates it with the Sodium Reactor Experiment (SRE, Building 4143) and the general time period of the SRE's decontamination / decommissioning, rather than its actual location at the OMR/SGR in Building 4009, and time period of operation.

Additionally, the 2006 Site Description does not mention the known tritium contamination associated with the Van de Graaf accelerator (Buildings 4009 or 4030), or the conversion of Building 4030 to offices before the Van de Graaf was removed and the tritium contamination discovered. As a result of being converted to administrative offices, Building 4030 may be considered a "non-radiological" location during the years after the Van de Graaf's operations and job processes associated with this location may be considered low-risk. Workers assigned to this location may not have been adequately monitored for radiation exposure, given the facility's operations and potential for radioactive contamination.

Section 14.1

Building Number:	**4030**
Building Alias:	**030/T030**
Building Name:	**Van de Graaf Particle Accelerator** **a.k.a. AE-6 Counting Room** **a.k.a. AE-6 Work Shop** **a.k.a. AE-6 Office Annex**
Building Function:	**SNAP Program Support** **Radioactivity Generation** **Outside Storage of Drums Containing Mixed Fission Product** **Site Purchasing Office, Traffic, Warehousing**
Other Buildings Involved:	**4035 (035/T035)**
Notes:	**DOE-NASA** **Tritium Use.**

Radionuclides of Concern: Regulated radiological materials were managed at Building 4030. The Van de Graaf accelerator produced neutrons by **H3**(p,n)He3 nuclear reaction. **The potential contaminant of concern is tritium.** Activation of building materials was negligible because drums of borated water were used around the target to thermalize and capture neutrons.

14.1.1 Description of Operations & Processes:

Building 4030 was constructed in 1958. It included two connected sections. The front section, was originally known as Building 4035 before the rear section was added. Combined, the two buildings formed Building 4030.[1]

A Van de Graff accelerator was moved into the facility in 1960 and operated through 1964 in support of the SNAP program. The accelerator provided a proton beam of up to tens of microamperes in current, with continously adjustable energies from a few hundred KeV up to a maximum of about 1 MeV. The Van de Graaf accelerator provided an adjustable energy proton beam to bombard a tritium target to produce neutrons. The building had an associated leach field likely used until 1961 or 1962, when the building was connected to the newly-built Area III site-wide sewage system. The Van de Graff accelerator was reportedly mothballed and remained in the building until 1966. A 1966 smear survey of the accelerator detected significant tritium contamination. To date, the disposition of the accelerator has not been determined.

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[1] EPA/HGL, *Final HSA 5-A,* p. 116, citation 498:

[498] Rocketdyne Report, 030-AR-0002, “Decontamination and Decommissioning (D&D) of Building T030,” November 13, 1997. Ref. 122119552

In 1965 (a year before the tritium contamination was discovered), Building 4030 was converted to an office. In 1972, it was used as a purchasing office for the site, and for traffic and warehousing. This location was used as an office until 1995.[1]

On March 29, 1966, personnel conducted a tritium smear on Building 4030 and its associated equipment. The tritium contamination was severe. Two of the samples contained sufficient contamination to saturate the gas proportional counter utilized in measuring tritium contamination. According to the report, the activity of the samples was “estimated” by covering each sample with a clean piece of sample paper with a 1/8 inch diameter hole at its center. As a result, the tritium beta particles from the sample area outside the hole were shielded and only a 1/8 inch diameter area of the sample was counting. This produced a count rate of approximately 75,000 dpm. As recorded, assuming an equal distribution of the contamination over the total area of the sample, a ratio of count rate to the area was established and the total sample count rate was calculated by extrapolating to the total area of the 1-inch diameter sample. The following are the result of five sample locations with the most severe estimated contamination.

1966 Building 4030 Tritium Contamination Levels

LOCATION	ACTIVITY (dpm/100 cm
Plate below target holder	~$1x10^5$
Tritium target storage can	~$1x10^5$
Lower cooling hose	~$1x10^5$
Target holder (sides and front)	~3.6x10
Target holder (rear)	~3.6x10

The EPA provides a detailed chronology of radiological investigations for this location. There are discrepancies between the 1988 findings by Rocketdyne and the 1995 findings by ORISE. In 1995, ORISE found that one sample of total tritium activity exceeded the average guideline for beta-gamma emitters (6,600 dpm/100 cm^2), and recommended additional sampling.[2] In a March

[1] EPA/HGL, *Final HSA 5-A,* p. 117, citation 507-509:

[507] ETEC Document, GEN-ZR-0007, “Radiological Survey of Shipping /Receiving and Old Accelerator Area-Buildings T641 and T030,” August 19, 1988.

[508] Rocketdyne Report, 030-AR-0002, “Decontamination and Decommissioning (D&D) of Building T030,” November 13, 1997.

[509] Mooers, A.R., Atomics International Internal Letter Re: Tritium Smear Survey, Building 030 Van de Graaff Accelerator, March 29, 1966.

[2] EPA/HGL, *Final HSA 5-A,* p. 120, citation 519:

[519] ORISE Document 96/C-4, “Verification Survey of the Interim Storage Facility; Buildings T030, T641, and T013; an Area Northwest of Buildings T019, T013, T012, and T059; and a Storage Yard West of Buildings T626 and T038, SSFL, Rockwell International, Ventura County, California,” Vitkus, T. J., and T. L. Bright, February 1996.

1996 letter, the release of the building was put on hold as a result of DOE's recommendation that Rocketdyne resurvey the building.[1]

The preliminary MARSSIM Classification for Building 4030 is Class 1 based on previous site activities.

[1] EPA/HGL, *Final HSA 5-A,* p. 120, citation 521:

[521] Montes, Michael, Letter Re: Buildings 030, 019, and 654, March 29, 1996.

15.0 Research Using Radioisotopes

Buildings 4064 / 4023

The 2006 Site Description described research at SSFL that required the use of special radioisotopes, and specified that "only small quantities of specially-prepared radioisotopes were brought to the SSFL for use in laboratories under carefully controlled conditions." The 2006 Site Description provides the requirements of special radioisotopes used for the TRUMP-S program as an example: 5 grams of plutonium, 4 grams of neptunium, and 4 grams of americium (which were apparently shipped to Missouri).

The 2006 Site Profile neglected to describe Building 4064 as a 4,418 square foot structure, equipped with a roll-up door, 11" thick walls, surrounded by an 8' fence topped with a barbed tape (double later) and an intrusion alarm, which was constructed specifically to store special nuclear materials, fissionable materials, in addition to radioactive waste.

According to the 2006 Site Description, Building 4023 operated between 1976-1983 in the performance of small sodium loop tests. The building's operations between 1962-1976 are not described, nor are operations that included TRUMP-S support (which involved transuranic products), nor are building operations that began in 1987 (Rocky Flats Plutonium Recovery Project).

It is apparent that the 2006 Site Profile provides an insufficient description of Buildings 4064 and 4023, used for research purposes involving radioisotopes. In addition, there are no incidents at either building referenced in the 2006 document.

A detailed description of Building 4064 and Building 4023 operations, processes, releases, and incidents are provided in this section.

Section 15.1

Building Number: **4064**
Building Alias: **064/T064**

Building Name: **Fuel Storage Facility**

Building Function: **Nuclear Material / Source Radioactive Material Storage**
Radioactive Waste Storage
Contained materials for TRUMP-S Tests

Notes: **Tritium & Neptunium**
Drainage through Area III to Area II Ponds

Radionuclides of Concern: U-233, U-234, U-235, U-236, U-238, Th-228, Th-232, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Ra-226, Cs-134, Cs-137, Sr-90, **H-3**, Na-22, K-40, Mn-54, Fe-55, Co-60, Ni-59, Ni-63, Eu-152, Eu-154, Pm-147, Ta-182, **Neptunium**

15.1.1 Description of Operations & Processes

Building 4064 was constructed in two phases; the first in 1958 and the second in 1963. It was built to meet AEC criteria for vaults for the storage of fissionable material, equipped with intrusion alarms, and fenced.[1] The HSA provides a detailed description of the building's features, equipment, schematics, and processes.

Building 4064 was designed and built as a special nuclear material and source radioactive material storage building. It was used for storing packaged items of source material (natural uranium, depleted uranium, thorium) and special nuclear materials (enriched uranium, plutonium, and U-233) of various forms and configurations. Originally, the north (Room 114) and south (Room 110 and 104 vault) contained steel racks for storing material. The south side was primarily used for the storage of highly enriched uranium and plutonium bearing items; the north side was primarily used for source material and "low" enriched uranium storage.[2]

Enriched uranium powders and source material powder packages were split into smaller units or combined into larger units in a glove box located in Room 104. The glove box was removed from Building 4064 at an unknown time. During shutdown and termination of the SNAP program, excess Zr-U (enriched uranium) alloy material was sectioned into lengths suitable for

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[1] EPA/HGL, *Final HSA 6,* p. 158, citation 5:

[5] Boeing Environmental Affairs, Fact Sheet, *Building 4064 – Fuel Storage Facility*, February 10, 2000.

[2] EPA/HGL, *Final HSA 6,* p. 159, citation 4:

[4] Remley, M. E. General Storage Data for Buildings 064 and 022, October 7, 1977.

packaging for shipment in DOE containers. This was done in Room 104; the floor was covered with plastic sheeting and the Zr-U was sectioned using a hack saw.[1]

During the early 1960's, the metal racks in the south half of Room 110 were removed in order to store material in "bird cages" and drums. This storage included large quantities of special nuclear material recoverable scrap. At this time, the fenced yard areas in the front, side, and back of Building 4064 were used to store 55-gallon drums of low-level enriched recoverable scrap. This material was shipped off-site in the mid-to-late 1960's and early 1970's, and may have relied on packaging containers constructed by employees at the Building 4163 Box Shop. Rockwell International claims that residual contamination from handling bare metallic pieces was from enriched uranium, natural uranium, depleted uranium, and thorium. Most reactor contracts had ended by the early 1980's. After 1980, no special nuclear material powders were handled or repackaged at this location. After all fissionable material had been removed, miscellaneous equipment and containers of radioactive waste (principally soil) were stored in Building 4064. In 1993, all nuclear material was removed and Building 4064 was decontaminated.

In 1989, EPA visited this location during the process of cleaning it up. EPA observed an area of radiation measuring 60 µR/hr. EPA used a shovel to dig at the area, about 1-foot into the soil and was able to increase the surface reading to 200 µR/hr. The technician conducting the onsite survey of the area declared that about 50 pCi/gm of beta radioactivity had been at this site.At the time of EPA's visit, SSFL personnel described a spill that had occurred in the early 1960's.[2]

The HSA provides a detailed description of previous radiological investigations and decontamination/cleanup of releases. In brief, Rockwell International discovered high alpha radioactivity on the concrete ramps leading to rooms 110 and 114 in 1988. The alpha activity was concluded to arise from natural elements in the concrete that could not be removed. Ambient gamma exposure rate measurements showed a contaminated area bordering and outside the eastern fence, but according to Rockwell, no contamination was detected inside the fenced-in storage yard. Ambient gamma exposure rate measurements made outside the fence in the 2-acre area showed an area of about 4,000 square feet contaminated with Cs-137. Two soil samples collected from an area of greatest exposure rate showed a Cs-137 radioactivity concentration of 2,500 pCi/g, regarded as 2,500 times Rockwell's background concentration. Beta activity was measured at 1,200 pCi/g in the area of greatest contamination.[3]

In 1992, Rockwell surveyed a 6,580-square-foot area comprising the fenced in yard that surrounded Building 4064 to assess its radiological condition. All alpha surface activity levels were found to be below "Rockwell International's acceptance limit" of 5,000 dpm/100 cm^2. All beta surface activity levels were found to be below "Rockwell International's acceptance limit" of

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[1] EPA/HGL, *Final HSA 6,* p. 159, citation 3:

> [3] Montgomery Watson Harza, DOE Leach Fields (Area IV AOC) RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Draft, October 2003, pp. 2-3.

[2] Dempsey, Gregg: *"Site Visit to Santa Susana Field Laboratory,"* EPA Memorandum to Daniel M. Shane, On-Scene Coordinator, Emergency Response Unit. July 28, 1989

[3] EPA/HGL, *Final HSA 6,* p. 164, citation 1:

> [1] Chapman, J. A., Radiological Survey of the Source and Special Nuclear Material Storage Vault-Building T64, GEN-ZR-0005, August 19, 1988, pp. 2, 91-92.

5,000 dpm/100 cm^2. All gamma exposure rates were found to be below “Rockwell’s acceptance limit” of 5 μR/h above Rockwell’s background rate of 15.3 5 μR/h. Rockwell concluded the fenced-in yard of Building 4064 met its criteria for release for unrestricted use.[1]

In 1992 ORISE concluded Rockwell’s cleanup was incomplete upon identifying three Cs-137 hotspots in the site yard. Rockwell subsequently remediated the hotspots and revised the Building 4064 side yard guidelines to meet a more restrictive 10 mrem/yr maximum dose rate for a residential scenario.[2]

In 1993, Rockwell removed all known radioactively contaminated equipment, components, and structures from Building 4064, as well as asbestos containing materials. All radioactive waste was packaged and shipped to an unnamed disposal facility. This activity may have relied on the construction of shipping containers by employees in the Building 4163 Box Shop.[3]

The preliminary MARSSIM classification for the building 4064 area is Class 1, due to its location within the ETEC and its former use as storage for radioactive source and special nuclear materials and radioactive waste.

15.1.2 Building 4064 Radiological Incident Reports

There have been several incidents associated with Building 4064 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

15.1.3 Building 4064 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0523	3/10/1959	SS Vault SSFL		Personnel entered vault area without required film badges.
A0028	2/18/1963	Yard SS Vault	MFP	Cask drain plug rusted out, draining contaminated water onto the ground.
N/A	5/3/1963	SS Vault	U	Cans of UC exploded inside SSFL vault.

[1] EPA/HGL, *Final HSA 6,* p. 164, citation 8:

[8] Kneff, D. W., Tuttle, R. J., and Subbraman, G., *Radiological Assessment of the Building T064 Fenced-in Yard*, Rockwell International, N704SRR990035, January 12, 1994, pp. 10, 40-41.

[2] EPA/HGL, *Final HSA 6,* p. 165, citation 1:

[1] Vitkus, T. J., Verification Survey of the Old Conservation Yard, Building 064 Side Yard, and Building 028, Santa Susana Field Laboratory, Rockwell International, Ventura County, California, ORISE 93/J-107, October 1993, pp. 5-11.

[3] EPA/HGL, *Final HSA 6,* p. 165, citation 3:

[3] Dahl, F. C. and Tuttle, R. J., *Final Radiological Survey Report of Building 064 Interior*, ETEC Report No. SSWA- ZR-0001, January 14, 1994, pp. 17-19.

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0468	10/8/1964	SS Vault	U	Can of UC exploded inside a “birdcage” shipped to SSFL Vault.
A0622	7/20/1967	SS Vault SSFL	U308	Outside transfer of U powder caused increased activity in vegetation samples.
A0095	1/12/1982	Vault		RAS Alarm Response.
A0109	9/21/1982	Vault		Response to RAS alarm at SS Vault.
A0218	6/8/1992	Storage Racks	U	Employee stacking fuel storage racks cut hand.
A0663	8/8/1995	Side Yard	Cs-137	Performing the modified Area IV transient survey in grid R24S25, a hot spot was found.
A0687	9/28/1998	Side Yard	Cs-137	Excavated 6 cubic yard of Cs-137 contaminated soil.

*Isotopes are written as they are presented in the incident database. The HSA research team believes that “MFP” is an acronym for Mixed Fission Products.

- On March 10, 1959 an employee entered the storage vault without a film badge and it was not known how long he was in the vault. The employee was reminded on other occasions to wear his film badge (A0523).[1]

- On February 18. 1963 soil east of the exclusion fence at the SS Vault was found to be contaminated during a routine survey. Three additional surveys revealed an area of 700 square feet of asphalt and soil contaminated with mixed fission products to a maximum of 700 mrad/h at 2 inches. It was deduced that the contamination resulted from a cask containing irradiated Seawolf submarine reactor fuel pins. The cask was received at the vault, stored, transferred to the Hot Lab for inspection, and returned to the vault for storage. After storing the fuel pins for 1.5-2 years it was shipped back to Westinghouse around May, 1962. Sometime during this last storage period, it is believed that the drain plug rusted through, permitting fluid contaminated within the cask to spill onto the asphalt. A soil sample showed 8,340 pCi/g beta-gamma gross radioactivity, including $1x10^6$ dpm/g of Cs-137 and $2x10^5$ dpm/g of Cs-134. Alpha activity was negligible in all samples. Approximately 2,365 gallons of soil and asphalt were removed at the vault to reduce the maximum contamination level to 0.5 mrad/h. Three inches of soil was removed from all the contaminated soil areas and 80 percent of the areas were found to be free of contamination upon resurveying. The remaining areas were excavated up to 1.5 feet. Fill soil was brought in by the maintenance department to return the

[1] EPA/HGL, *Final HSA 6,* p. 161, citation 1:

[1] Loba, M. L., Internal Letter, Re: Violation of Health Phys. Practices, March 13, 1959.

[1] EPA/HGL, *Final HSA 6,* p. 161, citations 2 & 3:

[2] Badger, F. H., North American Aviation Internal Letter, re*: Contamination Incident SS Vault Santa Susana*, November 11, 1965.

[3] Moore, J. D., Atomics International Internal Letter, re*: Radioanalysis Report*, February 22, 1963.

soil levels to their previous level (A0028).[1]

- On May 3, 1963 an explosion occurred in the north vault of Building 4064. The sources of the explosion were a 1-gallon can containing 8.3 kilograms of uranium carbide (3.7 percent enriched U-235) in the form of fines and pieces, and a 1-gallon can containing 2.5 kilograms of uranium carbide (4.9% enriched U-235) comprising sintered pieces. The fuel in both cans was immersed in Redline 60 oil. The explosion was believed to have been caused by the release of hydrogen gas from degrading uranium carbide. After 20 minutes elapsed, the Atomics International Fire Department entered the vault and smothered the cans with Metal X. According to Atomics International, a smear survey confirmed that contamination had been confined to the interior of the vault, however the Incident Report indicates that contamination was noted some contamination on the grill of the ventilation exhaust. The cans were removed and the vault was decontaminated using kerosene and K-pads. Atomics International planned to remove approximately 10 square feet of asphalt floor tiles where the cans had been located.[2]

- On October 8, 1964 a custodian found black oxidized powder deposited on the inside of a “bird cage” container. Investigation revealed that uranium carbide had oxidized blowing the lid off one 1-gallon can and warping the bottom of the container. The inside of the can was surveyed at 5 x 103 dpm/100 cm^2 alpha. Contamination levels on the concrete dock of the building 4064 increased to 200 dpm / 100 cm^2 alpha from a “clean” level. Evidence suggested that an inert atmosphere had not been sufficiently established in the 1-gallon container (A0468).[3]

- On July 20, 1967 an investigation was performed to identify reasons for increased alpha activity in vegetation samples between Building 4064 and the fire station. It was determined that uranium carbide and uranium oxide powder had been transferred from one 55-gallon drum to another in the Building 4064 storage yard. The drum from which material had been removed was still located in the yard on a piece of plastic sheeting and visible amounts of uranium oxide powder remained. The plastic was folded carefully and disposed of as radioactive waste. No “significant” surface contamination was found in areas other than the plastic sheeting and vegetation samples collected between Building 4064 and the fire station. Personnel were cautioned about procedures for transferring radioactive materials or opening

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[2] EPA/HGL, *Final HSA 6,* p. 161, citation 4:

[4] Coonce, G. L., Atomics International Internal Letter, re*: UC Fire at Building 064*, May 8, 1963.

[3] EPA/HGL, *Final HSA 6,* p. 162, citation 1:

[1] Owen, D. E., Atomics International Internal Letter, re*: Incident Report, Building 064 Vault, 10-8-64*, October 27, 1964.

drums of radioactive materials (A0622).[1]

- On January 12, 1982 an alarm went off in Building 4064. Crews arrived at the building to check it out and the all-clear was given within an hour of arriving on the scene. The cause for the alarm was unknown and the alarm was to be checked by maintenance (A0095).[2]

- On September 21, 1982 an alarm went off in Building 4064. Crews arrived at the building to check it out and the all-clear was given within an hour of arriving on the scene. The cause for the alarm was unknown and the alarm was to be checked by maintenance (A0109).[3]

- On June 8, 1992 an employee was stacking storage racks on a pallet when he cut the palm of his hand. No detectable activity was noted on the employee's hand or the storage racks, despite concern for fixed U-235 contamination under paint on the fuel storage racks (A0218).[4]

- On August 8, 1995 a hot spot of approximately 1 square foot was identified during an Area IV survey in grid number R24S25. The hot spot was measured at 10,000 cpm or 46 µR/h. Per Rockwell's procedure, a 1 meter ambient survey was performed, but it was below the 5 µR/h above background limit for classifying as a hot spot. However, the Building 4064 sideyard was a formally remediated facility, so the discovery was reported to the Area IV survey project manager. The hot spot was roped off and a sample was taken. The sample contained 271 pCi/g of Cs-137. The Cs-137 concentration was too low to be considered an inhalation hazard and the surface radiation was only three times background, so there were no specific safety concerns. According to Rockwell, the discovery of contamination did not warrant a formal occurrence report because building 4064 was not yet released for unrestricted use. The hot spot had been identified in a verification survey by the Oak Ridge Institute for Science and Education (ORISE), but had not been properly communicated to Rockwell. The discovery was cited as an example of the importance of a walk-about surface gamma surveying used in the Area IV characterization survey (A0663).[5] The exact location of this hot spot has not been identified but it appears to be west of Building 4064.

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[1] EPA/HGL, *Final HSA 6,* p. 162, citation 2:

> [2] Alexander, R. E., Atomics International, re: Radiation Safety Unit Weekly Newsletter for Period Ending July 22, 1967, August 2, 1967.

[2] EPA/HGL, *Final HSA 6,* p. 162, citation 3:

> [3] Bradbury, S. M., Rockwell International Internal Letter, re: Radiological Safety Incident Report, Building 064, 1/12/82, Unknown Date.

[3] EPA/HGL, *Final HSA 6,* p. 162, citation 4:

> [4] Bradbury, S. M., Rockwell International Internal Letter, re: Radiological Safety Incident Report, Building 064, 9/21/82, September 22, 1982.

[4] EPA/HGL, *Final HSA 6,* p. 162, citation 5:

> [5] Wallace, J. H., Rockwell International Internal Letter, re*: Radiological Safety Report, T064 South Vault, 6/8/92*, June 17, 1992.

[5] EPA/HGL, *Final HSA 6,* p. 163, citation 1:

> [1] McGinnis, E. R., Rockwell International Internal Letter, re: Radiological Incident Report, Soil Contamination Found in T064 Sideyard, 8/8/95, August 25, 1995.

- On September 28, 1998 ORISE discovered an area of elevated soil contamination in the side yard. The area measured approximately 18 feet by 6 feet and was located on the sloping bank between 10th street and the Building 4064 parking lot. A total of 6 cubic yard of soil were excavated until radiation levels reached background levels. ORISE resurveyed the area, verified that radiation levels were normal, and collected two soil samples. Rockwell collected additional samples to confirm that the remediation had been successful (A0687).[1]

[1] EPA/HGL, *Final HSA 6,* p. 163, citation 2:

[2] Rutherford, R., Rockwell International Incident Report, re*: Verification Survey,* September 28, 1998.

Section 15.2

Building Number: **4023**
Building Alias: **023/T023**

Building Name/Function: **SNAP Liquid Metals Component Test Building**
Corrosion Test Loop
Sodium Test Loop

Notes: **Tritium / Neptunium**
SNAP: DOE-NASA (NAA S&ID Rocketdyne Personnel)

Radionuclides of Concern: Possible radionuclides of concern identified include americium-241 (Am-241), isotopes of plutonium (Pu- 238, Pu-239, Pu-240, and Pu-241); fission products cesium-134 (Cs-134), Cs-137, strontium-90 (Sr-90); source and uranium products, thorium-228 (Th-228), Th-232, uranium-234 (U-234), U- 235, U-238; **isotopes of neptunium (Np-237)**; and activation products, cobalt-60 (Co-60), manganese-54 (Mn-54), europium-152 (Eu-152), Eu-154, and **tritium (H-3)**, nickel-63 (Ni-63), iron-55 (Fe-55), and tantalum-182 (Ta-182).[1]

15.2.1 Description of Operations & Processes:

Building 4023 served as the Liquid Metals Component Test Building and the Corrosion Test Loop. The "old" portion of Building 4023 was constructed in 1962, and the "new" building section was constructed in 1976.[2] While the 1969 site layout does not show a radioactive waste holdup tank, a plan-view of the building from a 1993 final survey report does. The sodium test loop was located in a small partitioned area of the "old" portion of the building, which has also been used

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[1] EPA/HGL, *Final HSA 5-A,* p. 22, citations 63-67:

> [63] Cabrera Services, Inc., *Final Status Survey Report: Final Status Survey Post Historical Site Assessment Sites, Block 1*, March 2007.
>
> [64] Rocketdyne, Rockwell International, *Building 023 Final Survey Procedure,* 023-SP-001, August 3, 1993
>
> [65] Rockwell International, *Revised TRUMP-S Project Radioactive Materials Usage Application,* 190TI000001, October 31, 1989.
>
> *[66] Sapere Consulting, Inc. and The Boeing Company, Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries, May 2005*
>
> *[67] Sapere Consulting, Inc. referenced a January 20, 1993, internal letter regarding potential contaminants at T023. The research team has not located this document in the documents provided to date.*

[2] EPA/HGL, *Final HSA 5-A,* p. 12, citations 12 & 13:

> [12]Drawings appear to indicate that A.C. refers to "asphaltic concrete." The ditches surrounding this building were paved and likely served as a pipe trench for the cooling system return and supply lines between the building and the evaporator (Atomics International Drawing 303-027-C2, Topographic Plan, March 4, 1963).
>
> [13] DOE, Certification Docket for the Release of Building 023 at ETEC, Docket No. DOE/CD-ETEC-023, February 1997.

for storage. The “new” building section held an analytical chemistry laboratory and a storage set-up room.[1]

The old portion of the building housed a small sodium loop to conduct studies of radioactive contamination transport. A 1976 Use Authorization allowed the use of a small section of activated stainless steel Experimental Boilers Reactor fuel cladding in a small sodium test loop to gather data on transport characteristics of radiological contamination in sodium loops.[2]

According to a 1987 Site Consolidation Assessment, Building 4023 served as a development and demonstration test facility in support of the Rocky Flats Plutonium Recovery Project in 1987. These operations were located in the east bay and chemistry laboratory, while the west bay of the building was being used for the storage of power jet hardware. Available information indicates the project included the mechanical and structural design of 24 glove boxes, special manipulators and conveyor systems. The project also included the development of design criteria, definition of process equipment and glove boxes to manage plutonium, development of flow diagrams, design and specification of equipment and glove boxes, safeguard evaluations, experimental verification designs, reliability, availability and maintainability evaluations, and preparation of conceptual design reports.[3]

In 1989, reports appear to indicate that Building 4023 served as a support facility for the Transuranic (TRU) Management by Pyropartitioning - Separation (TRUMP-S) operations in Building 4020 (Hot Lab). Rockwell International requested DOE’s approval to utilize the facilities for a 2-year period beginning July 1988 for the Kawasaki Heavy Industries (KHI) and the Central Research Institute of the Electrical Power Industry (CRIEPI) of Japan-sponsored ‘pyrochemical partitioning of actinides from PUREX waste” program. According to the reports, inductively-coupled plasma (ICP) analysis at Building 4023 was not higher than 10 µCi of activity. The ICP analyzer was located in Room 102 A. The material used in this experiment was listed as including uranium, neptunium (Np-237), plutonium (Pu-239), and americium (Am-241).

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[1] EPA/HGL, *Final HSA 5-A,* p. 12, citation 14:

> [14] ORISE, Verification Survey of Buildings 005, 023, and 064, Santa Susana Field Laboratory, Rockwell International, Ventura County, California, 94/K-14, October 1994.

[2] EPA/HGL, *Final HSA 5-A,* p. 13, citations 20, 21, 22:

> [20] Information contained in historical documents obtained by HGL to date have not provided information regarding specific building operations that occurred from 1962 through 1976. Additional information regarding the operations during this time period are needed.
>
> [21] DOE, *Certification Docket for the Release of Building 023 at ETEC*, Docket No. DOE/CD-ETEC-023, February 1997.
>
> [22] *Liquid Metals Test Building – 023, Santa Susana Facility, Ventura County, California, Building Piping Plan, 303- 023-M5*, January 1, 1963.

[3] EPA/HGL, *Final HSA 5-A,* p. 14, citations 26 & 27:

> [26] ETEC, *Site Consolidation Assessment*, April 16, 1987. p. 13.
>
> [27] Litwin, R.Z., *Rockwell International Background and Capability to Develop a Weapons-Grade Plutonium Fuel Cycle and Disposal Evaluation for the PDR*, October 5, 1992.

The process of transporting the material from Building 4020 Hot Lab to 4023 was identified as follows:[1]

"When aqueous samples are transferred from Building T020 to Building T023 for analysis and back to T020 for solidification and disposal, no more than 10 µCi are contained in the 20-milliliter aliquot needed for rare earth analysis in Building T023. The aliquot will be placed in a 25-mL glass vial and sealed with a screw top cap. The glass vial will be placed in a plastic bottle with a screw-top cap. R&NS will smear the bottle to make sure it is uncontaminated, and the plastic bottle will be sealed in a plastic bag. The bag will be placed in a carrier which will be transported to Building T023. At Building T023, a sphincter port will be used to introduce the sample and its plastic bottle into the nebulizer glove box. Excess sample and waste will be bagged out of the nebulizer glove box and taken back to T020 [Hot Lab] in a similar manner to that described above."

While program was listed as being part of "DOE's Private Sectors Initiative," and DOE agreed to provide the experimental materials and dispose of the waste. At the conclusion of the work, the facilities were to be decontaminated to a "level that they may be released for unrestricted use." The confirmatory survey was to have been funded by the project. The duration of these activities in Building 4023 could not be located.

A March 1991 environmental, health, and safety self-assessment of ETEC provided a five-year plan that included activities for the decommissioning of Building 4023. According to this document, activities planned for Building 4023 included the surveillance and maintenance of "remaining radioactively contaminated systems in and around" Building 4023, including a disconnected radioactively contaminated hood inside the building and the associated piping, and a radioactive liquid holdup tank, all of which were included in the Fiscal Year 1993 plan for decontamination and decommissioning. In 1992 and 1993, an analytical and ICP instrument was used to analyze small amounts of radioactively-contaminated solution from the Molten Salt Oxidation project for trace metals. According to a final radiological study completed in 1994, the work was reportedly completed without incident and the remainder of the radioactive solutions and containers were transferred to the Radioactive Material Handling Facility (RMHF). The

[1] EPA/HGL, *Final HSA 5-A,* p. 14, citations 28 & 29:

[28] Rockwell International, *Safety Analysis for Building T020, Operations, TRUMP-S,* 190ER000011, December 4, 1989.

[29] Rockwell International, *Revised TRUMP-S Project Radioactive Materials Usage Application,* 190TI000001, October 31, 1989.

study did not indicate the quantity or nature of the radioactive solutions and containers transferred to the RMHF. The building was released in February, 1998.[1]

15.2.2 Building 4023 Potential for Off-Site Contamination

According to the EPA Area IV Study and HSA, Building 4023's 1964 and 1994 plot plans show an "A.C. ditch" that is also depicted in aerial photos. EPA's research team did not locate any documented information regarding the contraction of the ditch, which terminated at a catch basin and then flows into an 18-inch corrugated metal pipe. The pipe directed flow to a drainage channel that ultimately led directly to the "R-2A Pond," located in Area II. The R-2A Pond was part of the Site Wide Reclaim Water System, designed and constructed by AEC-DOE and Atomics International to keep Area IV from flooding and to provide much needed water to the rocket engine test stand workers (employed by North American Aviation) throughout Areas I, II and III.[2]

The preliminary MARSSIM rating of Building 4023 is Class 1.

15.2.3 Building 4023 Radiological Incident Reports

There have been several incidents associated with Building 4023 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

15.2.4 Building 4023 Radiological Incident Report Summary: Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0084	12/18/1980	R/A SOD UM LOOP	Active Corrosion Products	Rinse water surged out of deconned loop leg contaminating the area
A0257	4/22/1981	Sodium Loop	Co 60/Mn 54	Five grams of hot radioactive contaminated sodium leaked from loop and burned

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[1] EPA/HGL, *Final HSA 5-A,* p. 15, citations 33-37:

> [33] Rockwell International, Document No. GEN-AR-0023, *An Environmental, Health, and Safety Self-Assessment of the Energy Technology Engineering Center*, *Volume 2*, March 18, 1991.
>
> [34] Flore, J.J., Department of Energy, Docket No. ETEC-023, *Certification of the Radiological Condition of Building 023 at the Energy Technology Engineering Center Near Chatsworth, CA*, March 12, 1997.
>
> *[35] Rocketdyne Report, Final Radiological Survey Report of Building 023, 023-ZR-0001, March 1, 1994.*
>
> *[36] Liddle, Roger, DOE/OAK, Letter, "Release of Facilities for Unrestricted Non-Radiological Use," April 21, 1997.*
>
> *[37] Wong, Gerald, DHS/RHB, Letter, "Boeing's Request for Concurrence in Release for Use Without Radiological Restriction, Rocketdyne Santa Susana Field Laboratory Building T023," February 19, 1998.*

[2] U.S. DOE Office of Environmental Audit, *"Environmental Survey Preliminary Report, U.S. DOE Activities at SSFL,"* 1989.

16.0 Miscellaneous Operations

Neither the Conservation Yard nor the Sodium Disposal Facility were intended for use with radioactive materials, but both were inadvertently contaminated.

Section 16.1

Building Number: **4583**
Building Alias: **583/T583**

Building Name/Function: **"Old Conservation Yard" / "ESG Salvage Yard"**
Salvage, Scrap & Barrel Storage Yard
Fuel Tank Farm

Notes: **Tritium**
Drainage to Area II Ponds

Conservation Yard Radionuclides of Concern: U-238, U-234, U-235, U- 236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, H-3, Na-22, Na-24, Cr-51, Mn-54, Fe- 59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb- 95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151.

16.1.1 Description of Operations and Processes

This location consisted of a 3-acre area comprising mostly natural terrain used between 1952-1977 as a salvage yard.[1] It was later known as the "Old ESG Yard." Radioactive and non-radioactive materials from the SRE and other programs were brought to this site for storage. Excess salvageable items were stored at this location and eventually, it spread to include surrounding areas. Although not operated as a radiologically-controlled facility, Rockwell surveyed these areas for contamination because, according to Rockwell, although there was no "deliberate" dumping or placing of radioactive materials at this location, since there were no controls in place, radiologically contaminated items were found. In addition, items from the DeSoto Facility were stored at this location.

In 1969, the barrel storage yard was converted to a material storage yard for Plant Services, which relinquished control of the area in 1986 to Rockwell's Transportation Department. The Old Conservation Yard / ESG Salvage Yard was used extensively during the 1960's and 1970's before it was closed in 1977 and cleared of materials. In 1988, shipping trailers and casks were stored in the old barrel storage yard. In the early 1980's, this location became a fuel tank farm, which was demolished in 1999.

15.1.2 Conservation Yard Radiological Incident Reports: There has been one incident associated with the Conservation Yard that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents

[1] EPA/HGL, *Final HSA 6* p. 186, citation 1:
[1] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.

database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

The preliminary MARSSIM classification for this location, due to its former use as a storage area for radioactive materials and because it is not apparent that a full radiologic characterization of the area was conducted, is Class 1.

The HSA provides detailed information and a chronology of previous radiological investigations conducted at this location. However, in brief, Rockwell International performed a radiological survey at this location in 1988 to determine whether residual contamination remained from former storage operations. Rockwell found that the average ambient gamma exposure rate in an area of the yard was 27.9 µR/h (Rockwell's acceptable background was 15.3 µR/h, and under 5 µR/h above). Rockwell also discovered Cs-137 contamination.

16.1.3 Conservation Yard Radiological Incident Report Summary Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0288	1/15/1976	conservation yard	MFP	Contaminated drums and soil discovered at Conservation Yard, etc.

*Isotopes are written as they are presented in the incidents database. The HSA research team believes that MFP is an acronym for mixed fission product.

• On January 15, 1976 a radioactive spill was detected at the conservation yard with a pug survey meter. The spill spread across the conservation yard access road and terminated in an equipment holding area. Contamination was found on barrels (up to 800 mrad/h), pallets (up to 2 mrad/h) and in the surrounding area (up to 35 mrad/h). Other contaminated items were discovered at the conservation yard, although it is not clear from the incident report when these items were discovered. Contaminated items included a barrel (5 mrad/h), several pallets (up to 8 mrad/h), a concrete block (3 mrad/h), and a radioactive liquid waste drum (5 mrad/h). A barrel was found down the hill on the Simi Valley side of the conservation yard (2 mrad/h) and a pair of gloves belonging to the conservation yard operator (.3 mrad/hr). Externally contaminated barrels appeared to have resulted from a double stacked barrel of radioactive liquid that corroded and leaked out onto the drums and pallet below. As for the source of the contaminated liquid that caused the spill, there were not any significant leads. However, the liquid was thought to be a cleaning solution. The area was secured and radioactively contaminated asphalt, soil, barrels and pallets were removed to the RMHF for disposition (A0288).[1]

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[1] EPA/HGL, *Final HSA 6* p. 187, citation 1:

> [3] *Harris, J. and Badger, F., Rockwell International Internal Letter, Re: Conservation Yard Spill, February 6, 1976.*

Section 16.2

Building Number: **4886**
Building Aliases: **886 / T886**

Building Name: **Sodium Burn Pit**

Building Function: **Waste Disposal Via Combustion, Incineration, Burial**

Radionuclides of Concern: U-238, U-234, U-235, U-236, Pu-239, Pu-240, Pu-241, Pu-242, Am-241, Th- 232, H-3, Na-22, Na-24, Cr-51, Mn-54, Fe-55, Fe-59, Co-60, Kr-85, Sr-89, Sr-90, Sb-125, I-131, Cs-134, Cs-137, Ce-141, Ce-144, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xe-133, Xe-135, Pm- 147, Eu-152, Eu-154, and Sm-151

16.2.1 Description of Operations and Processes

The "Old Sodium Burn Pit" is an area where radiologically contaminated materials had been dumped at some point in time. At some point, a protective dike or berm around this area had washed away and material from this pit was allowed to move off the site in an uncontrolled fashion.[1] EPA noted that Rocketdyne had not collected soil or water samples in this area to be analyzed for tritium. If the materials dumped at this area and others contained tritium, there was no way in Rocketdyne's measurement protocol to detect it.

The Sodium Burn Pit (Building 4886) comprised approximately 2 acres. It operated from 1956 until 1978. In the late 1950's, a 16,700-square-foot area on the western side of the site was developed into an unlined pond. In the 1960's, a rectangular concrete-lined pool was constructed at the southeast corner of the site, surrounded by a concrete slab. A shed was located south of the concrete lined pool and a steel protective shield containing portholes was located at the east end of the pool. The steel shield also had a hand hole to accommodate a hose nozzle.

In the late 1960's two man-made shallow water-filled unlined ponds, known as the upper and lower ponds, were constructed. The lower pond was located in the middle of the site; the upper pond was located just north of the concrete-lined pool. These ponds, (lower 8,250 square feet and upper 6,500 square feet) were connected by piping.

In May 1956, Atomics International decided to locate a waste disposal area on the western region of SSFL because this area was underlain by shale of the Santa Susana-Martinez Formation. Atomics International believed that the percolation rates in the shale were low and that the rock appeared to be unfractured.[2]

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[1] Dempsey, Gregg: *"Site Visit to Santa Susana Field Laboratory,"* EPA Memorandum to Daniel M. Shane, On-Scene Coordinator, Emergency Response Unit. July 28, 1989

[2] EPA/HGL, *Final HSA 8* p. 40, citation 1:

> [1] Jarrett, A. A. and Roth, J. N., *Quarterly Progress Report, January, February, March 1956*, Atomics International, May 8, 1956, pp. 1-2.

In 1987, Rockwell reported that the Burn Pit was used extensively during the 1960 to 1970 period for the disposal of combustible materials such as kerosene, Na, and NaK from scrap test components such as pumps, valves, etc., from the SRE, SNAP, and other nuclear program operations. The area comprised a concrete pad adjacent to a concrete pool containing water and upper and lower pond area, both of which down-sloped from the pool. A steam lance was used to clean the equipment. Components to be cleaned were placed on the slab, opened to expose the Na or NaK, and then washed off with water. The water reacted with the sodium to generate hydrogen, which often burned in air. The washed items were placed into the concrete pool, where the reaction with water continued, and were removed from the pool and placed into the upper or lower pond, where they stayed until all residual sodium had reacted. Some items were retrieved and disposed of off-site as solid waste. An area adjacent to and west of the upper pond area was used for the storage and burial of materials.

In 1988, Rockwell reported that “Santo-wax,” used as a coolant for organic moderated reactors, was also burned in the area. Rockwell also reported that occasionally, firearms were used on vessels to open containers to the atmosphere. Those items, after cleaning, were removed to a dumpster for a scrap dealer. Some large components and vessels were buried in place. Some barrels and scrap were buried on the far western side of the site. According to Rockwell, material was also dispersed onto surrounding land by explosions that extended to Building 4009. The facility was also made available for the open burning of any combustible material.

Radiological surveys had shown that the upper and lower ponds were contaminated with Cs-137 and zirconium hydride slugs contaminated with 93% enriched uranium. Radioactive contamination was suspected in the area because of the potential for radionuclide transport and migration from the ponds in the direction of surface-water runoff, and because of the dispersion and scattering of radioactive material during cleaning operations.[1]

In 1978, Rockwell initiated cleanup of the Sodium Disposal Facility. Up until the mid 1980’s, pieces of debris such as pipes, elbows, machined metal parts, and tubes were dug up, “pushed over,” and reburied in the upper and lower ponds using bulldozers. All visible scrapped tanks were moved to Building 4133 for further disposition. The western p ond area was excavated, and hazardous materials and trash were removed. The concrete-lined pool was drained of water by a hazardous waste disposal company. Its walls were found to be radioactively contaminated and were scabbled. The lower and upper ponds were surveyed; both were found to be radiologically contaminated with the lower pond showing the highest readings. Cs-137 was identified as the principal gamma-emitting isotope.[2]

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[1] EPA/HGL, *Final HSA 8* p. 41, citations 1 & 2:

> [1] Chapman, J. A., *Radiological Survey of the Sodium Disposal Facility–Building T886*, ETEC Report No. GEN-ZR- 0004, June 3, 1988, pp. 7-8, 19-20.
>
> [2] Rockwell Internal Letter from F. H. Badger to R. J. Tuttle, Re: *Radiological Information on Old Sodium Disposal Area*, April 23, 1987.

[2] EPA/HGL, *Final HSA 8* p. 45, citations 1 & 2:

> [1] Klein, A., *Final Report for Decontamination and Decommissioning of Former Sodium Disposal Facility (FSDF) – B4886*, Boeing Report No. EID-04628, November 17, 1999, p. 12.
>
> [2] Chapman, J. A., *Radiological Survey of the Sodium Disposal Facility–Building T886*, ETEC Report No. GEN-ZR- 0004, June 3, 1988, pp. 7-8, 19-20.

In March, 1987 Rockwell conducted a site characterization study wherein 23 trenches were excavated between 1 and 7 feet in depth inside and north of the upper and lower ponds. A trench was also excavated along the southern and western boundaries to channel precipitation around the ponds, deflect run-on rainfall, and minimize possible material dispersion. Laboratory analysis of soil samples found Cs-137 activity levels as high as 200 pCi/g. While the trenches were open, items of debris were uncovered together with differing colored soils and pungent odors. The exposure rate in this area was 80 µR/h. Rockwell estimated background gamma radiation to be 15 µR/h. In one trench in the lower pond, gamma radiation levels were found to be 2 to 4 times background while beta radiation levels were up to 14 times background at a 1-foot depth. Items of radioactive debris found included zirconium hydride reactor fuel end caps contaminated with U-238 and a thoriated oxygen sensor used in the sodium loops. These items were not removed at the time of the investigation.[1]

In February 1989, DOE conducted the first phase of an environmental survey of Area IV and concluded that the removal of contaminated equipment from the Sodium Burn Pit area was incomplete. Additionally, the diversion ditches, which had been installed to channel storm water away from the contaminated areas, had been breached during cleanup operations. As a result, storm water was free to run onto the site and potentially remove contaminated soils and sediments. This was designated a Category II finding, having the potential for release of contaminated runoff due to inadequate controls. Contaminant concentrations in water runoff exceeded drinking water standards for arsenic, chromium, and thorium. Cs-137 was identified as the main radioactive contaminant in soil.[2]

On July 13, 1989 Gregg Dempsey from the EPA Office of Radiation Programs collected duplicate moist samples from the upper pond. These were analyzed for gamma emitting isotopes and H-3 (tritium). Results indicated normal or background levels of radioactivity in the area, for example. H-3 indicated a maximum of 0.59 pCi/g and K-40 indicated a maximum of 28.81 pCi/g. Cs-137 was found at levels consistent with those from atmospheric fallout from nuclear weapons testing (Cs-137 maximum 0.94 pCi/g). A dry soil sample collected from the lower pond was analyzed for gamma emitting isotopes. The lower pond gamma levels were found to be roughly twice those of the upper pond. Mr. Dempsey recommended that additional water samples be collected and analyzed for H-3 and Sr-90.[3]

In 1991, Rockwell conducted a baseline beta-gamma radiological survey of the Sodium Burn Pit Area, at near the soil surface. In the lower pond, the survey found elevated gamma activity at five locations; one location measured about twice normal background (27.5 µR/h) for gamma

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[1] EPA/HGL, *Final HSA 8* p. 46, citation 1:

> [1] Schiffman, J., *United States Department of Energy, Environmental Survey Report*, June 16, 1989, pp. 8-10, 16, 20- 21.

[2] EPA/HGL, *Final HSA 8* p. 46, citation 1:

> [1] Schiffman, J., *United States Department of Energy, Environmental Survey Report*, June 16, 1989, pp. 8-10, 16, 20- 21.

[3] EPA/HGL, *Final HSA 8* p. 46, citations 3 & 4:

> [3] Dempsey, G., *Report on Environmental Samples Collected at the Rocketdyne Santa Susana Field Laboratory July 1989*, , November 8, 1989, pp. 3-4.
>
> [4] Dempsey, G., *Site visit to Santa Susana Field Laboratory Operated by Rockwell Rocketdyne*, Memorandum, July 28, 1989, pp. 5-6.

contamination, and substantially elevated above background (6,215 dpm/100 cm^2) for surface beta contamination.[1]

The HSA provides additional details about further radiological investigations conducted at the Sodium Burn Pit area. In addition, it appears retroactive licenses may have been issued to address multiple fission product contamination in the soil.[2]

The preliminary MARSSIM Classification for Building 4886, the Sodium Burn Pit Area, is Class 1 because of its former use as a disposal area for non-radioactive and radioactive materials, and because it is not apparent that a full radiologic characterization of the area had been conducted.

16.2.2 Radiological Incident Reports

There have been several incidents associated with the Sodium Burn Pit that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. Summaries of all available incident reports are provided in Attachment A.

16.2.3 Sodium Disposal Facility Radiological Incident Report Summary Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0464	06/11/1964	Sodium Disposal Area	I-131	Employee spilled caustic R/A solution on ground while cleaning tank.
A0630	05/03/1968	Burn Pit		Three contaminated drums discovered being burned at the Sodium Burn Pit.
A0075	10/06/1978	Burn Pit & Shed	Mixed Fission Products	Scrap removed from Sodium Burn Pit found contaminated, as was the pit.

- On June 11, 1964 an employee spilled approximately 2 gallons of caustic radioactive solution labeles “0.15 mrad/h,” on the ground while cleaning a stainless-steel tank. The incident report did not mention any efforts made to clean up the spill. By the time Health & Safety personnel arrived, the employee was inside a tank wearing red-line coveralls, gloves, and rubber boots. He then left the tank, rinsed off his gloves and boots, and walked around the area. The ground-surface reading measured approximately 0.1 mrad/h with a G.M. and window probe. A reading of 100 dpm/gram (units may be incorrectly presented in the source document) was recorded in the center of the spill. It was recommended that bioassays be conducted on both employees assigned to the area. There was no follow-up to the incident report concerning the

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[1] EPA/HGL, *Final HSA 8* p. 47, citation 1:

> *[1] Collins, J., Baseline Radiological Survey of the Sodium Disposal Facility (T886), Rockwell International Report No. N704SRR990034, August 31, 1992, pp. 1, 6-12, 18.*

[2] EPA/HGL, *Final HSA 8* p. 48, citation 3:

> *[3] Rockwell International Authorization Review by F. E. Begley, February 6, 1989.*

bioassay (A0464).[1]

- On May 3, 1968 three radiologically contaminated drums were discovered being burned in the burn pit. The site was then sampled for radiological contamination. At the time of the HSA investigation, EPA awaited receipt of Incident Report A0630.

- In 1978, a survey of old sodium barrels located at the Sodium Burn Pit was conducted pending outside vendor bidding for salvage rights. Three radiologically contaminated sodium barrels and a pallet with pieces of pipe, valves and trash were found. The barrels had a maximum activity of 1 mrad/h. A subsequent survey found the upper half of the walls of the concrete-lined pool to be contaminated to 1,000 cpm (0.4 mrad/h). The contaminated waste had spread south of the concrete-lined pool because a survey in the region of Building 4730 identified two radioactive items. The metal waste storage area at Site 4886 contained five pallets of finned tubing contaminated to 5 mrad/h. All radioactive items were removed and moved to the RMHF for disposal (A0075).[2]

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[1] EPA/HGL, *Final HSA 8* p. 43, citation 1:

> *[1] Atomics International Incident Report from D. E. Owens to R. M. Hill re: Sodium Disposal Area spill on June 11, 1964, dated June 18, 1964.*

[2] EPA/HGL, *Final HSA 8* p. 44, citation 2:

> *[2] Rockwell International Internal Letter from F. H. Badger to W. R. McCurnin re: Preliminary Radioactive Survey Sodium Burn Pit, dated October 6, 1978.*

17.0 Additional Processes, Programs & Associated Facilities

This section contains a partial listing of additional facilities, operations, job processes, and incidents that were excluded from the 2006 Site Description / Site Profile.

The operations and facilities that were excluded include Coal Gasification facilities, the Sodium Components Test Installation (SCTI), Sodium Pump Test Facility (SPTF), the Small Components Test Laboratory (SCTL), Laser Testing operations and facilities, and several miscellaneous locations that supported a variety of programs and purposes; the Radioactive Laundry, Shipping and Receiving, and Hazardous Waste Materials Facility (HWMF) among them.

Presumably, many of these locations were excluded from the Site Profile on the premise that they were not considered “radiological facilities” or integral to the nuclear programs at SSFL. However, several of the facilities have histories of supporting the nuclear programs at SSFL, or handled radioactive materials regardless of being designated a “non-radiological” location. Many of these facilities have documented radiological incident reports contained in the Incidents Database. In some cases, the excluded facilities were located in close enough proximity to a known source of radiation exposure (like the RMHF or an experimental reactor building) to warrant concerns about worker exposure and appropriate monitoring.

Given the nature of SSFL operations, worker rotation, diverse job duties among the workforce, and the shifting nature of building function as programs and projects overlapped and changed over the years, a robust Site Profile cannot exist without some reference to all processes that were undertaken at the site, and a thorough review of building/facility history over the course of SSFL operations.

Section 17.1 - COAL GASIFICATION

The Rockwell International Molten Salt Coal Gasification Process (Rockgas Process), the 1-Ton and 1/4 Quarter Ton-Per-Hour (TPH) Coal Hydropyrolysis Pilot Test Facility, and coal gasification support facilities were operated under ETEC and DOE.[1]

According to Rockwell International's Energy System Division, under contracts with the DOE, the division advanced the development of two processes for the extraction of clean-burning gas (or liquid hydrocarbons) from coal at SSFL. DOE-ESG developed a system that used a molten salt mixture at a high temperature to convert any kind of coal to low or medium Btu industrial gas. The molten salt, from which sulfur and ash are removed for disposal, was continuously regenerated and recycled. These processes are further explained in Section 8.4 pertaining to Building 4005.[2]

In 1978, DOE and Rockwell International negotiated the construction and modification of facilities at the SSFL Energy Bowl Area.[3] Several coal gasification pilot plants, testing facilities, and support facilities were operated at SSFL beginning in the mid-1970's.[4] Two vertical test stands (VTS) were modified to accommodate coal gasification and liquefaction pilot test plants. In 1975, coal hydroliquefaction, a process where pulverized coal was put into a high-pressure environmental to produce benzene, toluene, and napthalene, was carried out. The liquids were then condensed, and the products were transferred into about one hundred 55-gallon drums. Some of the condensed liquids were sent out for qualification and quantification analysis. During the transfer of the liquids to the 55-gallon drums, workers had contact with the liquid, breathed the fumes, and spilled the liquids onto their clothing.[5]

To obtain pulverized coal, rock coal was ground through a fine mesh in a pressurized system. Workers were required to open plugged lines to obtain the pulverized coal. Workers were provided with dust masks, but their use could not be confirmed. The coal hydroliquifaction operations were conducted from approximately 1976 until 2005.[6] Coal gasification processes are related to radium exposure and directly related to occupational skin cancer.

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[1] Rockwell International for DOE, *"Advancement of Flash Hydrogasification: Task VIII — Performance Testing"* by A.Y. Falk, M.D. Schuman, and D.R. Kahn. June 1986. Work performed under DOE Contract #DE-AC21-78ET10328

[2] Rockwell International Energy Systems Group (ESG) Annual Report. File: ESG_Report.pdf

[3] Internal Letter, Rockwell International, *"One-Quarter-Ton-Per-Hour Coal Hydropyrolysis Conversion Test Facility"* September 15, 1978 Contract EX-77-C-01-2518

[4] S.J. Yosim and K.M. Bartley, *"The Gasification of Various Coals in Molten Salts,"* Rockwell International, Energy Systems Group, Canoga Park, CA.

[5] United States District Court for the Central District of California, No. CV-97-1554. Undated. Document # BNA08759547. Retrieved from Department of Toxic Substances Control (DTSC) publicly accessible Historical Archives Database, File HDMS-01690476-122119551.pdf

[6] Pratt & Whitney, "*Status of the Pratt & Whitney Rocketdyne/DOE Advanced Single Stage Gasifier Development Program,"* Presented at the Gasification Technologies Conference October 12, 2005. File: Pratt_Rocketdyne_Coal.pdf

Section 17.1.1

Building Number: **4048**
Building Alias: **048/T048**

Building Name: **Plant Development Unit (PDU)**

Building Function: **Instrumentation Building**

Radionuclides of Concern: None identified.

17.1.1.1 Description of Operations and Processes

Building 4048 appears to have been constructed in approximately 1978 and is identified in a 1978 industrial planning map as the Plant Development Unit (PDU) instrumentation building.[1] The PDU was designed and operated by Rockwell for DOE to demonstrate the technical feasibility of producing sulfur-free, low-Btu product gas by partial combustion of Illinois No. 6 coal in a sparged bed of molten, sodium carbonate salt. These operations are described in detail in Section 8.4 pertaining to Building 4005.

The PDU was designated as a "non-radioactive" facility that operated from November 1978 to June 1981.[2] The MARSSIM Classification for Building 4048 is Class 1 due to its proximity to Building 4005 and location within ETEC.

17.1.1.2 Radiological Incident Reports

No radiological incident reports were located for this building.

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[1] EPA/HGL, *Final HSA 5-A,* p. 148, citation 633:
[632] SSFL Area IV, ETEC Industrial Planning Maps, 1962-1992.

[2] EPA/HGL, *Final HSA 5-A,* p. 148, citation 634:
[634] Rockwell International, Environmental Monitoring Program Plan, Santa Susana Field Laboratory, Area IV, ER- AN-0006, September 30, 1992.

Section 17.1.2

Building Number: **4049**
Building Alias: **049/T049**

Building Name: **Hydraulic Test Facility (1959)**
Control Center, Piqua Test Loops (1968-1977)
PDU Control Center, Coal Gasification (1977-1988)

Building Function: **Various**
Notes: Drainage to the Area II R-2 Pond

Radionuclides of Concern: C-14, S-35, P-32, Fe-59, Co-60, Mn-54, Ni-59, Fe-55

17.1.2.1 Description of Operations and Processes

Building 4049 was constructed in 1959 as a hydraulic test facility control center for an outdoor vertical test stand (VTS). It was located within the fence-line boundary of Building 4005. According to a 1988 radiological survey of the building, the building was not associated with the SNAP program. The outdoor test stand was used for tests with terphenyl organics and finned sintered-aluminum-product cladding materials, sodium-water reaction tests, and a variety of sodium and NaK hydraulic tests. From 1968 to 1977, Building 4049 was used as a control center for Piqua Test Loops. In 1977, Building 4049 was designated as a control and test center for the PDU coal gasification process.[1] An undated table listing buildings that generate waste at the SSFL site indicates that Building 4049 also served as a computer services building.[2] By 1988, according to the August 1988 radiological survey, the building was abandoned. Building 4049 was demolished in 1999.

An undated laboratory status report identified burning high boiler residue contamination at Building 4049 included the radionuclides of concern, listed above, in addition to activation corrosion products (ACPs). According to Boeing, ACPs include, at a minimum, Co-60, Mn-54, Ni-59, Ni-63, and Fe-55.

The preliminary MARSSIM classification for Building 4049 is Class 1 because of previous incident reports, its location within ETEC, stains and open storage surrounding the building in aerial photographs, and the building's location within the fence-line boundary of Building 4005.

17.1.2.2 Radiological Incident Reports

There have been several incidents associated with Building 4049 that could have resulted in a release to the environment and worker exposure. The following table provides information

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[1] EPA/HGL, *Final HSA 5-A,* p. 150, citation 640:

[640] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.

[2] EPA/HGL, *Final HSA 5-A,* p. 150, citation 641:

[641] Unknown, Table of SSF Waste Generators, Undated.

presented in an incidents database provided by Boeing.

17.1.2.3 Building 4049 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0425	3/31/1960	Support Lab	ACP*	“Empty” pipe opened in clean lab contaminated employee with H.B.R.
A0479	4/1/1960	Building 4049 HBR	ACP*	Employee contaminated clothing while working around open HBR pipe.
A0476	4/17/1960	Building 4049	None Identified	Vacuum surge tank sprayed on employees’ personal clothing.
A0358	4/27/1960	Pad SS	None Identified	HBR was sprayed on employee when it was opened.

*Activation corrosion products have been defined as typically comprising Co-60, Mn-54, Ni-59, Ni-63, and Fe-55.

- On March 31, 1960 a pipe containing high boiler residue was opened, with high boiler residue spilling onto someone’s shoes and pant legs. Activated corrosion product (ACP) contamination levels were recorded at 500 dpm/100 cm^2. These ACPs have been defined by Boeing as typically comprising Co-60, Mn-54, Ni-59, Ni-63, and Fe-55 (A0425).[1]

- An incident occurred on April 1, 1960 during which an employee came in contact with an open pipe containing high boiler residue. According to the incident report, there were high boiler residue spots on his undershirt and work shirt. A smear of his skin showed no skin contamination and the shirt and undershirt showed no detectable contamination (A0479).[2]

- On April 19, 1960 machine oil from the vacuum surge tank sprayed an employee’s shirt. The shirt was surveyed and smeared and found to contain no detectable contamination of radiation. The shirt was returned to the employee (A0476).[3]

- On April 27, 1960 an employee opened the high boiler residue line and had high boiler residue spray on the employee’s shoes, pants, and shirts. The articles of clothing were surveyed and smeared, and following cleaning, there was no contamination detected. The incident report did not indicate the contamination levels detected prior to cleaning, if any (A0358).[4]

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[1] EPA/HGL, *Final HSA 5-A,* p. 150, citation 643:

[643] Warren, J.W., Internal Letter Re: Radiological Safety Incident Report,A0425, April 22, 1960.

[2] EPA/HGL, *Final HSA 5-A,* p. 150, citation 644:

[644] Warren, J.W., Internal Letter Re: Radiological Safety Incident Report A0479, May 19, 1960.

[3] EPA/HGL, *Final HSA 5-A,* p. 150, citation 645:

[645] Warren, J.W., Internal Letter Re: Radiological Safety Incident Report A0476, May 19. 1960.

[4] EPA/HGL, *Final HSA 5-A,* p. 150, citation 646:

[646] Warren, J.W., Internal Letter Re: Radiological Safety Incident Report, Building 049 Pad-SS, April 27, 1960.

Section 17.1.3

Facility Name: **SSFL Energy Bowl Area Test Facility:**
Building Numbers/Function: **B-900 Control Room**
B-901
B-923 VTS I, VTS II, VTS III Coal Gasification
B-924 Bowl Steam Cont. Building
B-934 Bowl VTS-III Control Room
Laser Engineering Test Facility (LETF)
Components Test Laboratory I (CTL-I)
Components Test Laboratory V (CTL-V)

Operations/Processes: **$^1/_4$-Ton Per Hour Coal Hydropyrolysis Conversion Test Facility**
1-Ton Per Hour Gasifier Reactor Development Program
4-Ton Per Hour Gasifier Reactor Development Program

Contaminants of Concern: Possible Radium, Benzene, Coal Dust, Coal Tar, Coal Tar Creosote, Distillates, Sodium Hydroxide, Xylene (BTX), Char Residue

17.1.3.1 Description of Operations & Processes

The Bowl Area is comprised of three Bowl Area test-stand structures, a retention pond, a skim pond, a control center, and buildings used to support DOE coal gasification facilities. It was located within the ETEC operations area.[1] The facility was used during the 1950's and 1960's to test rocket engines, and trichloroethylene (TCE) was used for each flushing (approximately 50-100 gallons per rocket engine test).[2] During the rocket engine testing period, the TCE and water run-off from the flame bucket cooling and unused fuels were discharged to the unlined Bowl Skim Pond (capacity approximately 200,000 gallons). The pond was part of the Site-Wide Water Reclaim System, where Area IV industrial effluent, waste water, and reactor blowdown was directed. The surface of the skim pond was periodically ignited to allow the accumulated fuel to burn off. This pond discharged to the R-1 Pond (Area II) and ultimately to the Perimeter Pond (Area I) before draining off-site.

In December, 1975 the Rockwell One-Quarter Ton Per Hour ($^1/_4$ TPH) Coal Hydroyrolysis Conversion Test Facility was activated by Rocketdyne to develop a hydrogenation process for coal liquefaction and gasification under a DOE-sponsored hydrogasification program.[3] The facility was used to develop process system and subsystem design data required to advance the development of a single-stage hydrogasifier (reactor).[4]

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[1] Author unknown. *"29 DOE Buildings Smith Briefing / 30 Bldgs on IL's from ETEC, Status as of 8/9/95"*. Document retrieved from publicly accessible historical archives at California Department of Toxic Substances Control (DTSC). File: HDMSE00375150.pdf

[2] November, 1992. Author Unknown. *"Bowl Area (Bowl Retention Pond, Bowl Skim Pond, and Bowl Test Stands,"* November 1992. Document retrieved from publicly accessible Historical Archives Database, California Department of Toxic Substances Control (DTSC), File: HDMSp01739799.pdf

[3] DOE Contract #EX-77-C-01-2518

[4] Ibid. 122119551

In 1978, plans were begun to modify the facility toward further characterizing the performance and requirements of the reactor system, provide additional data for process optimization, and for design of the 4-TPH reactor that was slated for construction at the Bowl Area VTS-III facility in 1979 under contract with DOE. By January, 1979 the 4-TPH Gasifier Reactor Development Program was underway.

The expansion of the 1/4 TPH facility established a dual test position test facility, with provisions for a coal flow loop. The expansion allowed for additional contract and company-sponsored programs to be conducted simultaneously with the existing gasification reactor development contract. The expanded facility made use of common test and instrumentation systems for multiple shift operations for employees (i.e. first shift dedicated to DOE Reactor Development Program; second shift dedicated to the hydropyrolysis process applications and development. The facility was located at the SSFL Energy Bowl Area Test Facility.[1] [2]

According to a Rockwell International Annual Report, under contracts with DOE Rockwell advanced the development of two processes for the extraction of clean-burning gas (or liquid hydrocarbons) from coal. The process used a molten salt mixture at high temperature to convert any kind of coal to low or medium Btu industrial gas. The testing of the process progressed at a rate of 24-tons-per-day.[3] This process is related to, and more fully described in Section 8.4 related to Building 4005.

From 1978-1983 the facilities were operated by Rocketdyne and DOE to demonstrate high temperature reaction of pulverized carbonaceous feedstocks with hydrogen in a short residence time reactor. A key element of the coal gasification reactor concept is the injector/reactor technology pioneered and developed by NASA and Rocketdyne. It was first used in liquid-fueled rocket engines.

Waste was stored in drums at the floor of the Bowl Area, and were apparently stored onsite for some period before being disposed as hazardous waste. Disposal reportedly occurred some time between 1980-1983; Rocketdyne was unable to locate disposal manifests or other records.[4]

There are indications that Rockwell-DOE coal gasification research at SSFL continued until approximately 2005, under Pratt-Whitney Rocketdyne.[5]

No incident reports were located for the locations described above.

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[1] Rockwell International for DOE, *"Advancement of Flash Hydrogasification: Task VIII — Performance Testing"* by A.Y. Falk, M.D. Schuman, and D.R. Kahn. June 1986. Work performed under DOE Contract #DE-AC21-78ET10328

[2] United States District Court for the Central District of California, No. CV-97-1554. Undated. Document # BNA08759547. Retrieved from Department of Toxic Substances Control (DTSC) publicly accessible Historical Archives Database, File HDMS-01690476.pdf

[3] Rockwell International, Annual Report. Page 7. File: ESG_Report.pdf

[4] November, 1992. Author Unknown. *"Bowl Area (Bowl Retention Pond, Bowl Skim Pond, and Bowl Test Stands,"* November 1992. Document retrieved from publicly accessible Historical Archives Database, California Department of Toxic Substances Control (DTSC), File: HDMSp01739799.pdf

[5] Pratt & Whitney Rocketdyne DOE Advanced Single Stage Gasifier Development Program presentation, Gasification Technologies Conference, October 12, 2005. File: Pratt_Rocketdyne_Coal.pdf

17.2 SODIUM COMPONENTS TEST INSTALLATION

The SCTI Building Complex and later Power-Pak installation included Buildings 4006, 4355, 4356, 4357, 4359, 4360, 4361, 4392, 4457, 4656, 4756, and some facilities at the ETEC SSFL Energy Bowl Facility. Although mostly designated as “non-nuclear” or “non-radiological” facilities, some of the locations have documented use of radioactive materials and radiological incidents. Those locations with radiological incidents are included below, for addition to the SSFL Site Profile.

The proximity of the SCTI and Power-Pak to nearby SNAP Buildings 4010, 4012, 4019, and 4024 raised EPA’s concern about radioactive contaminant migration and airborne emissions. In addition, some SCTI buildings were constructed atop the former SNAP facilities that were noted to be extensively contaminated with radioactivity.

The SCTI was a development test facility for liquid metal (sodium) system components. It provided a test site for the non-nuclear developmental testing of typical liquid metal reactor components, primarily steam generators. The SCTI Complex was originally designed to test sodium-heated steam generators and sodium-to-sodium intermediate heat exchangers under simulated sodium-cooled nuclear power plant operating conditions at a power level of 35 megawatts thermal. It operated from 1964 through 1995 and underwent system upgrades to the steam and feed water systems in 1973. Further modifications in the late 1970’s and early 1980’s included the addition of a second sodium heater and the replacement of most of the steam/feed water system and the water make-up system. Operations included sodium tank cleaning, generation of steam from a sodium heat source, water treatment, X-Ray operations and radiography.

In general, locations associated with the SCTI are designated “non-radiological.” However, EPA included worker testimony from the DOE-EPA interview component of the Area IV Study and employees state that although they were not monitored for radiation exposure at this location, some of the tanks held radioactive materials. In addition, EPA based MARSSIM Classifications of the SCTI buildings on the lack of radiological investigations as well as concerns about the proximity of the SCTI Complex to SNAP Critical Testing Facilities that were noted to have extensive radiological contamination. Based on EPA’s assessment, the proximity of the SNAP facilities presented potential radiological contaminant migration pathways via surface water run off and airborne releases.

Due to the nature of SCTI operations, it was common for SCTI employees to be involved in DOE Coal Gasification processes at ETEC. It is common for employees of the SCTI and Coal Gasification facilities to have utilized Time Clock Locations in Area I. And, there is growing evidence, particularly during the Site Remediation period at SSFL, that SCTI employees should have been consistently monitored for radiation exposure. Under contract with DOE-ETEC, Boeing was required to provide all employees engaged in Site Remediation activities with adequate radiation protection.

SCTI’s size, operations, processes and incidents necessitate its addition to the SSFL Site Profile to ensure a comprehensive characterization of facility operations.

Section 17.2.1

Building Number: **4356**
Building Alias: **356/T356**

Building Name/Function: **Sodium Components Test Installation (SCTI)**
Steam Generation / Components Cleaning
X-Ray Operations

Associated Buildings: **Building 4656 Cooling Stacks**

Radionuclides of Concern: Sealed source use of Cs-137 and Ir-192 are noted below in Radiological Use Authorizations and Radiological Incident Reports. This suggests potential use of other sealed sources as well. Radionuclides associated with potential migration from Systems for Nuclear Auxiliary Power (SNAP) Buildings 4010 and 4012 include: Sb-125, Am-241, Cs-134, Cs-137, Co-60, Eu-152, Eu- 154, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, tritiated titanium H-3, and natural and enriched U-234, U-235, U-238

17.2.1.1 Description of Operations & Processes

Building 4356 was constructed in 1959 as the Sodium Components Test Installation (SCTI) High Bay. Although this location was designated as, “Non-Nuclear,” several radiological incidents are noted below. Workers at this location were not considered to be “radiation workers,” and were not routinely or consistently monitored for radiation exposure.

Building 4356 did not contain any restrooms or heating / ventilation features. The ceiling height was 65 feet. The HSA provides a detailed description of the SCTI’s features and schematics, and references four sodium drank tanks; a reaction tank in below-grade concrete pits; 22 aboveground tanks containing sodium, sulfuric acid, calcium hydroxide, sodium hydroxide, morpholine, brine, gaseous argon, hydrazine, deionized water, and diesel oil.

The SCTI was a development test facility for liquid metal (sodium) system components. It provided a test site for the non-nuclear developmental testing of typical liquid metal reactor components, primarily steam generators. The SCTI Complex was originally designed to test sodium-heated stem generators and sodium-to-sodium intermediate heat exchangers under simulated sodium-cooled nuclear power plant operating conditions at a power level of 35 megawatts thermal. It operated from 1964 through 1995 and underwent system upgrades to the steam and feed water systems in 1973. Further modifications in the late 1970’s and early 1980’s included the addition of a second sodium heater and the replacement of most of the steam/feed water system and the water make-up system. Operations included sodium tank cleaning, generation of steam from a sodium heat source, water treatment, X-Ray operations and radiography.

Radiological Use Authorizations for this location include the permitted use of two 250 µCi Cs-137 sealed sources and one 100 µCi Cs-137 sealed source that were used as sodium level gauges. Sealed source use of Cs-137 and Ir-192 are noted at this location, and suggest potential use of other sealed sources as well. Additionally, radionuclides associated with potential migration from SNAP Buildings 4010 and 4012 include Sb-125, Am-241, Cs-134, Cs-137, Co-60, Eu-152, Eu-154, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, H-3, and natural and enriched U-234, U-235 and U-238. Because the general slope of Area IV is in a southerly direction, runoff from SNAP Buildings 4010 and 4012 could potentially impact Building 4356. The SNAP buildings handled radioactive materials and generated radionuclides, which means there is a possibility, according to the EPA research team, of radiological contamination in the area of Building 4356.

The preliminary MARSSIM classification of Building 4356 is Class 1 because of sealed radioactive material sources that were used at this location, and the potential for radioactive material migration via surface water flow and airborne releases from SNAP Building 4010 and 4012, in addition to the lack of site investigation.

17.2.1.2 Building 4356 Radiological Incident Report Summary - Data Provided by Boeing

There have been several incidents associated with Building 4356 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing.

17.2.1.3 Radiological Incident Reports - Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0639	10/7/1974	SCTI TANK #5	Cs-137	Source removed from SCTI surge tank and stored without approval.
A0093	12/8/1981	TEST STAND	Ir-92	Radiographic source pigtail uncoupled and fell to deck.
A0138	5/11/1985	SCTI 3RD DECK	Ir-92	Source stuck in short radium tube during radiographic operation at SCTI
A0153	2/20/1986	SCTI	Ir-92	Radiography barrier removed; employees entered area.

- On December 8, 1981, an iridium-192 (Ir-192) radiographic source pigtail uncoupled and fell to the deck of the SCTI test stand. A pigtail is a source assembly that consists of the sealed source and a connector that attaches the source to the control cable. The HSA research team could not locate the original incident report (A0093).[1]

- On May 11, 1985 an employee gammagraphing between the 2nd and 3rd deck of the SCTI could not retrieve the 45 curie (Ci) Ir-192 source. The source had become stuck in the short radium tube during radiographic operations. The employee was advised to stay cleaer of the area and security and management were notified. Survey meters and dosimeters were brought to Building 4356 and security road blocks were put in place. The dose rate at the radiographer's barrier rope on the east side indicated 12 mR/hr. The radiographer pointed out the source location below the floor on the 3rd deck along the steam generator. The dose rate was approximately 3 R/h at 4 feet from the back side of the source. A bend in the tube was pried back to allow the source to be cranked back into the lead camera. One employee

[1] EPA/HGL, *Final HSA 5B,* p. 67, citation 3:

[1] Interview No. 279 conducted by DOE in 2010.

received 2 mrem during the source recovery for a total of 13 mrems for the day. The health physicist on site received 18mrem during the recovery (A0138).[1]

[1] EPA/HGL, *Final HSA 5B,* p. 68, citation 1:

[1] Internal Correspondence from Badger, F.H. to Radiation & Nuclear Safety Group, Rockwell International, *Re: Radiological Safety Incident Report, T-356 SCTI, May 11, 1985*, May 15, 1985.

Section 17.2.2

Building Number: **4006**
Building Alias: **06/T006**

Building Name/Function: **Sodium Laboratory**

Radionuclides of Concern: Building 4006 was predominantly a non-radiological facility, but there are records of minor uses of radioactive materials, including UO_2, Mn-54, H-3 foils in gas chromatographs, and sodium loop level gauges possibly employing cesium-137 (Cs-137) sources. Radionuclides that may be present as a result of residual radioactivity in Building 4006 include: Cs-137, Mn-54, H-3, and natural and enriched uranium (U-234, U-235, U-238). Radionuclides associated with potential migration from Systems for Nuclear Auxiliary Power (SNAP) Buildings 4010, 4012, and 4024 include: Sb-125, Am- 241, Cs-134, Cs-137, Co-60, Eu-152, Eu-154, Pu-238, Pu-239, Pu-240, Pu-241, Sr-90, **H-3**, and U-234, U-235, U- 238.

17.2.2.1 Description of Operations & Processes

Building 4006 was constructed between 1957 and 1959 as a sodium laboratory. Its nearby Cooling Tower (Building 4616) was demolished in the 1980’s to make room for a Power-Pak associated substation. The HSA provides a detailed description of Building 4006’s features and schematics.

Building 4006 was considered a “non-nuclear” sodium laboratory. However, Use Authorizations provided for use of radioactive materials. In addition to a documented radiological incident contained in the Incident Reports Database, a 2008 Resource Conservation and Recovery Act (RCRA) Facility Investigation Report (RFI) describes other incidents associated with Building 4006 that include a sodium fire on November 25, 1987 resulting in a release of sodium metal, a mercury spill in a sink on January 21, 1992, and a tetralin fire on August 16, 1959.[1]

- 1973 Radiological Use Authorization No. 66 (September 28, 1973) specified that sodium (Na) would be added to canisters containing uranium oxide (UO2) in Building 4006.[2]
- 1974 Radiological Use Authorization No. 81 (June 26, 1974) permitted the use of tritiated titanium (H-3) foils as gas chromatograph detectors, used at the location until 1986.
- 1976 Radiological Use Authorization No. 101 (April 8, 1976) permitted the handling of 0.5 µCi of manganese-54 (Mn-54) contained in sections of activated piping with frozen sodium. The unpacking of the pipes occurred in Building 4006.

The preliminary MARSSIM classification of Building 4006 is Class 2 because regulated radiological material was handled at this location; Building 4006 aerial photographic analysis

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[1] EPA/HGL, *Final HSA 5B,* p. 103, citation 3:

> [3] Group 5 – Central Portion of Areas III and IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume V – RFI Site Reports, Appendix I, Coal Gasification Process Development Unit, CH2M Hill, Draft in Progress November 2008, p. Table I.2-1.

[2] EPA/HGL, *Final HSA 5B,* p. 104, citation 4:

> [4] Sapere Consulting, Inc. and The Boeing Company, Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries, May 2005, p. O-5.

noted possible staining; there is potential for radioactive material migration via surface water flow and airborne release from SNAP Buildings 4010, 4012, and 4024.

17.2.2.3 Radiological Incident Reports Summary - Provided by Boeing

There has been one incident associated with Building 4006 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing.

17.2.2.4 Radiological Incident Reports - Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Istopes	Description of Incident
A0484	8/11/1960	BLDG. MET. LAB	Activation Products	Polishing samples of SRE Moderator Can contaminated "clean" area.

Section 17.2.3

Building Number: **4355**
Building Alias: **355/T355**

Building Name/Function: **Sodium Components Test Installation - Control Center SCTI Small Components Test Loop**

17.2.3.1 Description of Operations & Processes

Building 4355 was the SCTI Control Center. It was used to monitor and control operations in Building 4356. It contained the control room, data acquisition system, offices for facility management and staff, restrooms, a small chemistry laboratory, and facility record storage.[1]

During the DOE-EPA Employee Interviews, Employee No. 195 indicated that, although workers at this location were not required to wear monitoring or film badges, some of the sodium tanks had radioactive material "to measure the level of the materials in the tanks." Other employees indicate their need for radiation badges at other parts of the site, but as employees assigned to SCTI they were considered "non-nuclear" workers.[2]

Radiological use authorizations permitted the operation of Bowed Tubes Measurement. Authorization 117D, dated July 1, 1984, permitted the use of a 1.0 microcurie cobalt-60 (Co-60) sealed source that was checked annually to ensure that no leakage occurred.[3]

The MARSSIM Classification of Building 4355 is Class 1 because of its use of sealed radioactive material sources, and the potential for radioactive contaminant migration via surface water flow or airborne release from SNAP Buildings 4010 and 4012. According to EPA, because the general slope of Area IV is in a southerly direction, runoff from SNAP Buildings 4010 and 4012 could potentially impact Building 4355.

17.2.3.2 Radiological Incident Reports

There has been one incident associated with Building 4355 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing.

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[1] EPA/HGL, *Final HSA 5B,* p. 60, citation 1:

> [1] Kneff, D.W. et al., Sodium Component Test Installation (SCTI) Demolition Final Report, EID-08336, October 1, 2003, pgs. 13-14.

[2] EPA/HGL, *Final HSA 5B,* p. 60 & 61, citations 3-1:

> [3] Interview No. 195 conducted by DOE in 2010.
>
> [1] Interview No. 63 conducted by DOE in 2010.

[3] EPA/HGL, *Final HSA 5B,* p. 61, citation 6:

> [6] Review of Radiation Safety Records Management System, 2010.

17.1.2.3 Building 4355 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Istopes	Description of Incident
A01044	4/15/1988	Outside Barrier	Ir-92	[Redacted] passed through radioactive barrier of radiographer.

Section 17.2.4

Building Number: 4357
Building Alias: 357/T357

Building Name/Function: SCTI Heat Transfer Loop Control Building

Radionuclides of Concern: Sealed source use of Cs-137 & Ir-192 suggests potential use of other sealed sources as well. Radionuclides associated with SNAP Buildings 4010 and 4012 present concerns at this location.

17.2.4.1 Description of Operations & Processes

Building 4357 was constructed in 1958 as the Heat Transfer Loop Control Building, and later a Pump Bearing Test Facility Control Building for the Liquid Metal Engineering Center (LMEC) and Energy Technology Engineering Center (ETEC). It provided a test site for the non-nuclear developmental testing of typical liquid metal reactor components, primarily steam generators.[1] It later became part of the Sodium Component Test Installation (SCTI) Complex, serving as a storage building.

17.2.4.2 Radiological Incident Reports

There have been no radiological use authorizations or incident reports found for this location.

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[1] EPA/HGL, *Final HSA 5B,* p. 71, citations 7 & 8:

> [7] Sapere Consulting, Inc. and The Boeing Company, Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries, May 2005, p. P-25.
>
> [8] Kneff, D.W. et al., Sodium Component Test Installation (SCTI) Demolition Final Report, EID-08336, October 1, 2003, pgs. 5, 13.

Section 17.2.5

Building Number: **VTS-III (ETEC SSFL Energy Bowl Area)**
Building Alias: **Steam Accumulation Blowdown Evaluation Rig (SABER)**

Building Function: **Large Scale Steam Valve Testing**

Associated Buildings: **Building 923 - Civil Works / Structure**
Building 934 - Control Room
Building 901 - Pre-Test Building
Building 924 - Steam System

17.2.5.1 Description of Operations & Processes

The Steam Accumulation Blowdown Evaluation Rig (SABER) was located in the ETEC area known as the SSFL Energy Bowl Area. Its purpose was to conduct the Large Scale Steam Valve Test (LSSVT) to demonstrate large steam Valve Test Article performance, and to obtain two-phase flow design data that would otherwise be unavailable. The test system design, procurement and construction management was performed by ETEC.[1]

The program involved searching for a test facility that could supply the steam flow and steam quality conditions required for the valve tests. The search identified the SABER in the SSFL Energy Bowl Area as the only existing site that could meet the required test conditions.

This facility supported DOE POWER-PAK operations. In 1986, ETEC / Rocketdyne / DOE installed the Power-Pak Facility at the SCTI for the purpose of supplying 25 megawatts of electrical power, which was intended to be sold by the government to the Southern California Edison Company. Because the new equipment would become an “integral part of [the] existing steam generator test complex and, as such, a specialized test facility,” no plans were made to submit designs for checks and County building permits were not requested, according to Rockwell International.[2] It is assumed that this precedent prevailed for other operations that met this criteria.

There were no incident reports discovered for this location.

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[1] Steam Accumulator Blowdown Evaluation Rig, Large Scale Steam Valve Test Action Description Memorandum. Document retrieved from publicly accessible Historical Archive courtesy of California Department of Toxic Substances Control (DTSC). File #HDMS00019780.pdf

[2] Internal Letter, Rockwell International to Ventura County. “*In Reply, Refer to 86RC00245,”* January 10, 1986. Document retrieved from publicly accessible historical archives courtesy of California Department of Toxic Substances Control (DTSC). File: HDMSE00024518.pdf

17.3 SMALL COMPONENTS TEST LOOP (SCTL)

BUILDINGS: 4026, 4226, 4826, 4358

The Small Component Test Loop (SCTL) Complex is comprised of the four buildings listed above, and may involve other Area IV locations. Research on the SCTL for inclusion to the SSFL Site Profile is incomplete. CORE Advocacy has included some buildings associated with SCTL operations where radiological incidents are documented, and will update this section of the 2016 Site Description as more information is obtained.

Building 4358 was originally built to support the Sodium Component Test Installation (SCTI) and was later moved to support the SCTL. The SCTL originally began as the Large Component Test Loop (1957). In 1970, it was modified and became the SCTL.

The SCTL complex consisted of an enclosed component test area, a sodium transport and storage system, an instrument and control system, and other interfacing systems. The sodium transport and storage system consists of four test loops, a thermal conditioning loop, and two liquid sodium storage/drain tanks that act as reservoirs for normal and emergency draining.

The SCTL's principal purpose was to provide a test bed for non-nuclear qualification testing of typical liquid metal fast breeder reactor components and to obtain test data for verification of the elevated temperature design criteria of the piping design guide. In 1974, the facility was again modified and expanded. In 1978, a new control room was added, giving the complex its final appearance.

Testing within the facility continued periodically from 1959 until 1985. The facility was maintained in inactive “standby” status, with the sodium systems under an inert cover gas, until late 1995.

Although designated a “non-nuclear” or “non-radiological” facility, radiological incidents are documented. Its proximity to known sources of radioactivity and radionuclide generation (SNAP Buildings 4010, 4012, 4019, 4024) may have resulted in radioactive contaminant migration due to surface water flow and airborne releases.

Worker records show that employees associated with the SCTL, designated as “non-radiation” workers, were frequent participants in Site Remediation activities that should have necessitated consistent radiation monitoring.

The SCTL should be included in the SSFL Site Profile to ensure an accurate characterization of facility operations.

Section 17.3.1

Building Number: **4026**
Building Alias: **026/T026**

Building Name/Function: **Small Components Test Loop (SCTL) Control Building**

Associated Buildings: **Building 4726 Electrical Cooling Station**
Building 4805 Time Clock Shack
Building 4426 Uninterruptible Power Supply (UPS)

17.3.1.1 Description of Operations & Processes

Building 4026 was originally built as the Large Components Test Loop. Operations began in 1959 with a pump test.[1] This facility used to test small components such as valves and pumps in liquid sodium.[2] The HSA provides a detailed description of Building 4026's features and schematics.

Although designated a "non-radiological" facility, radiological incidents are contained in the Incident Report Database that suggest the use of sealed sources at Building 4026. Aerial photographs of this location depict staining and a probable open storage area.

The preliminary MARRSIM classification for Building 4026 is Class 2 due to sealed source use, documented incidents, lack of site investigation, and potential radioactive material migration via surface water flow or airborne releases from SNAP buildings nearby.

17.3.1.2 Radiological Incident Reports - Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Istopes	Description of Incident
A0465	9/10/1969	Gammagraph	Ir-192	Employee disregarded warning signs and entered field of radiographic operation.
A0238	10/3/1979	SCTL	Ir-192	Stuck gammagraph source recovered.

[1] EPA/HGL, *Final HSA 5B,* p. 126, citation 7:

[7] U.S. Department of Energy, *Small Component Test Loop*, Energy Technology Engineering Center (ETEC) Website, http://www.etec.energy.gov/History/Sodium/SCTL.html, accessed November 25, 2009, p.1.

[2] EPA/HGL, *Final HSA 5B,* p. 126, citation 8:

[8] Rutherford, P.D., Site Environmental Report for Calendar Year 1998 , DOE Operations at Rocketdyne Propulsion & Power, RD99-115, The Boeing Company, Rocketdyne Propulsion & Power, September 22, 1999, p. 2-10.

17.4 DOE LASER ENGINEERING

SSFL-ETEC Energy Bowl Facilities were involved in the research and development of laser technology: The Hydrogen Fluoride Chemical Laser, the Sigma Tau Laser, the “RACHL,” and others. Some of these projects involved DOE. Others appear to have been carried out in facilities owned or operated by DOE, or situated on DOE-optioned land, although DOE involvement and proprietary interests in the laser engineering program remains unclear at this time. This section is incomplete. CORE Advocacy will provide more information on the SSFL ETEC Laser Engineering Facilities as it is obtained.

Section 17.4.1

Building Number: **LETF**
Building Alias: **Laser Engineering Test Facility**
The "RACHL"

Building Function: **Hydrogen Fluoride Chemical Laser**

17.4.1.1 Description of Operations & Processes

The Laser Engineering Test Facility (LETF) was located in the ETEC area known as the SSFL Energy Bowl Area. The program required Rockwell International to develop a fluorine atom diagnostic and a fluorine molecule diagnostics system. Modification of the facility was to incorporate a Steam Ejector system.[1] There were several entities involved in the RACHL, including Rockwell International, Department of Defense (DOD) and DOE. The LETF Building was later used for DOE coal gasification operations.

[1] Internal Letter, Rockwell International, "*Hydrogen Fluoride Chemical Laser Technology,"* June 30, 1976. Retrieved from publicly accessible Historical Document Archive, courtesy of Department of Toxic Substances Control (DTSC). File #HDMS200410653.pdf

17.5 Miscellaneous Additions - Various Processes and Operations

Several facilities that participated in various processes or serviced and supported diverse programs over the decades of SSFL's operations were excluded from the 2006 Site Profile. On the following pages, CORE Advocacy has identified a partial list of the excluded locations, and provided descriptions of their operations and processes. As more information is obtained, this section will be updated accordingly.

Some of these locations may have been designated "non-radiological" facilities but could have handled radioactive materials at some point in time. In addition, regardless of facility designation there may be documented incidents involving radiological materials. The locations of some of the facilities and their proximity to various sources or generators of radioactivity may result in concerns about worker exposure, regardless of the facility designation or processes.

Section 17.5.1

Building Numbers:	**4273 / 4283**
Building Alias:	**273/T273 - 283/T283**
Building Name/Function:	**Radioactive Laundry**
Associated Buildings:	**Building 4316 Maintenance Skid Shack**
Notes:	**Tritium** Drainage to the Area II Ponds

Radionuclides of Concern: U-238, U-234, U-235, U-236, Pu- 239, Pu-240, Pu-241, Pu-242, Am-241, Th-232, H-3, Na-22, Na-24, Cr-51, Mn-54, Fe-59, Co- 60, Kr-85, Sr-89, Sr-90, Sb-125, I-129, I-131, Cs-134, Cs-137, Ce-141, Ba (La)-140, Nb-95, Ru-103, Ru-106, Xn-133, Xe-135, Pm-147, Sm-151

17.5.1.1 Description of Operations & Processes:

Buildings 4273 and 4283 were constructed in approximately 1957 for use as a radioactive laundry.[1] The building included a radioactive laundry and protective clothing storage area. Contaminated laundry from the SRE Building 4143, the Engineering Test Building 4003, and the RMHF Building 4021 was brought to this location for cleaning. Operations were discontinued in 1971.[2]

The HSA research team could not locate a more detailed description of these buildings. These buildings may have had a septic tank and a leach field.

The preliminary MARSSIM classification for Buildings 4273 and 4283 area is Class 1. Items of radioactive laundry were washed and dried in Buildings 4273 and 4283 for approximately 14 years. It is not apparent where wastewater from laundry operations discharged or that a full radiological characterization of the area was conducted.

17.5.1.2 Building 4273 Radiological Incident Reports

None found.

The HSA provides a detailed chronology of previous radiological investigations and decontamination/cleanup of releases. DOE released these locations for unrestricted use in 1985.

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[1] EPA/HGL, *Final HSA 6,* p. 146, citation 1:

> [1] *Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.*

[2] EPA/HGL, *Final HSA 6,* p. 146, citation 2:

> [2] Chapman, J. A., *Radiological Survey of the T513 Parking Lot; Old R/A Laundry Area; Plot 333; and Areas between the SRE to RMDF, and KEWB to RMDF*, Energy Technology Engineering Center Report No. GEN-ZR- 0009, August 26, 1988, pp. 8, 19, 54, 61, 63-64, 77, 79.

Section 17.5.2

Building Number: **4133**
Building Alias: **133/T133**

Building Name: **Hazardous Waste Materials Facility (HWMF)**

Building Function: **Contaminated Sodium Cleaning**
Burn Pit Facility (Waste Disposal)
Drum Storage

Radionuclides of Concern: Although Building 4133 was considered a non-radiological site, low levels of Cs-137 were discovered here. Radiological surveys were conducted at the building area because of inadvertent radiological contamination of the facility (Building 4029) that provided the residual sodium for treatment in Building 4133.[1]

17.5.2.1 Description of Operations & Processes:

This facility is technically considered to be a "non-radiological" facility, and was not included in the 2006 SSFL Site Description or Site Profile. Boeing Employment Summaries may indicate that employees assigned to this building were not radiation workers, not monitored for radiation exposure, or were not at risk of being exposed to radiation. In addition, the processes and potential releases resulting from the operations of the HWMF may not be appropriately included in SSFL data used in dose reconstruction. However, Building 4133 received radioactively contaminated components as standard operating procedure.[2]

A portion of Building 4133 was initially constructed as Building 4724, the Contaminated Sodium Cleaning Facility used to support the Sodium Reactor Experiment (SRE). When Building 4724 was closed, the upper portion of the building was decontaminated and released for unrestricted use. This portion of the building was used for the construction of Building 4133.

In December 1977, Building 4133 was constructed at its current location. It has been identified as the Sodium Burn Facility on industrial planning maps, but also is collectively referred to as

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 180, citation 3:

> [3] Morton, J., Draft Verification Survey of Building 4059 (Phase 1), *Building 4133, and the 17th Street Drainage Area, Santa Susana Field Laboratory*, The Boeing Company, Ventura County, California, Oak Ridge Institute for Science and Education, February 2000, pgs 2-3.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 173, citations 5 & 6:

> [5] *B/133 Status Report*, Unknown Author, March 15, 1993 through October 29, 1993, HDMSe00381574 – HDMSE 00381640.
>
> [6] Soucy, R.C., *ETEC Waste Verification Plan for the Hazardous Waste Management Facility (HWMF), GEN-AN- 0041*, Energy Technology Engineering Center, November 29, 1993, p. 5.

the Hazardous Waste Management Facility (HWMF) with Building 4029. Unlike the Sodium Burn Pit, this facility treated sodium and other metals inside the building structure.[1]

Building 4133 was designed for the treatment of non-radioactive alkali metals, including sodium, sodium-potassium alloy (NaK), and lithium. The processes used to size-reduce solid components resulted in metal oxides that were removed from the air by a Peabody Variable Throat Venturi air scrubber and spray tower located outside Building 4133. Rinse water drained to a neutralizing pit or storage tank, and could be pumped to the aboveground tank when the other was full. Substances that may be contained in the scrap materials to be treated in the facility include: sodium, lithium, potassium, NaK, and lithium hydride. Building 4133 was also used as a drum and equipment storage area in the 1960's and 1970's.[2] The RFI report also notes that prior to 1978, the Building 4133 area was used for parking and equipment/drum storage in support of the Sodium Reactor Experiment (SRE) operations.

The HWMF began operation in 1978 as a drum storage yard and was fully permitted in 1983 as a RCRA hazardous waste treatment and storage facility for non-radiological chemical wastes generated onsite. However, status reports for 1993 indicate that while operating as the HWMF, Building 4133 received pipes and tubes that were radioactively contaminated above background levels. Standard operating procedure at Building 4133 dictated that if an object with sealed, inaccessible, internal surfaces was to be cut open at Building 4133, then a radiation survey overcheck was to be performed during and after cutting operations. Any material found to have radioactive contamination was transferred to the Radioactive Material Handling Facility (RMHF).[3] A 1993 Rockwell letter states that water used to wash buried objects from the Building 4886 Sodium Disposal Facility at Building 4133 was found to contain low concentrations (less

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[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 160, citations 1-6:

> [1] Sapere Consu t ng, Inc. and The Boe ng Company, *Historical Site Assessment of Area IV Santa Susana Field Laboratory, Ventura County, California, Volume 2 – Area IV Site Summaries*, May 2005, p. G-11.
>
> [2] McG nn s, E.R., *Building 4133 Radiation Survey Report, RS-00015*, The Boe ng Company, January 14, 2004, p. 8. [3]
>
> Santa Susana Area IV, Atom cs Internat ona /Energy Systems Group P ann ng Maps, March 1962–November 1992.
>
> [4] Knudsen, K.T., *Safety Analysis Document – Building 133 Hazardous Waste Management Facility, 133-ZR-0003*, *Rev. C,* Energy Techno ogy Eng neer ng Center, June 28, 1991, Rev sed Apr 1, 1996, p. 5.
>
> [5] *The Boeing Company Closure Plan Hazardous Waste Management Facility, Buildings T029 and T133, Santa Susana Field Laboratory, Ventura County, California*, MWH, December 2003, p. 3-5.
>
> [6] MWH, *Group 7 – Northern Portion of Area IV RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Volume II – RFI Site Reports*, June 2009, pg. B.2-2.
>
> [7] Energy Techno ogy Eng neer ng Center, *Operation Plan: Hazardous Waste Management Facility, 133-AN-0001*, March 3, 1991, p. 25.

[2] EPA/HGL, *Final HSA 7-3-NBZ,* p. 173, citation 7:

> [7] Science Applications International Corporation, *Final RCRA Facility Assessment (RFA) Report for Rockwell International Corporation, Rocketdyne Division*, Santa Susana Field Laboratory, Ventura County, California, May 1994, p. 7-3.

[3] EPA/HGL, *Final HSA 7-3-NBZ,* p. 173, citations 5 & 6:

> [5] *B/133 Status Report*, Unknown Author, March 15, 1993 through October 29, 1993, HDMSe00381574 – HDMSE 00381640.
>
> [6] Soucy, R.C., *ETEC Waste Verification Plan for the Hazardous Waste Management Facility (HWMF), GEN-AN- 0041*, Energy Technology Engineering Center, November 29, 1993, p. 5.

than 10 pCi/L) of cesium-137 (Cs-137), suggesting a means of potential radioactive contamination at Building 4133.[1]

The preliminary MARSSIM classification for the Building 4133 area is Class 1, due to the possibility of cutting of radioactive contaminated pipes and tubes, and proximity to other radiological facilities.

[1] EPA/HGL, *Final HSA 7-3-NBZ,* p. 174, citation 7:

> [7] Internal Correspondence from Tuttle, R.J. to Rutherford, P.D., Rockwell International, *Re: Disposal of Potentially Contaminated Wash Water at T133*, June 3, 1993.

Section 17.5.3

Building Number: **4011**
Building Alias: **011/T011**

Building Name/Function: **Radiation Instrument Calibration Laboratory**

Associated Buildings: **Building 4403 Traffic Dispatch Building**
Building 4711 Electrical Substation

Notes: Possible Tritium

Radionuclides of Concern: Am-241, Cs-137, Co-60, Eu-152, Eu-154, Ir-192, Pb-210, Pu-238, Pu-239, Pu-240, Pu-241, K-40, Ra-226, Sr-90, Ta-182, Tc-99, Th-230, Th-232, **H-3**, and U-234, U-235, U-238.

17.5.3.1 Description of Operations & Processes

Building 4011was used to support various non-nuclear programs until 1984. From 1984 to 1996, the north section of Building 4011 was used for calibration and repair of radiation detection instruments. Calibration and repair would have involved instruments containing radioactive contaminants from any of the Area IV nuclear facilities. Service work used only sealed radioactive sources and electroplated calibration sources. After 1996, laboratory activities were transferred to Building 4100 (AETR).

The Property Inventory and Control Department used the south section of the building. The south side of Building 4011 was used as a materials warehouse for non-radiological materials. Industrial planning maps indicate that Building 4011 was an administration and services building in the late 1960's and early 1970's, a development support shop in the mid-1970's, a manufacturing support shop in the late 1970's and early 1980's, a machine shop in the mid-to-late 1980's, and a storage facility in the early 1990's.[1] The HSA provides a detailed description of Building 4011 features and schematics.

The preliminary MARSSIM classification for Building 4011 is Class 1 because of sealed and unsealed radioactive material sources, reported radiological incidents, and previous investigations.

17.5.3.2 Radiological Incident Reports - Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Istopes	Description of Incident
A0531	4/26/1960	West of Bldg.11	MFP	Leak test of OMRE shipping cask spilled radioactive liquid on the ground.

[1] EPA/HGL, *Final HSA 5B,* p. 184, citation 4:
[4] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992.

Incident File Name	Date of Incident	Location of Incident	Istopes	Description of Incident
A0519	7/14/1964	SS 19th & F St.		Empty but labeled radioactive shipping containers found in private car.
A0083	7/2/1980	RIHL [Hot Lab] and Bldg. 11	Ta-182	Unexplained exposure, over guidelines.
A0318	4/13/1985	Calibrator	Cs-137	Calibration source came lose from actuator rod.
A0651	1/6/1994	Inst. Calb. Lab		Internally contaminated air sampling pumps not labeled.
A0658	12/6/1994	T011 Calib. Lab	Cs-137	28 Ci Cs-137 calibration source dislocated from release pull rod.

*Isotopes are listed as written in the Incident Report Database. The HSA research team believes that “MFP” is an acronym for “mixed fission products.”

- On April 28, 1960 during the final leak test of the Organic Moderated Reactor Experiment (OMRE) trailer cask cooling system, a union between the two circulating lines was not tightened. When the pump was turned on, water ran out from the system onto the trailer bed and blacktop through bolt holes where the cask was secured. The water was soaked up immediately and confined to an area of about 1 square foot. Approximately 1 pint of radioactive liquid containing mixed fission products was spilled on the ground to the west of Building 4011. All loose dirt was cleaned up and a s ample of the blacktop was taken. Results shoes 216 dpm beta-gamma. The incident report notes that this type of operation should have been done in an area that had the proper facilities for handling contaminated equipment. (A0531).[1]

In addition to the incidents noted in Boeing’s Incident Database, the HSA research team identified two other incident pertaining to Building 4011.

- Sludge in a sink trap in Room 120 (Building 4011) was found to contain 27.2 pCi/g of U-234. The sink and trap and a portion of the drain line were removed and disposed of as radioactive waste.[2] It was not clear to the HSA research team from figures included in the HSA whether the drain line was connected to the former septic tank, or the sewer line.

- On January 15, 1976 a radioactive spill in the Rocketdyne conservation yard was discovered. In the search for the origin and the extent of contamination, numerous radioactively

[1] EPA/HGL, *Final HSA 5B,* p. 185, citation 1:

[1] Klostermann, J.P., Radiological Safety Incident Report, Bldg. #11 (West Side), Atomics International, April 28, 1960.

[2] EPA/HGL, *Final HSA 5B,* p. 185, citations 2, 3, &4:

[2] Barnes, J., Final Radiological Survey Data Package for Building 011, Santa Susana Field Laboratory, The Boeing Company, July 28, 1998.

[3] Rash, M., Final Oversight Verification and Confirmation Radiological Survey Report for Buildings T-011, T-019, T-055, and T-100, Tetra Tech EM, Inc., December 20, 2002, p. 9.

[4] Rash, M., Final Rocketdyne Technical Support and Field Oversight Document Review for Buildings T009, T011, T019, T055, and T100, Tetra Tech EM, Inc., December 20, 2002, pgs 8-9.

contaminated barrels and pallets were recovered from a wide area of the Santa Susana Field Laboratory (SSFL) complex on the whole. A pallet in the Building 4011 receiving yard with two acetone barrels on it was discovered to be radiologically contaminated at approximately 800 mrad/hr beta. According to the incident report, all contaminated items that had been detected were transferred to the Radioactive Materials Handling Facility (RMHF) for disposal with the exception of three large concrete structures and a 1 mrad/hr spot on the asphalt in the Building 4011 yard. The incident report does not describe how these items were handled. Externally contaminated barrels appeared to have resulted from a double-stacked barrel of radioactive liquid that corroded and leaked.

Section 17.5.4

Building Number: 4641
Building Alias: 641/T641

Building Name/Function: Shipping and Receiving

Notes: Building 4641 served as a transfer point for all SSFL incoming/outgoing shipments.

Radionuclides of Concern: All radionuclides used at SSFL Area IV should be considered potentially present at any shipping/receiving or waste disposal location (i.e. RMHF).

17.5.4.1 Description of Operations & Processes

Building 4641 was constructed in 1964 to be used for shipping and receiving. It served as a transfer point for all SSFL incoming and outgoing shipments. Through 1985, this included radioactive materials. However, it should be noted that the documented incident below involved radioactive materials in 1989.

Non-radioactive materials were reportedly stored in the warehouse, while radioactive and nuclear shipments were reportedly only handled on the outdoor dock. However, the storage area may have been used to store drums containing mixed fission products. Radioactive materials included individual gamma-graphic sources, radioactive laundry, and shipping casks.

While reportedly “no radioactive containers were opened in the area of Building 4641,” and “the building had a radiation detector alarm system in the dock, and the alarm system was never triggered,” these assertions are inconsistent with building function and known operations. In addition, the failure of an alarm to be triggered may not be a reliable indication of safe radiation levels in the area. To the contrary, given the building’s function, it could suggest a faulty alarm system or poor calibration of detection equipment.

17.5.4.2 Building 4641 Radiological Incident Reports

There has been one documented incident associated with Building 4641 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing.

17.5.4.3 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0581	6/20/1989	Bldg. 4641 Traffic SSFL	Be-7	Radioactive material arrived at SSFL Traffic without any labels or control.

• On June 20, 1989 13 mCi of solid Be-7 arrived at the facility in a box without any labels or controls, in violation of State of California regulations. The incident was summarized as “a loss of control and security required of radioactive materials.” There were no known releases to the environment or worker exposure documented, as a result of this incident.

Section 17.5.5

Building Number: **4066**
Building Alias: **066/T066**

Building Name/Function: **Instrumentation Repair / Calibration**

Notes:
Designated "Non-Radiological" Facility
Documented Radiological Processes & Incidents
Rocketdyne Employees
Workers Not Monitored for Radiation Exposure

Radionuclides of Concern: Uranium, due to documented incidents / processes. In addition, this building's proximity to Building 4059 raises concerns about the following radionuclides: U-238, U-234, U-235, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Cs-137, Sr-90, H-3, Fe-55, Co-58, Co-60, Ni-63, Ba-133, Eu-152, Eu-154, Eu-155, Pm-147, Ta-182

17.5.5.1 Description of Operations & Processes

Building 4066 area comprised Building 4066, Time Clock Building 4806, and the land surrounding these two buildings. Building 4066 was constructed in 1963 for use in calibrating and testing non-radiological equipment. It was a 4,800-square-foot steel building with concrete foundations and floor, corrugated steel siding and roof, housing a 3,524-square-foot laboratory.[1]

Building 4066 contained internal partition walls with wood framing and drywall. One room had copper shielding in the walls to provide radio-frequency shielding for instruments. A steel test-stand was located outside the south side of Building 4066.

There were no Radiological Use Authorizations issued for Building 4066. The preliminary MARSSIM Classification for the Building 4066 area is Class 1 due to its location within ETEC, close proximity to SNAP Reactor Building 4059, and because no site investigation has been conducted.

Surface water in the vicinity of the former Building 4066 likely flows east into a storm drain on SSFL's 20th Street, that directs the water southeast via an intermittent stream through Area III to a pond in Area II. The storm drain collects storm water from the northern and eastern portion of EPA's Subarea HSA-5C. Storm water originating from the former SNAP reactor Building 4059 discharges into this storm drain. Consequently, this storm drain may provide a pathway for the migration of radionuclides originating from the former research reactor. In addition, the sanity sewer lines located along the northern and eastern side of Building 4057 presented some concern to EPA because, if radioactive materials were released into the sanitary sewer system, residual contamination may exist in the materials surrounding the sewer lines.

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[1] EPA/HGL, *Final HSA 5C,* p. 41, citations 1&2:

[1] Pendleberry, S. L., *Removal of DOE Buildings, Demo Pak A*, Boeing Report EID-04366, May 18, 1999, pp. 4-6.

[2] Santa Susana Area IV, Atomics International/Energy Systems Group Planning Maps, March 1962–November 1992. Ref. 122119552

17.5.5.2 Building 4066 Radiological Incident Reports

There has been one documented incident associated with Building 4066 that could have resulted in a release to the environment and worker exposure. The following table provides information presented in an incidents database provided by Boeing. In addition, there has been one historical document located that describes ongoing radiological processes at this location.

17.5.5.3 Radiological Incident Report Summary - Data Provided by Boeing

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0599	10/31/1966	Instrument Shop	U	Contaminated furnace switch taken to clean instrument shop for repair.

- In October 1966, an in-line vacuum switch was removed from the tiltpour pumping system and hand-carried to Building 4066. When the instrument technician opened the switch to calibrate it, a fine black powder, assumed to be uranium oxide, leaked out onto the technician's clothing and work bench. The technician's clothing was removed; he showered in Building 4020 (Hot Laboratory), and was subsequently found to be free of contamination. The area around the work bench was decontaminated (A0599).[1]

  •*It should be noted that as a "non-radioactive" location, workers of Building 4066 were considered "non-radiological" workers and were not monitored for radiation exposure. In addition, the worker involved in this contamination incident was sent to Building 4020 (Hot Laboratory) for decontamination procedures. However, Building 4020 was considered a restricted area, and was not supposed to be accessible to workers that were not monitored for radiation exposure.*

- Atomics International's Safety Progress Report acknowledged Building 4066's routine use of radiological materials by specifying that the Radiation Safety Department would need to be actively involved before employees were allowed to work on instruments or equipment. In addition, the report specifies ongoing work and repair of the radioactive exhaust system. Its need for repair suggests that it had been formerly used, and it is therefore reasonable to assume that it was radioactively contaminated as a result.[2]

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[1] EPA/HGL, *Final HSA 5C,* p. 41, citation 3:

> [3] Anonymous, Atomics International Monthly Progress Report to M. E. Remley, re: *In-Line Vacuum Switch*, November 8, 1966.

[2] Atomics International Monthly Progress Report, October 1966. R.E. Remley. File: HDMSP00051133.pdf

18.0 SANTA SUSANA FIELD LABORATORY'S ASSOCIATED FACILITIES:

Downey • Canoga • VanOwen • DeSoto

18.1 Downey Facility

The 2006 Site Profile provides insufficient and incomplete information about operations at the Downey Facility. The current SEC is in effect until 1955. According to Boeing, AEC operations and the Water Boiler Neutron Source (WBNS) reactor existed and were operational at Downey until 1956, after which time suitable site remediation activities likely would have involved employees of North American Aviation, the DOE Contractor.[1] It would be reasonable to consider these employees eligible to EEOICPA.

Downey Facility is located on Lakewood Boulevard in Downey, California. The 2006 Site Description states that AEC activities were limited to only a "small portion of a large building." However, that assertion is contradicted throughout Boeing's 2001 radiological survey of the Downey Facility, which documents radioactive materials storage, handling, use, and nuclear research in several uncontrolled areas that were accessible to all employees. There is no indication that these operations were carried out in a "secluded" area, or that they were conducted in a location that was deemed suitable for the safe handling of radioactive materials and nuclear research.

According to Boeing, the WBNS reactor was developed and operated on the only loading dock of the Downey Facility. As the only loading dock, it was considered the shipping and receiving point of entry and exit for all operations. In addition to the operation of the WBNS on the loading dock, the "exponential pile" of source material was stored on the loading dock. Given the normal function of a "loading dock," is likely that this area was frequented by employees that were not appropriately monitored for radiation exposure.

Downey Facility also hosted a 2 MeV Van de Graaf Particle Accelerator, a radiochemical laboratory, a neutron counting room, and a *"construction area with a small .05W teaching reactor."* There is no indication that a "construction area" was suitably equipped to contain or house any type of experimental or teaching reactor, or associated radioactive materials. There is no indication that the "construction area" used for the teaching reactor was located in a secluded, restricted, or otherwise controlled area.

The quality of site remediation following the removal of the WBNS and transfer of AEC operations to Canoga Park and SSFL remains undetermined. According to Boeing's radiological survey, records of the facility's early activities are "sketchy, anecdotal, and non-existent."

Boeing references the storage of the exponential pile on the loading dock, and additional radioactive materials used in the "Pearlman Laboratory" and the basement of the "Finger Building." In addition, the basement was identified as the location of the film dosimetry processing and calibration source storage. Pearlman's Laboratory was identified as the location of a radiochemistry lab. These locations are not indicative of seclusion, nor a "small area in a

[1] Boeing, Engineering Product Document #RS-00019, Radiation Survey of Downey Facility prepared by P. Liddy & P. Rutherford, May 4, 2001.

large building." Photographs of the WBNS on the loading dock show workers standing around the reactor, holding survey equipment. The reactor is surrounding by several wooden shipping containers (indicative of typical loading dock operations). One worker can be seen atop several stacked wooden shipping containers, using survey equipment near the top of the reactor. The final designation of the wooden shipping containers is unknown.[1]

Given the involvement of NAA nuclear space propulsion systems that involved both DOE and NASA, the development of the Space Shuttle and International Space Station in DOE locations at SSFL Area IV, DOE involvement and proprietary interests in Downey operations after 1955-56 should be evaluated. As more information is obtained about agency and contractor projects, there may be justification to add years to the covered time period for Downey workers (potentially under the SEC class).

18.2 Canoga Park / Van Owen Facility

The 2006 Site Profile provides insufficient and incomplete information about operations at the Canoga / Van Owen Facility, which is not covered by EEOICPA after 1960. CORE Advocacy is currently evaluating historical documents related to Canoga Facility. There are some indications that Canoga and Van Owen Facility may have supported DOE operations at SSFL after 1960. A newly obtained incident report documenting a 1967 uranium fire at the Canoga Facility is provided below.

The Special Nuclear Materials License (No. SNM-21) authorized Atomics International Division of North American Aviation to receive and possess 50 grams of uranium enriched in uranium-235 (U-235) for use in fission counter tubes. SNM-21 was amended eight times to increase the number and type of nuclear materials that could be handled at both the Canoga Park and SSFL sites, and it was in effect until September 27, 1996.[2] [3] In addition, in 2005 DEEOIC acknowledged the original North American Aviation - AEC contract, wherein North American Aviation was permitted its discretionary use of its facilities and locations owned by the company *or* leased by AEC to perform functions affiliated with fulfilling its contractual obligations.[4] It would be reasonable that Canoga and VanOwen facilities would be used, as required, to support SSFL or DeSoto DOE operations.

The 2006 Site Description indicates that AEC-sponsored activities at Canoga Facility occurred in the VanOwen Building from 1954-1960 following the move from Downey Facility in 1955. In addition, the 2006 Site Description indicates the principal work in the VanOwen Building included design, development and operation of small aqueous fuel reactors, fuel development, radiochemistry, and beryllium machining. The reactor activities at Canoga Facility involved the

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[1] Boeing, Engineering Product Document #RS-00019, Radiation Survey of Downey Facility prepared by P. Liddy & P. Rutherford, May 4, 2001. Page 11.

[2] U.S. Nuclear Regulatory Commission, *Materials License,* SNM-21, September 15, 1977.

[3] U.S. Nuclear Regulatory Commission, NUREG-1077, *Environmental Impact Appraisal for Renewal of Special Nuclear Material License No. SNM-21,* June, 1984.

[4] Division of Energy Employees Occupational Illness Compensation (DEEOIC) Peter M. Turcic Memorandum to Christy Long, District Director of Seattle, Subject: *Atomics International and Energy Technology Engineering Center,* September 7, 2005

construction of small 10-W aqueous uranyl sulfate homogenous reactors (L-47 / L-77) for use in training institutions. According to the 2006 Site Description, reactor fueling only occurred after the reactors were installed at the training institutions (contradicting the previous statement that the reactors operated at Canoga Facility). Reportedly, only a few fuel elements for the organic moderated reactor (OMR) were fabricated at the Canoga Facility.

The 2006 Site Description indicates that AEC-processes at VanOwen occurred in the machine shop (including beryllium machining), a radiochemical laboratory, and office space. In addition, the 2006 Site Description indicates wastewater from all facilities except the laboratory was discharged into a common treatment plant; wastewater from the radiochemical laboratory went to a clarifier where it was tested to ensure safe release to the sanity sewer); and sludge from the clarifier was disposed off-site at a licensed low-level facility.

18.2.1 L-47 Reactor

In 1996, ORAU reviewed 59 terminated research and test reactor license docket files and concluded that License R-19 provided insufficient decommissioning and disposition information about the L-47 reactor licensed to Atomics International for operations at Canoga Facility between 1957-58.[1] [2] Upon ORAU's visit to the Canoga Facility, the L-47 reactor could not be located. No information on its disposition, or that of its fuel, could be located.[3]

According to the NRC, in December 1956 and January 1957 Atomics International submitted three applications to the AEC to construct, manufacture, possess, and use a 5-watt nuclear research reactor; the Model L-47 intended for demonstration, experimentation and sales purposes. Construction Permit No. CPRR-14 was issued August 2, 1957 (the license for the reactor erroneously stated that the Permit was issued July 2, 1957), to North American Aviation for construction of the 5-watt (thermal) utilization facility; a "homogenous solution-type reactor utilizing highly enriched uranyl sulfate as fuel in distilled light water."

Records indicate the recommended amount of fuel to be purchased for the L-47 was 2,000 grams of fully-enriched uranium-235 (U-235) in the form of uranyl sulfate. The amount of fuel actually purchased was not clearly identified. The L-47 was installed in the Reactor Room at VanOwen and began operating August 29, 1957. It operated for 73 watt-hours in 1957. Operations data was not located for 1958. License R-19 was terminated by the AEC June 30, 1958.

The L-47 was considered by some to be a "poor man's reactor;" the original name of the reactor was the "Penny Ante." It was quickly replaced by the more powerful 10-watt Model L-77.[4]

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[1] AEC License R-19 authorizing operation of the L-47. August, 1957. File: Vanowen_AEC_1957-08-05.pdf

[2] AEC Docket No. 50-50 License R-19 Termination Request. June 30, 1958. File: Vanowen_AEC_1958-06-30.pdf

[3] Nuclear Regulatory Commission memorandum to Michael F. Weber, Chief, Low-Level Waste and Decommissioning Projects Branch Division of Waste Management re: Rockwell International Site Visit. January 29, 1996.
File: Vanowen_NRC_1996-01-29.pdf

[4] AEC License R-40 authorizing operation of the L-77. May, 1958. File: Vanowen_AEC1958-05-17.pdf

18.2.2 L-77 Reactor

The L-77 Reactor license to operate at Canoga Facility was amended to allow for operations at DeSoto Facility, issued June 28, 1960.[1] To date, CORE Advocacy has not located any information on L-77 operations at the Canoga / VanOwen Facility prior to its transition to the DeSoto Facility.

18.2.3 Canoga Facility - Incidents After 1960

- A May 19, 1967 Atomics International internal memo references commendations for several employees involved in a uranium fire at the Canoga Facility on May 17, 1967.[2]

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[1] AEC License Amendment, L-77 Operations to DeSoto Facility. June, 1960. File: Vanowen_AEC_1960-06-28.pdf

[2] Atomics International Internal Memo, *"Commendation Re: Uranium Fire, Canoga Facility, May 17, ,1967"* May 19, 1967. File: 810_Uranium_Fire_Canoga.jpg.pdf

18.3 DeSoto Facility

The 2006 Site Profile contains insufficient and incomplete information about operations, processes, and incidents at the DeSoto Facility that is likely to compromise the dose reconstruction process. It should be noted that currently, the SSFL Site Profile lacks historical sources associated with DeSoto operations.

Currently, CORE Advocacy's review of DeSoto Facility operations is ongoing. Some newly obtained information is provided, below. CORE Advocacy anticipates a submission to NIOSH-ABRWH pertaining to DeSoto Facility, exclusively. It should be noted that several reports contained in the Incident Database (some of which are referenced below) document insufficient sampling and worker monitoring practices well after the expiration of the 1964 SEC. This may support a need to expand the current SEC into subsequent years.

The 2006 Site Description indicates that radiological operations occurred at the DeSoto Facility between 1959 to the mid-1980's; Atomics International used nuclear fuel material and other radioactive materials in Buildings 101 and 104 between 1959-1983. In addition, the 2006 Site Description states a reduced level of work was continued by Rocketdyne (Building 104) into the mid-1990's.

However, given SSFL's site remediation activities and NASA operations in Area IV during this time period, for which DeSoto played a supportive role (and vice versa), newly obtained information should be carefully reviewed to verify the accuracy of the 1983 end-date for nuclear operations, and the reduction of Rocketdyne work into the 1990's at DeSoto.

Before 1984, Buildings 101 and 104 were designated as 001 and 004. Much of the historical documentation available refers to these building numbers.

18.3.1 L-77 Nuclear Reactor (NRC Licensed)

The 2006 Site Profile describes the L-77 as a small, low-power (10 W) research reactor that was operated in Room 416-61 of Building 104/004 from 1960-1976; it used enriched uranyl sulfate solution. The L-77 is described as a prototype teaching reactor sold to many universities and around the world. Reportedly, the laboratory housing the L-77 was decommissioned and decontaminated in the late 1970's, and the NRC released the facility for unrestricted use and terminated the reactor's license in February of 1982. The 2006 Site Description provides no sourced historical documentation of facility operations, or incident reports associated with the L-77.

18.3.2 Advanced Test Reactor (ATR) Fuel Fabrication and Supportive Activities

The 2006 Site Profile indicates that the NRC-licensed fuel fabrication operations were conducted in the northern section of the first floor of Building 101, with radiochemistry support operations conducted on the first and second floors of Building 104. These support activities included hot chemistry laboratories (east section of second floor), an emission spectroscopy laboratory (Room 411-72, first floor), and an X-ray diffraction laboratory (Room 411-58, first floor). The fuel fabrication facility reportedly produced a variety of different fuel elements for test reactors. Many fuel manufacturing programs began in 1959 using 2% to 93% enriched uranium metal and composites. Some of the work involved developing uranium-aluminum allows and, because of the uranium, occurred in sealed glove boxes. One of the larger programs was fuel manufacture for the ATR using uranium-aluminum (UAIx) powder with an enrichment of 93% (an incident involving UAIx is described in the Log Book entry summary, below). Fuel manufacturing ended in 1983, according to the 2006 Site Profile. In addition, the AEC-sponsored work involving the manufacture of beryllium-containing parts took place at DeSoto Facility.

Reportedly, D&D of Buildings 101 and 104 included removal of all fuel and radioactive materials and waste; removal of contaminated equipment, drain lines, tanks and ventilation ducts, and cleaning of all surfaces including floors, walls, and ceilings. The preceding two paragraphs is the only information about ATR operations and fuel fabrication / supportive activities provided in the 2006 Site Profile. The 2006 Site Description provides no sourced historical documentation of facility operations, or incident reports associated with the ATR.

18.3.3 Gamma Irradiation Facility (GIF)

The 2006 Site Description indicates that the GIF was a state-licensed above-ground vault in Building 104 that used sealed Cs-137 and Co-60 sources for radiation hardening tests of electronic components and for food irradiation research. The GIF consisted of Rooms 41M-11 and 41-M11A on the northeast corner of Building 104. Activity is reported to have ceased in the late 1980’s and the sources were apparently shipped off the site for recycling in the early 1990’s. Bi-annual leak checks of these sources detected no leaks. In 1995, a Rocketdyne survey of the GIF reportedly verified that it was not contaminated. However, the 2006 Site Description provides no sourced historical documentation of facility operations, or incident reports associated with this operation.

18.3.4 Mass Spectroscopy Laboratory (Helium Laboratory)

The 2006 Site Description indicates that up until 1995, Rocketdyne used the state-licensed Mass Spectroscopy Laboratory to analyze miniature radioactive specimens of neutron-irradiated nonfissile metals from DOE and international reactors for helium content. The Mass Spectroscopy Laboratory consisted of Rooms 414-69, 416-72, 414-75, 416-76, 416-76A, 414-77, 418-80, 416-80A, and 414-81, in the northeast section of the 1st floor of Building 104. The 2006 Site Description does not provide a detailed description of operations or processes associated with these locations, or any incident reports associated with the operations of the Mass Spectroscopy Laboratory / Helium Laboratory.

According to the 2006 Site Description, operations at this location generated very small quantities of radioactive, hazardous and mixed waste, including radioactive solvents, solvent wipes, and acids shipped from other U.S. and international research organizations. In 1995, the equipment was shipped to Pacific Northwest National Laboratory in Richland, Washington, where it continues to be used.

The 2006 Site Description indicates that fuel fabrication was terminated in 1984, but small-scale laboratory research work on gamma irradiation and analysis of radioactive samples continued until 1995. Remedial activities occurred at various times in the 1980’s followed by NRC license termination. In the mid-1998, all remaining equipment, interior walls, and drain lines were removed. The facility was reportedly decontaminated; residual contamination was reported to be “low-level and confined to the laboratory. No elevated radiation levels or contamination outside the laboratory were detected before or during D&D.”

The 2006 Site Description indicates that no contaminated water held in tanks was ever above the MPC, but this assertion is contradicted in the log book, which documents water sampling practices and radiation readings, prior to release into the municipal sewer system.[1]

18.3.5 DeSoto Facility, Select Log Book Entries - Various Locations

A DeSoto Facility Log Book (October 28, 1964-November 19, 1965) chronicles several incidents that could have resulted in a release to the environment and worker exposure. In addition, sampling of the contaminated water holdup tanks and releases to the municipal sewer system are documented. Below is a summary table of select Log Book entries from the first 50 pages of the document (which exceeds 300 pages). The document is provided in its entirety on the disk accompanying the 2016 SSFL Site Description. A partial list of additional incidents involving the DeSoto Facility is provided, at the conclusion of the table summary below.

18.3.6 DeSoto Log Book Entry Summary (Select Entries - First 50 Pages)

Date	Location	Isotopes	Entry Summary
10/29/1964	119-336	unknown	[REDACTED] reported to H.P. with some grey dust on his hands which had fallen out of elephant trunk in Room 119-336. Smears of the dust indicated >1600 dpm/10c most of the dust off with alcohol and kimwipes and then washed hands in the change room using soap and scrub brush. 2nd spears indicated no detectable contamination alpha, beta or gamma. Meter check also indicated no detectable radiation. He was released.
10/29/1964	11D-08D	unknown	Smears of the vac pump in 11D-08 indicated internal contamination ~600 dpm/100cm^2 beta-gamma. The log book entry indicates no alpha contamination was detected.
10/29/1964	11D-08D	Cs-137	Smears on floor 11D-08D indicated general (beta-gamma only) contamination from 150 dpm / 100 cm made temporary shoe-covered area until maintenance can scrub and wax.
10/29/1964	11D-08D	MFP	Smears on floor 11D-08D indicated general (beta-gamma only) contamination from 150 dpm / 100 cm made temporary shoe-covered area until maintenance can scrub and wax.
10/30/1964			… smears taken in the room indicated a maximum of 70 dpm alpha and 100 dpm beta gamma. Maintenance personnel were therefore not required to wear respirators. Smears of old motor indicated 102 dpm alpha and 210 dpm beta-gamma. The motor will be decontaminated in the filter bank room. Maintenance was unable to decontaminate the motor. It will be left in the room and decontaminated sometimes during the week.
11/2/1964			Smeared & monitored piece of SNAP-10 fuel rod (plastic bag container) ok, tagged it @ 150 mr/hr at surface.

[1] De Soto Facility, Atomics International Log-Book, Building 104. Document retrieved from publicly accessible historical archive, courtesy of the California Department of Toxic Substances Control (DTSC). File: HDMSp01640471.pdf

Date	Location	Isotopes	Entry Summary
11/3/1964			Checked 3 containers of Hallam elements for shipment to SS [Santa Susana] Materials Vault at SanSu [Santa Susana] (4064). Total activity = 2770 mr maximum surface intensity = 2.2 mR/h. At one meter from container surface = 0.6 mR/h. Checked cask being trans-shipped to San Su vault, contained less than 1 curie of irradiated stainless steel. 65 mr/h at cask surface & 5mr/h at one meter.
11/4/1964		BeO	Checked irradiated BeO to be machined in [REDACTED]'s lab. 25 mr/h @ surface, < .05 mr/hr at 1 meter.
11/4/1964	416-41	EU	Spill in Rm 416-41. Etching acid with enriched uranium spilled in hood and onto floor. No smears taken before because of obvious contamination. Floor scrubbed by D/766. Smears taken after scrub revealed no detectable contamination. Sampled and released FED II to city sewer system.
11/5/1964	119-41 (1114)		Received a call from Rm 119-41 that smoke was coming from the [illegible] ventilation ducts. HP called control center and responded with repirator. It was found that ventilation from F.B. 40 was off. HP requested that rooms 119-41 & 45 be evacuated. In checking the roof it was found that the main switch was on but the filter bank off. Maintenance was called. [Redacted] checked the emergency off switch in Room 119-42 and found someone had tripped it. F.B. to back in service at 09:30. Suggest a protective cover be placed over the switch. Control canter called out all clear.
11/5/1964	Bldg. 004	UC	Shut down bank at 21:45. Started back up 22:35. Finished filter change on filter bank #5 Building #004. Smears of the floor of the absolute side read 12 counts over background beta-gamma. Smears taken of the pre-filter floor read background for beta-gamma. Neither side showed any alpha count. The dirty filters were reading 0.70 mr at3 inches inside the filter bank and somewhat less outside the bank. The men were in the bank about an hour and half. While two men were helping from outside - which helped to speed up the change. The used filters were all tagged and wrapped in sheets of poly for protection against contamination. The start-up of the change was slowed down because of a shortage of useable filters. The men had to make several trips to the Nordhoff warehouse to pickup additional filters.
11/6/64			0900-1045. Control center put a call in for RA [illegible] on the traffic code, HP responded. It was found a R.A. liquid waste drum was leaking through the [illegible] hole. The spillage was controlled and liquid transferred to a new drum. Smears of the area were [illegible]. The liquid was from maintenance liquid waste. Firemen washed the area down with water. All clear at 10:45.
11/10/1984 [sic?]		U MFP	Checked recorder for [Redacted]. No contamination detected. Smears of MFP operation indicated contamination (22,431 dpm beta-gamma, 616 dpm alpha) limited to small ram block. Smear after draining indicated no detectable contamination. Checked can of normal Uranium for transfer to Bingham. No contamination. 4 mr @ surface. ~0.6 [illegible] sampled Fed I to [Redacted]. Smeared glove box 1242 (now 11H-42a) for SNAPTRAN; external background alpha, beta, gamma, internal indicated 150 dpm alpha / 1600 dpm beta-gamma.

Date	Location	Isotopes	Entry Summary
11/11/64	11H-37		Obtained several smears in room 11H-37 in preparation for outside contractor work. Only the panel around furnace is significantly contaminated. When guard screens are removed, piping thereunder may also be contaminated, but no smears could be taken at this time. [Redacted] has been informed of results.
11/12/1964	1030	U NaK	Fire - Room 1030. Apparently butyl alcohol in induction furnace system overheated, blew off tygon line and released = 7,000 of NAE into steel catch pan; 25 grams of normal uranium in furnace at time; no problem with it. Fire extinguished by fire department. Much smoke - plastic induction enclosure was damaged. Maintenance cleaned up after project personnel removed NaK butyl solution to safe place. No injuries.
11/12/64	115-13	Thorium	Smears of Room 115-13 indicate contamination to 300 dpm / 100 cm2 alpha. Contamination apparently resulted when thorium oxide was being sifted. The sieves did not fit tightly and airborne contamination caused the room to become contaminated. Lab was decontaminated by project personnel and subsequent smears revealed contamination reduced to acceptable limits.
11/14/64		EU	Monitored shipment to Montebello SPERT III rods 4-8% Enriched U. 2-3 mc . 616 [illegible] 5.0 mrem/h at surface of rods; .2 mr/h at external shipping container. Changed filter paper in constant air monitor in hallway of radiochemistry Building #4 because no air flow could be detected and unit seemed to be overheating. F/M reported louder than normal noise. After sample paper change, noise subsided. Filter Bank # 52 down at 12:10 hrs to change bearings. The timer to the #2 alpha [illegible] is not working. Bank 52 will not be back in service until some time Monday. Signs have been posted at the effected rooms. At the start of the bearing change I was told that only the bearing and the [illegible] will be worked on. At the end of the shift when I had not been notified of the bank being turned back on, I checked the bank. In addition to the motor and bearings they also had been working on the fan. Smears taken of the fan indicated 8 dpm alpha and 42 dpm beta-gamma indicating that any tools used could be contaminated and that some contamination has gotten past the absolute filters. Since no one was at maintenance, I didn't have any way to check their tools.
11/16/64	11H-37B 11H-22		Spill in SNAP Area 11H-37B not contaminated ran into brown room d/789. Mopes and buckets were contaminated (15 dpm alpha, no beta-gamma). Maintenance mopped up 11H-37B, will mop brown room. … Spill of radioactive waste in 11H-22 and aisle, 11H indicated 90 dpm beta-gamma 80 dpm alpha. Localized; maintenance will mop up.
11/16/1964		4.91% UC	Spill involving 100 grams of 4.91% vitro UC fuel stock in room 115-09 (1003). See report for details. [Report was not located].

Date	Location	Isotopes	Entry Summary
11/17/1964	11D-08D		H&S provided a R/A smear & meter DEP survey in Lab #11D08D. The survey was performed during and after the welding of R/A capsules. A meter survey revealed 110 mR/h beta/gamma at approx. 6" from the capsules. A smear survey revealed the following: Welding Tip - 16,240 dpm/100cm Clamp - 900 dpm/100 cm Welders Glove - 26,200 dpm/100 cm Welding gun 5,000 dpm / 100 cm Floor Area <30 dpm / 100cm Work Bench 200 dpm / 100 cm A smear survey of a glove box in Lab 11D-08D revealed the following: Outside Areas - 150 dpm/100cm the inside due to the hi-level contamination.
11/18/1964		U	Monitored and prepared 8 ea. birdcages for transfer to Santa Su. All birdcages speared <1 d/m 100/cm2 alpha and <30 d/m /100 cm2 beta-gamma. The maximum cm [sic] reading at the surface revealed .4mR/h gamma. The birdcages are definitely contaminated on inside. As per [Redacted] H&S was unable to check the contamination level insisde due to the cans being previously closed.
11/18/1964	11D-08D		A smear survey was conducted in the northern corner of Lab 11D-08D after removal of the glove box from the corner. The survey revealed a maximum of 200 dpm/100cm was notified.
11/18/1964			H&S advised and assisted in preparing the service grinder in Lab 11H & 428 for grinding a 6 mR/h sample. Sample will be ground on 11-19-64.
11/18/1964	Aisle 115		1700: Notified Captain [Redacted] of extreme dust raised by sand blasting Aisle 15. Eye & throat irritation apparent. Visibility under worst condition ~20 ft. Conversation between [Redacted - four employees] resulted in continued operation until 1900. Blasting is supposed to resume this weekend.
11/19/1964	11H-37B	Enriched U	H&S provided coverage in Lab 11H-37B during the period of time a piece of 93% Enriched "U" was being cut in half. Air samples were taken and revealed $434x10^{-11}$ a maximum of 6 mR/hr gamma at 2" and 100 dpm/100cm $100cm^2$ beta-gamma. A smear survey was taken of the area around the service grinder and revealed a maximum of 12 dpm/100cm 100 cm^2 beta-gamma.
11/19/1964	11H-428		A smear survey was conducted by H&S of misc. tools in Lab 11H-428 and revealed a maximum of 240 dpm/100 cm gamma. Advised operations to clean immediately.
11/29/1964			Routine radiation survey of areas designated "clean" where there is possibly some non-belonging radiation revealed 0.1 mR/h above bkg.
11/30/1964	11H-37		Smears taken of pit in 11H-37 and of plate covering pit indicated 400 dpm alpha; 500 dpm beta-gamma on top of side of plate (now facing down); bottom side of plate & walls of pit indicated contamination within limits for yellow tag area. Water sample from pit indicated 0 dpm alpha, beta, gamma/ cc of water.

Date	Location	Isotopes	Entry Summary
12/3/1964	119-33	Cs-137	Smears of Cs-137 hood in 119-33 indicated no contamination on floor in front of hood, but ~3,000 dpm beta-gamma on all inside surfaces (walls, floor, but not ceiling) of hood and ~3,000 dpm geta gamma on [ineligible] exterior.
12/3/1964	119-33	Cs-137	Smears of Cs-137 hood in 119-33 following alconox scrubbing reveal 100 to 200 dpm on floor of hood and outer lip. No other significant contamination on other surfaces.
12/5/1964	1059		At the request of [Redacted], next tenant of 1059, smears were taken of the walls. Results are as follows, left side, middle, right side: North Wall 12.3-102 / 16-68 / 8-48 East Wall [no reading indicated] / 36-102 / [no reading indicated] South Wall 82-224 / *3,345-11,934 / 4 *probably from cutting of R/A ducting
12/8/1964	Filter Bank #53 Room 1126		Filter Bank #53 down to change filters. What appeared to be coolant water was found in the bottom of the bank. Upon removal of the pre-filters, water marks could be seen from the exhaust trunk leading from room 1126. A visual inspection, smear, and meter survey of the exhaust outlet revealed that contaminated water had been confined to the wooden surface directly below the exhaust outlet. Smears taken indicated as follows: [Ranges provided for purposes of this document]: 0 to 2,000 dpm alpha / 0 to 2,400 dpm beta-gamma A visual inspection of the ducting in Room 1126 to determine the cause of the high smear results revealed what appeared to be water marks, indicating a leak in the ducting. This probably explains the reason for the north side and top of the bank being contaminated. It probably should be noted that the fan and ducting on the clean side of the absolute filters are now highly internally contaminated. Due to lack of true decontamination of the outside of the bank, could not be completed. To preclude a similar recurrence, a sign has been placed on the bank room switch prohibiting the use of the bank until the cause of the occurrence can be determined.
12/8/1964	1131 (119-45)		Vent filters in Room 1131 (119-45) were changed. FED II back in service @ 2300 hours. Smears taken indicated general contamination of aisle 119 to room 1131. Contamination was highest at the filter bank doors (250 dpm alpha) and progressively decreased to background at Room 1131 and at the north double doors. Smears taken inside the filter bank room indicated contamination of 2,000 dpm alpha on the floor and 1,000 dpm alpha on the bank itself. Due to the lack of sufficient time, neither a complete decontamination of the filter bank room or a complete smear survey of same could be performed. At the end of the 3rd shift, three decontaminations had succeeded in reducing the contamination levels to 40 dpm alpha at the bank doors, 10 dpm at Room 1139, and the guard post, and background at 1131 and the north end of the double doors. Maintenance is holding two men over to finish the decontamination of the area. The release of the area will have to be initiated on the first shift.
12/11/1964			Shoes of guard on 3rd shift working detox in Bldg HQ 001 SNAP & FED II area were found to be contaminated to 20 dpm alpha. Cleanings reduced this to < 1.0 dpm. He walked patrol without shoe covers. [Note: Guard involvement in detox procedures].

Date	Location	Isotopes	Entry Summary
12/19/1964	Room 426-07		At 1515 hours [Redacted] of D/734 entered room 426-07 and after being in the room approximately 3 minutes began to feel groggy. He recognized that the symptom was probably due to insufficient oxygen content in the room air, and at the same time heard hissing from a needle valve used to purge on of LASERS with nitrogen. He shut off the valve, exited from the room, and called the control center. After a telephone call to [Redacted], it was decided that [Redacted] should be taken to the West Valley Park Hospital as a precautionary examination. [Redacted] was released from the hospital at 1800 hours on 12/19/64. [Redacted] when questioned as to the probable cause of the valve being left opened states that [Redacted] had probably used the LASER last and could have left the valve open. He also stated that if this were the case, the valve had been open and filling the room with nitrogen for 20 hours.
12/21/1964	119-41		Routine check of respirators in 119-41 indicated general contamination in and out on 3 of 4 checked, of about 350 dpm alpha, beta, gamma. The fourth mask marked “*” indicated 600 dpm alpha, and 900 dpm beta-gamma on exterior; interior indicated same as others.
12/21/1964	11D-27D		[Redacted] D/766 got dust in his right eye from ductwork in 11D-27D. First check indicated 856 dpm alpha, no beta/gamma. After 1, 2 and 3 washings all indicated 40 dpm alpha. After 4th washing, 16 dpm alpha. After 5th washing indicated 4 dpm alpha.
1/5/1965	Loading Dock	Ir-192	Source - approx. 10 curies arrived dock & delivered to X-Ray w/out identification on the outside of the container. A letter will be written from Santa Susana. Informed [Redacted] of situation in 1159 i.e. 57 smears indicated general floor contamination to ~500 dpm beta gamma / 400 dpm alpha. Spot contamination to 4,500 dpm alpha; 7,000 dpm beta-gamma
1/14/65			Smears taken of the cars in the HQ-1 parking lot indicated from 0 to 127 dpm beta-gamma (no alpha was detected). Since [redacted]’s smears indicated just about the same levels, the panic button was not pushed at SS. [Redacted] suggested also that an air sampling be taken since [redacted] would probably want such results. A few minute sampling was taken but the results could not be calculated since the hurricane [illegible] in excess of the [illegible] of [illegible] at which it is calibrated.
2/2/1965			Smear from trousers of [redacted] revealed alpha contamination to 300 dpm/ 100 cm2 and 900 dpm / 100 cm2 beta-gamma. Company clothes were provided and an attempt is being made to decontaminate pants in question. Decontamination unsuccessful. Trousers were confiscated by H&S.
2/6/1965	Bldg. 001 119-33B	U-235	Called in by [Redacted] to give coverage to maintenance on the removal and replacement of a scrubber system in Room 119-33B Bldg. 001. The water in the bottom of the scrubber was checked with the 2650 and showed a reading of 50 mR/hr (beta gamma) at 6”. Smears were taken of the U-235 carbon oxide just inside of the scrubber itself, showing a reading of 11,000 dpm / cm^2 beta gamma. The working crew were instructed to wear gloves at all times along with respirators while cutting into the pipe to keep internal contamination to a minimum. Nasal smears and a complete survey was conducted of all men working in the area at the close of the working day. No contamination was found. Work on this will continue through tomorrow until completion.

Date	Location	Isotopes	Entry Summary
2/7/1965	Bldg. 001 119-33B	U-235	Instructed crew to decontaminate area under the new scrubber location. This area was reading 11,000 dpm cm checked out at about 530 dpm/cm which was considered a much better working level since all of the loose U-235 oxide had been removed.
2/7/1965	Bldg. 001 119-33B	U-235	The working crew has been carefully instructed on the use of gloves at all times and a survey of the working personnel is made often to keep the spread of contamination to a minimum. The changing of dirty shoe covers often has helped to keep contamination at a minimum. The removal of contaminated pipe and tools coming out of this area made it necessary that all items were thoroughly checked out because of the ease with which U-235 powder is picked up by anything placed on the floor. [Continued following page].
2/7/1965			[Continued from previous page]. For example, the used contaminated pipes taken from the duct work of the scrubbers had to be re-rapped [sic] in plyethylene sheets several times and kept from touching the floor before they could be removed from the area - with a clean area background reading for beta, gamma, as well as alpha. Cleaned up, and headed for home.
2/9/1965			Survey made of red flammable cabinet outside of reclamation area per [redacted] with following results: Outside 30 dpm / 100 cm < bkgd alpha. Inside 155 dpm / 100 cm2 beta gamma and 16 dpm/100cm alpha. This cabinet should have been decontaminated before removal from 11D-08.
2/12/1965	RMDU [sic] shed		Smears of elephant trunk ducting left outside RMDU shed indicated no detectable contamination on outside of bag; but ~2,700 dpm alpha and 4,383 dpm beta-gamma on ducting inside bag. Indicated 7.0 mR/h at contact of bag w/ gin [sic] 2651.
2/16/1965			Arrived on the scene a bright and cheerful HP man - only to find the office filled with humanity. … Lunch hour - Called by Control Center to check out an individual in the cafeteria dressed in Red-Line coveralls. Found said individual to be [Redacted] from Building #004 Room #413-53 (a clean area). He works for [redacted] D/734/431 Metallurgy & Mechanics. He seemed quite innocent of his sin, since he claimed he had only worked at HQ for five years and besides, he in an “Engineer” and was not cognizant of the basic health & safety instructions governing tagged areas. Rule #7 covers this infraction.

18.3.7 Partial List of Incidents / Notes of Operations Associated with DeSoto Facility

- On January 12, 1961 Health & Safety was notified of a radioactive spill of 3% enriched uranium carbide in Room 423-29. The Control Center was notified immediately. Upon further investigation, it was learned that a [Redacted] had been weighing approximately 4 grams of uranium carbide which was contained in a small plastic box when it suddenly ignited. Smoke enveloped the immediate area and a small portion of the burning sample spilled on [Redacted] lab coat. The lab coat was discarded and rolled up to smother the flame. The employee was taken to the Health & Safety Lab for a nasal smear, which indicated significant contamination. Further precautionary measures were deemed necessary by the monitor. The employee was taken to the Health & Safety Bioassay Lab for further evaluation. Smear survey of the area revealed approximately 500 d/m beta-gamma and 300 d/m alpha on the floor and surrounding tables. (Incident Report #A0550).[1]

- Transfer of Neutron Source: On August 21, 1963 a request was made by the SNAP Experimental Unit to continue the development of the neutron scatter gage in Room 426-73. The original trasnfer of the 7 Pu-Be neutron sources to the L-77 was approved by Criticality Safeguards in May, 1963. Approval was granted.[2] It was determined that the experiments would be performed at the L-77 (Bldg. 004), and that no more than three sources would be out of the shielded shipping container at any one time.[3]

- On December 13, 1966 an Air Sample Radioactivity Worksheet for DeSoto Facility, Room 1110-62 indicated the following readings: Alpha: Total Counts 271 per 5 Minutes - 54 c/m gross - 54 c/m net - 226 d/m - 6.3×10^{11} uc/cc. Beta-Gamma: Total Counts 498 per 5 Minutes - 99 c/m gross - 90 c/m net - 320 d/m - 8.0×10^{11} uc/cc. UC 20% fire ~ 6.0 Kg total. (Incident Report #A0309).[4]

- An Atomics International Safety Newsletter (1967) describes the apparent loss of airflow across two weighing hoods in Building 001 Room 110-62. Apparently, duct work was not connected to the facility exhaust system; it terminated after passing through the false ceiling. The condition was corrected by Plant Services.[5]

- An Atomics International Safety Newsletter (1967) describes smear surveys of Room 1110-62 that revealed “excessively high” (3.5×10^4 d/m-100 cm^2) contamination levels that required project personnel to spend a total of four shifts decontaminating the area to acceptable levels. According to the report, a contributing factor to these levels was the fact that the shaft seal on the ATR chipmunk glove box was installed backward, allowing “gross leakage from within the box to the room atmosphere.”

  Data from lapel air samplers worn by personnel operating the ATR chipmunk during periods of high airborne activity ranged as high as 1.0×10^{8} uCi/cc.[6]

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[1] Incident Database, provided by Boeing.

[2] Internal Letter, Atomics International. A.R. Moore / A.R. Yarrow, “*Transfer of Neutron Source,”* August 21, 1963. Document retrieved from publicly accessible historical document archive, courtesy California Department of Toxic Substances Control (DTSC). File: HDMSP001841089.pdf

[3] Internal Letter, Atomics International, *“Transfer of Neutron Source Approval,”* May 24, 1963. Document retrieved from the publicly accessible historical document archive, courtesy of the Department of Toxic Substances Control (DTSC). File HDMSP001841090.pdf

[4] Incident Database, provided by Boeing.

[5] Internal Letter, Atomics International. “*Radiation Safety Unit Weekly Newsletter for the Period Ending July 15, 1967”* M.E. Remley - R.E. Alexander. July 25, 1967 Document retrieved from the publicly accessible historical document archive, courtesy of the Department of Toxic Substances Control (DTSC). File HDMSp01641279.pdf

[6] Internal Letter, Atomics International. “*Radiation Safety Unit Weekly Newsletter for the Period Ending July 15, 1967”* M.E. Remley - R.E. Alexander. July 25, 1967 Document retrieved from the publicly accessible historical document archive, courtesy of California Department of Toxic Substances Control (DTSC). File HDMSp01641279.pdf

- An Atomics International Safety Newsletter (1967) describes unusual exposure readings observed on an L-77 location badge utilized during the year 1966. Investigation of personnel exposures for the period in question indicated normal exposures for those associated with the L-77 operations as well as for workers in adjoining labs. The cause of the location badge exposures was not identified.[1]

- On June 18, 1970 a depleted uranium fire occurred in Room 119-42, in an oven. The fire occurred during an attempt to “oven dry” 20 pounds of depleted uranium chips, which had been generated from a milling operations in room 11-H-28 on the same day.

  [Redacted] discovered the fire when he observed flames emanating from the top of the oven door. Upon discovering the fire, [Redacted] applied G1 powder to the two stainless steel trays containing the uranium. The oven temperature had been regulated for 500˚F but had not reached that temperature. Estimated temperature upon ignition was 350˚F. When the writer arrived at the facilities the fire had been extinguished by Protective Services. Floor smears taken throughout the room indicated maximum surface contamination levels of <50dm/100 cm^2 and <30 d/m / $100cm^2$ beta. Two air samples taken between 1330 and 1500 hours indicated maximum airborne concentrations of 1.6×10^{10} uCi/cc on immediate count. A 38-hour air sample collected over the balance of the weekend indicated airborne concentrations of 3.0×10^{11} uCi/cc. Personnel involved were asked to submit bioassay samples on the following Monday. Contamination was below permissible limits (A0636).[2]

  CORE Advocacy notes that this incident, among others contained in the Incident Database that are documented after 1964 (the end of the SEC period), indicates poor worker monitoring practices that may compromise the ability to conduct dose reconstruction.

  Given the nature of the incident involving contaminated smoke likely directed toward the ceiling and ventilation system, the floor should not have been the only surface sampled. In addition, workers should have been subjected to nasal smears, but there is no indication of such an evaluation. Bioassay samples should have been taken prior to workers leaving for the weekend, where several days passed before bioassay samples were collected.

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[1] Internal Letter, Atomics International. “*Radiation Safety Unit Weekly Newsletter for the Period Ending July 15, 1967*” M.E. Remley - R.E. Alexander. July 25, 1967 Document retrieved from the publicly accessible historical document archive, courtesy of California Department of Toxic Substances Control (DTSC). File HDMSp01641279.pdf

[2] Incident Database, provided by Boeing.

19.0 CONCLUSION

The 2006 Site Description is insufficient and inappropriate for use in dose reconstruction. It contains an incomplete list of DOE facilities, operations, processes, and incidents that resulted in environmental releases and worker exposures.

CORE Advocacy has identified approximately 51 facilities that were excluded from the 2006 Site Description. The majority of these omitted facilities were considered “radiological.” Approximately 381 radiological incidents were also excluded. The omission of these facilities and all corresponding data on processes, years of operations, releases, and incidents casts serious doubt upon the validity and integrity of SSFL environmental data currently used in TBDs 3-6.

Among the omitted facilities are a nuclear reactor (HMRFSR), a hot laboratory (Building 4009), an extra particle accelerator (Building 4009), and a low-level radioactive waste incinerator which operated for nearly 25 years before being dismantled and disposed as radioactive waste (Building 4664).

Also omitted are all references to a major nuclear incident that occurred in 1969 (S8DR, Building 4059). In addition, several processes and programs that involved complexes, installations and facilities of both radiological and non-radiological processes have been omitted.

The current 2006 Site Description has provided a dramatically diminished perception of DOE operations and processes at SSFL. Moreover, it has likely contributed to a systematically underestimated probability outcome for the majority of SSFL dose reconstructions. Consequently, coupled with challenges SSFL workers experience from the outset of the EEOICPA claims process, EEOICPA legislation continues to fail the employees of SSFL and its associated sites.

CORE Advocacy identified numerous designated “non-nuclear” facilities that, throughout the history of site operations, engaged in radioactive processes without a “radiological” designation. This brings into question whether or not the facilities were properly licensed or designed to safely handle or dispose of radioactive materials. More importantly, the “non-nuclear” workers assigned to these locations do not appear to have been adequately monitored for radiation exposure. There are growing indications that the need to monitor workers was determined solely on facility designation.

In 2014, Boeing acknowledged a “phenomenon” wherein approximately 8,400 “non-nuclear” SSFL workers have “blank” radiation records in their employment files.[1] Based on Boeing’s explanation, it appears non-nuclear employees were anticipated to, at some point, require radiation monitoring. It does not appear that worker designations or monitoring practices were consistent or in sync with the ever changing operations that are documented at SSFL. This issue alone makes a compelling case for an expanded SEC.

SSFL’s many complexities underscore the need for a comprehensive and robust site characterization. It is a privilege to submit the following document for your review and consideration for addition to the SSFL Site Profile.

Sincerely,

D’Lanie Blaze
CORE Advocacy for Nuclear & Aerospace Workers
COREAdvocacy.org

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[1] The Boeing Company, *“Commentary on the ABRWH Meeting, Redondo Beach, California,”* November 6, 2014.

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