FINAL
TECHNICAL MEMORANDUM
SUBAREA HSA-5A
HISTORICAL SITE ASSESSMENT
SANTA SUSANA FIELD LABORATORY SITE
AREA IV RADIOLOGICAL STUDY
VENTURA COUNTY, CALIFORNIA

Prepared for:

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LIST OF ACRONYMS AND ABBREVIATIONS

ACA	articulated control assembly
ACP	activated corrosion product
AEC	U.S. Atomic Energy Commission
AETR	Advanced Epithermal Thorium Reactor
ARRA	American Recovery and Reinvestment Act
Atomics International	Atomics International Division of North American Aviation, Inc.
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
CT	computed axial tomography
D&D	decontamination and decommissioning
DCGL	derived concentration guide limit
$DCGL_W$	derived concentration guide limit, wide area
DHS	Department of Health Services
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
DTSC	Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
EPIC	Environmental Photographic Interpretation Center
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
FCEL	Fast Critical Experiment Laboratory
FOIA	Freedom of Information Request
HEPA	high-efficiency particulate air
HGL	HydroGeoLogic, Inc.
HR	House Resolution
HSA	Historical Site Assessment
ICP	inductively-coupled plasma
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
MWd	megawatt days
NBZ	Northern Buffer Zone
NRC	Nuclear Regulatory Commission
NSA	nuclear safety analysis
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
PRG	preliminary remediation goal
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RHB	Radiological Health Branch
RMHF	Radioactive Material Handling Facility
S2DR	SNAP 2 Demonstration Reactor
S8DR	SNAP 8 Development Reactor
SBZ	Southern Buffer Zone
SETF	SNAP Environmental Test Facility
SGR	sodium graphite reactors
SHEA	Safety Health and Environmental Affairs
SNAP	Systems for Nuclear Auxiliary Power
SPTF	Sodium Pump Test Facility
SSFL	Santa Susana Field Laboratory
TM	technical memorandum
TO	task order
TRU	Transuranic
TRUMP-S	TRU Management by Pyropartitioning – Separation

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1.0 INTRODUCTION

This technical memorandum (TM) presents a summary of the identified environmental concerns associated with past radiological operations within a portion of Area IV at the Santa Susana Field Laboratory (SSFL) site located in eastern Ventura County, California (Figure 1.1). The SSFL site consists of four areas: Areas I, II, III, and IV; and two buffer zones: the Northern Buffer Zone (NBZ) and the Southern Buffer Zone (SBZ). The U.S. Environmental Protection Agency (EPA) is conducting a radiological characterization study of SSFL Area IV and the NBZ pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). EPA's study consists of a Radiological Historical Site Assessment (HSA), gamma scanning of accessible areas, geophysical surveys, soil and water testing. EPA's gamma scanning, geophysical, soil and water testing investigations are being developed and presented in separate work plans and data reports.

HydroGeoLogic, Inc. (HGL) has been tasked by EPA to conduct the radiological characterization study within SSFL Area IV/NBZ (hereafter called the "Area IV Study"). Figure 1.2 illustrates the location of Area IV and the NBZ. EPA has elected to subdivide the Area IV Study Area into subareas. Subarea boundaries are based on existing Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) areas for the SSFL site. EPA has further subdivided some RFI areas based on features such as roads, drainage pathways, building use, and number of buildings.

Table 1.1
Area IV Study Area
Subarea Designations

Area Designation	Number of Sites
HSA-3	1
HSA-5A	26
HSA-5B	46
HSA-5C	23
HSA-5D	21
HSA-6	38
HSA-7	18
HSA-8	8
BZ-NE	2
BZ-NW	2

The objective of the HSA component of the radiological study is to provide a comprehensive investigation that identifies, collects, organizes, and evaluates historical information relevant to nuclear research operations as it pertains to radiological contamination in the Area IV Study Area. Once these areas have been identified, potential areas where radiological contamination may exist at the site will be identified for sampling.

This work is being executed by HGL under EPA Contract EP-S7-05-05, Task Order (TO) 0038 under the technical direction and oversight of EPA Region 9. In accordance House Resolution (HR) 2764, the Department of Energy (DOE) is funding EPA's Area IV Study. DOE elected to fund EPA's study with funding allocated under the American Recovery and Reinvestment Act (ARRA) of 2009. On December 6, 2010, the DOE and the State of California Department of Toxic Substances Control (DTSC) signed an Administrative Order on Consent (AOC) for cleanup of the Area IV and the NBZ. Under this AOC, radiological contaminants will be cleaned up to background concentrations as defined by EPA's July 2011 radiological background study.

1.1 TECHNICAL MEMORANDA AND THE RADIOLOGICAL HISTORICAL SITE ASSESSMENT

This TM presents information relating solely to sites and buildings located within Subarea HSA-5A. This TM, along with the other TMs prepared for the subareas identified in Table 1.1. Each TM has been made available in draft for review and informal comment by SSFL stakeholders and the general public. EPA responded to each comment via draft "Response to Comment" tables, which were also made available to SSFL Stakeholders. Each draft was edited as described in the Response to Comment tables, and these edits along with any new information made available to EPA have been compiled into EPA's official Radiological HSA for the Area IV Study Area.

The content of each TM is based on guidance provided in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM, Revision 1, August 2000). MARSSIM is used as an investigative tool to gain an understanding of the nature and extent of radiological contamination left at a site. The TMs provide preliminary recommendations for MARSSIM classifications based solely on historical information, which may be incomplete. The preliminary classifications identified in the TMs will be used to guide the subsequent gamma scanning and multimedia sampling effort. Once more complete historical environmental data have been obtained, and the results of geophysical surveys, gamma radiation scanning surveys, field observations, and the results of soil sampling and laboratory analyses are available, the preliminary classifications presented in the TMs will be revised.

1.2 GOALS AND METHODOLOGY OF THIS TM

This TM is focused on radiological information within subarea HSA-5A and the drainage channels that lead to and from this area. The location of subarea HSA-5A is shown on Figure 1.3. Plate 1 presents a summary of the features related to potential radiological sources identified within the HSA-5A subarea. Detailed information pertaining to the use of radioactive materials and the potential release of radionuclides at sites and buildings within HSA-5A are provided in Sections 2 and 3 of this TM. Preliminary findings specific to HSA-5A are presented as follows:

- Descriptions and locations of potential, likely, or known activities that involved radioactive material, radioactive waste, or mixed waste;
- Initial MARSSIM classifications (e.g., Class 1, 2, 3) of potentially impacted areas;
- A site-by-site assessment of the likelihood or "weight of evidence" of radiologically contaminated media;
- An assessment of the likelihood of potential migration pathways; and,
- Identification of, confirmation of, and, if appropriate, addition or subtraction to, the list of the potential radiological contaminants of concern.

As specified in MARSSIM, a "site" is defined as any installation, facility, or discrete, physically separate parcel of land, or any building or structure or portion thereof, that is being considered for survey and investigation (MARSSIM, Revision 1, August, 2000). MARSSIM guidance defines all sites as either "non-impacted," or "impacted" by radiological operations. All of the sites at the Area IV Study Area are considered to have a reasonable potential for residual contamination, so none is classified as "non-impacted." Impacted areas of the Area IV Study Area are divided into one of three classifications.[1]

- *Class 1 Areas:* Areas that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiation investigations).
- *Class 2 Areas:* Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination.
- *Class 3 Areas:* Areas that have a low potential for radioactive contamination.

The information provided in this TM together with comments and recommendations provided by SSFL stakeholders and the general public will be used in the EPA's investigation strategy for sampling and analysis for residual radiological contamination in surface and subsurface soil within HSA-5A. In addition to the HSA, information gathered by EPA's Area IV and NBZ gamma scanning program and targeted geophysical investigation will assist EPA in fine-tuning the overall investigation strategy for the Area IV Study Area, and in making the final determination of the appropriate MARSSIM classifications.

1.3 BRIEF DESCRIPTION AND HISTORY OF SSFL AREA IV AND THE NBZ

The SSFL site occupies 2,850 acres of rocky terrain with approximately 700 feet of topographic relief near the crest of the Simi Hills. The Area IV Study Area comprises approximately 465 acres. Though some of the study area is relatively flat, some portions of the area exhibit steep relief and rugged terrain. The site elevation is between 1,880 feet and 2,150 feet above sea level. The overlying soils of the Area IV Study Area consist of weathered bedrock and alluvium that have been eroded primarily from the surrounding Chatsworth and Santa Susana formations. Several geological faults cross this area.

[1] *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 1*, NUREG-1575, Rev. 1, EPA 402-R-97-016, Rev. 1, DOE/EH-0624, Rev. 1, August 2000, pp. 2-5.

The climate in the vicinity of the SSFL site 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.

A shallow groundwater system exists in the surface soils at small isolated locations. A regional groundwater system exists in the deeper fractured Chatsworth Formation. In some areas, groundwater from the Chatsworth Formation flows through fractures in the rock and emerges at the ground surface as seeps or springs. Groundwater underlying the SSFL site is not currently used, or anticipated to be used, as a source of drinking water for the nearby communities or at SSFL, but nearby residents may in the future consume groundwater emanating from this site

In addition to rocket and small engine testing facilities in other portions of the SSFL, North American Aviation, Inc., had facilities at Area IV for researching, developing, and constructing equipment to use nuclear energy through its Atomics International (AI) Division.[2] According to a 1959 company brochure, AI maintained a nuclear field test area covering approximately 300 acres at the SSFL site.[3] Under contract to DOE and private customers, AI supported the development of civilian nuclear power, as well as the testing of non-nuclear components related to liquid metals within 90 acres of Area IV of the SSFL site. The facilities within these 90 acres would later be referred as the Energy Technology Engineering Center (ETEC).[4]

Nuclear facilities at ETEC included 10 nuclear research reactors over the period July 1956 through February 1980. These research reactors are listed in Table 1.2.

Table 1.2
Research Reactors Located at the Santa Susana Field Laboratory[5]

Reactor Acronym	Building No.	Facility Name	Power Level (kW)	Period of Operation	Power Generated (MWd)	Radioactivity at End of Operation (10^3 Ci)
KEWB	4073	Kinetics Experiment Water Boiler	1	7/1956 to 11/1966	1	6
L-85/AE-6	4093	L-85 Nuclear Experimentation Reactor	3	11/1956 to 2/1980	2	18
SRE	4143	Sodium Reactor Experiment	20,000	4/1957 to 2/1964	6,700	120,000
SER	4010	Systems for Nuclear Auxiliary Power (SNAP) Experimental Reactor Facility	50	9/1959 to 12/1960	13	300

[2] North American Aviation, Inc., *The North American Story,* December 1960, p. 7
[3] Atomics International, A Division of North American Aviation, Inc., *Atomics International,* December 1959, p. 5.
[4] http://www.etec.energy.gov/History/Area-IV-History.html
[5] 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 1.2 (continued)
Research Reactors Located at the Santa Susana Field Laboratory[6]

Reactor Acronym	Building No.	Facility Name	Power Level (kW)	Period of Operation	Power Generated (MWd)	Radioactivity at End of Operation (10^3 Ci)
S2DR	4024	SNAP Environmental Test Facility	65	4/1961 to 12/1962	13	390
STR	4028	Shield Test Irradiation Facility	50	12/1961 to 7/1964	1	300
S8ER	4010	S8ER Test Facility	600	5/1963 to 4/1965	215	3,600
STIR	4028	Shield Test Irradiation Facility	1,000	8/1964 to /1974	28	3,714
S10FS3	4024	SNAP Environmental Test Facility	37	1/1965 to 3/1966	16	6,000
S8DR	4059	SNAP Development Reactor Facility	619	5/1968 to 12/1969	182	220

Seven criticality test facilities (i.e., facilities housing operations involving masses of fissionable material capable of sustaining a nuclear chain reaction) were also located on Area IV.[7] These are listed in Table 1.3. Other nuclear facilities within Area IV included the Radioactive Materials Disposal Facility and the Hot Laboratory, as well as the Sodium Disposal Facility, or Area IV burn pit. Each of these facilities will be addressed as a site within the appropriate TM along with supporting buildings and open areas.

According to the DOE ETEC web site, most nuclear research related programs and operations ceased in 1988 and were replaced with decontamination and decommissioning operations.[8]

Table 1.3
Criticality Test Facilities at the Santa Susana Field Laboratory[9]

Facility Name	Building No.	Period of Operation	Notes
SNAP Critical Test	4373	1957 to 1963	First SNAP-2 criticality tests
Organic Moderated Reactor	4009	1958 to 1967	Basic tests of reactor concept
Sodium Graphite Reactor	4009	1958 to 1967	Basic tests of reactor concept
SNAP Critical Equipment	4012	1961 to 1971	Later SNAP criticality tests
Fast Critical Experiment	4100	1961 to 1972	Started as Advanced Epithermal Thorium Reactor (AETR)
SNAP Flight Systems	4019	1962	SNAP flight system criticality
SNAP Transient Test	4024	1967 to 1969	SNAP transient response tests

[6] 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.
[7] Atomics International, A Division of North American Aviation, Inc., *Atomics International*, December 1959
[8] http://www.etec.energy.gov/History/Area-IV-History.html
[9] 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. 25.

The NBZ is a 175-acre parcel of land that abuts the SSFL property (Figure 1.2). The NBZ is a naturally vegetated area containing drainage channels that transport surface water from the SSFL downslope to surrounding populated areas.[10] The NBZ was purchased by the Rocketdyne Division of Rockwell International (Rockwell) in 1998 from the adjoining Brandeis-Bardin Institute (now known as the American Jewish University) because an environmental contractor found that the NBZ contains radioactive and chemical contamination that had migrated from the SSFL.

With the exception of 452 acres owned by the U.S. Government in Area I and Area II, which is outside of the Area IV Study Area, the entire SSFL site, including the NBZ, is owned and operated by The Boeing Company.

1.4 BRIEF DESCRIPTION AND HISTORY OF HSA-5A

Subarea HSA-5A is approximately 38.4 acres of flat land that contained 37 buildings over the years. It includes B, G, and 11th through 17th Streets. Drainage is generally to the southeast. There are no ponds in this subarea. Radiological operations in the HSA-5A area related to the SNAP and SNAP 8 programs as well as to the Advanced Epithermal Thorium Reactor and the Fast Critical Experiment Laboratory.

1.5 SITES IN HSA-5A

During the peak of operations, Subarea RFI-5A comprised 27 sites, most of which were buildings. This technical memorandum addresses each of these 27 sites within Subarea HSA-5A. Of the 27 sites, 3 were reactor buildings and 14 housed operations possibly involving radioactive materials. Of the 27 sites in Subarea HSA-5A, only 2 buildings and a parking lot remain today.

1.6 SITE SUMMARY METHODOLOGY

In preparing this TM, the following types of documents were reviewed:

- radiological characterization reports;
- previous radiological surveys;
- decontamination and decommissioning (D&D) reports;
- environmental monitoring reports;
- license termination reports;
- aerial photographs dating back 50 years;
- building floor plans;
- piping diagrams and construction drawings;
- RFI reports;
- unusual occurrence reports;
- incident reports;

[10] Agency for Toxic Substances and Disease Registry, *Draft Preliminary Site Evaluation, Santa Susana Field Laboratory,* Atlanta, GA, December 3, 1999, pp. 2-5.

- plant operating reports and logs;
- safety analyses reports;
- facility surveillance and maintenance reports; and
- information obtained from interviews with former workers or other persons.

Numerous documents were obtained through information requests sent to Boeing, DOE, and other parties. EPA sent formal information requests to Boeing, DOE, the Nuclear Regulatory Commission (NRC) and the California Department of Public Health and Environment (CDPHE) under § 104(e) of the CERCLA. 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 site, including Area IV, as well as some offsite facilities. The information acquisition process is complete.

EPA sent Boeing its original information request letter on June 24, 2009. Boeing provided an initial response to this request on August 20, 2009, and a supplemental response on December 10, 2009. On June 8, 2010, Boeing provided relevant site drawings and maps as identified by EPA during a review of flat files at Boeing's Safety, Health, and Environmental Affairs (SHEA) building on site. Subsequently, on June 17, 2010, EPA sent Boeing a supplemental information request letter specifically requesting all maps, diagrams, and as-built drawings for past and current buildings in Area IV. On July 15, 2010, Boeing responded and provided additional documents, including maps and drawings. On November 15, 2010, Boeing provided a third supplementary group of documents. On December 23, 2010, and January 11, 2010, Boeing provided numerous additional documents in response to both EPA original information requests and EPA queries of Boeing's document database for the SSFL.

In October 2010, EPA also sent the National Aeronautics and Space Administration (NASA) a formal information request letter. On November 22 and December 2, 2010, EPA received information responsive to this request.

EPA sent DOE its original information request letter on June 24, 2009. DOE provided an initial response to this information request on August 31, 2009. Subsequently, DOE provided supplemental responses to this initial information request on a monthly basis. Additional information responsive to the EPA's information request was received in September, October, November, and December 2009, as well as January through December 2010 and January through July 2010. On June 17, 2010, EPA sent DOE a supplemental request for information, specifically requesting maps, diagrams, and as-built drawings for past and current buildings in Area IV. Starting in its July 2010 supplemental response to EPA, DOE provided information that was responsive to both the EPA information requests letters.

Other requests for information pertaining to the site have included § 104(e) information request letter sent to the NRC and CDPHE. The purpose of the inquiries to both the NRC and the CDPHE was to identify and obtain any nuclear materials licenses pertaining to the site that may not have been captured via the information requests sent to other parties.

In preparing the HSA-5A TM, 849 individual documents and photographs were reviewed. The review process was conducted by first screening over 80,000 documents amassed for the project. These screening efforts produced 692 documents relevant to past operations at facilities within

HSA-5A and were therefore determined to warrant in-depth evaluation. Each of these 692 relevant documents was thoroughly evaluated for information considered useful for assigning MARSSIM classifications. In addition to screening and evaluating reports and other documents, a comprehensive aerial photograph analysis of Area IV was prepared. This analysis is provided in Appendix A of the HSA.

1.6.1 Contents of EPA's Site-by-Site Analyses

The subject areas considered and addressed for each site discussed in Section 2 of this TM are presented below. For each subject area, the list of criteria evaluated and the associated parameters for the evaluation are described. The most complete available information was used to evaluate the site; no known information was omitted from the description. In the event that known information did not conform to one of the listed subject areas, it was included in the most logical place.

Site Description
A physical description of the site including, at a minimum, the following data elements: building numbers of all buildings within the site; date of construction of building(s); buildings in the vicinity not associated with the site; location of site relative to street(s); site plan(s); and floor plan(s) from as-built or plan drawings, if available.

Building Features
Information related to dimensions or size of building(s), below-ground structures, vaults, pipelines, sumps, condensation lines, sewers, drains, swales, and leach fields. If none of these features were identified, the text "no information was located" was inserted.

Former Use(s)
Details of past use(s) of the site, including dates of activities.

Information from Interviewee(s)
This category includes information about the site provided by interviewee(s). If no information has been obtained for a particular site, the text "none to date" was inserted. Individuals who have been interviewed include:

- Former SSFL Employees (e.g., health physicists, electricians, mechanics, construction inspectors, nuclear technicians, etc.)
- Survivors of Former Employees;
- Former Contractors (and one survivor of a former Contractor);
- Community Stakeholders;
- Residents in surrounding areas.

At the discretion of the Interviewee, each interview was conducted either by representatives of the EPA only, representatives of the DOE only or jointly by EPA and DOE representatives. EPA's primary objective of the interview program was to help direct the soil sampling crews to potential source areas of radiological contamination identified during the course of each interview. All information on potential source areas, corroborated or not, was recorded in EPA's HSA process.

At the time of writing this TM, the EPA had completed forty-nine (49) interviews. Under the DOE/EPA joint interview program, eighteen (18) interviews have been conducted. Approximately 107 former employees have requested to be interviewed by DOE only and those interviews are complete. An additional eighty five (85) people were referred to EPA and DOE by interviewees during the course of the interviews, and of these, only twenty (20) could be located, which resulted in four (4) additional interviews. DOE has provided all of their interview transcripts to EPA for use in EPA TMs.

The interview information obtained to date relevant to this TM is depicted on the relevant Plate 1 figure. Appendix B of the HSA provides a summary of the interview process and completed interview summaries of each interview.

Radiological Incident Reports
Reports on any documented incidents at the site with the potential for release of radioactivity into the environment. If no incident reports were found, the text "none found" was inserted.

Current Use
Current use of the site, or date of demolition of building/structure.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s)
Previous radiological investigations such as surveys, decontamination activities, and cleanup activities were evaluated. The evaluation of previous investigations and cleanups addressed, at a minimum, the following elements:

- agency conducting the investigation;
- purpose of the investigation;
- dates of the investigation;
- details of releases inside building, to air, to soil, and to surface water, as applicable;
- decontamination/cleanup activities; and
- final survey results.

Radiological Use Authorizations
Use authorizations have been defined as issuance of a license for radioactive material(s) from an appropriate regulatory agency. All known licenses issued for the site were included; if none were found, the text "none found" was inserted.

Former Radiological Burial or Disposal Locations
A description of known burials and/or disposals of radiological materials on the site, including applicable dates, if known. If no documented burials and/or disposals were identified, the text "none found" was inserted.

Aerial Photographs
The applicable photographic analyses from the report prepared by the EPA's Environmental Photographic Interpretation Center (EPIC) in March 2010 were included for each site. These analyses include photographs from the following dates:

- December 22, 1952;

- August 19, 1957;
- August 21, 1959;
- 1962/1963;
- March 1, 1965;
- August 13, 1967;
- April 20, 1972;
- May 16, 1978;
- October 21, 1980;
- August 21, 1983;
- October 10, 1988;
- June 19, 1995; and
- June 8, 2005.

Aerial photograph anomalies were interpreted as a trigger for assigning a higher scrutiny to a particular site than other information (such as historical documents) would indicate.

Radionuclides of Concern
Radionuclides used/generated at the site. This description includes, at a minimum, the types of radiological material(s) managed at the site; radionuclides known or suspected to have been handled or generated on the site; and how the identified radionuclides impact the list of radionuclides of concern in the background study. If no information was available, the text "none found" was inserted. It is important to note that not every radionuclide listed in this historical site assessment will have a sample analysis. The radionuclides are listed for completeness, indicating that they have been mentioned or discussed in a cited document or report. However, many of the facility and site reports reflect the conditions at the time, thus every mention of a specific radionuclide does not mean it would be present now, due to decay. For this reason, the Radionuclides of Concern sections described for each facility or site list those found in historical records. The Radionuclides of Concern (Table 3.3) lists radionuclides that will be analyzed and does not include those that would have decayed in the years since operations ceased.

Drainage Pathways
This category includes information on the direction of surface water flow on the site and the presence of sanitary drains, storm drains, septic systems, or leach fields on or near the site.

Radiological Contamination Potential
The potential for radiological contamination was evaluated for each site. Evaluations included consideration of the completeness of past cleanup and remedial operations. Many past clean-up efforts likely did not achieve the requirements of the DTSC/DOE AOC dated December 2010 that generally requires a cleanup to background levels for both radiological and chemical contaminants. Background studies for the site are nearing completion with EPA leading the radiological background study and the DTSC leading the chemical background study. The potential for radiological contamination is quantified in this TM by assigning a preliminary MARSSIM class describing the possibility for residual radiological contamination at the site based on all information collected to date. The basis for assigning the preliminary MARSSIM classification includes an examination of the following data elements:

- historical site operations;

- previous radiological investigations;
- reported incidents of releases;
- decontamination and remediation operations at the site;
- interviews with former workers;
- drainage pathways on or near the site;
- aerial photograph interpretation; and
- site reconnaissance.

Recommended Locations for Soil/Sediment Sampling

For each site, recommendations were made for possible targeted soil/sediment sampling locations. The selection of potential sampling locations was based on locations with the highest potential for radiological contamination as well as at the particular site based on all known information collected to date. The criteria evaluated for developing recommended soil/sediment sampling locations include the following:

- topography of the site;
- historical site operations;
- radiological investigations;
- reported incidents of releases;
- decontamination/cleanup operations at the site;
- interviews with former workers;
- storm drains on or near the site;
- sewer lines on or near the site;
- aerial photograph interpretation; and
- site reconnaissance.

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2.0 FINDINGS

This section organizes the building areas within HSA-5A according to five logical "clusters" (a.k.a. groups) based on operational characteristics and geographic locations. Plate 1 depicts the entire HSA-5A subarea and should be referenced while reading Section 2. Each HSA-5A group (discussed in Sections 2.1 through 2.5, below) is depicted in an accompanying group map, which serves as a guide for the text describing the building areas in that group and also as an index for the group's site photograph and building layout drawings.

2.1 GROUP 1

The Group 1 index map is presented in Figure 2.1. Following Figure 2.1, the site photograph and layout drawings for each building area within HSA-5A Group 1 are presented. HSA-5A Group 1 includes six buildings including Building 4024, the Systems for Auxiliary Nuclear Power (SNAP) Environmental Test Facility (SETF), Building 4023, the Liquid Metals Component Test Building, and Building 4027, the SNAP Engineering Development Laboratory.

2.1.1 Building 4023 Area

Site Description: The Building 4023 area comprises Building 4023 and the land surrounding the building located on 12th Street. The "old" portion of Building 4023 was constructed in 1962, and the "new" building section was constructed in 1976.[11] The facility was approximately 20 feet below the general grade of the adjacent 12th Street and was surrounded by an "A.C. Ditch" to the north and east of the building.[12,13] Figures 2.1.1a through 2.1.1d provide a current photograph and the best available building-specific drawing(s) that the research team could find. The 1969 site layout does not show a radioactive waste holdup tank; however, a plan view of the building from a 1993 final survey report shows a waste holdup tank to be located directly east of the building between the building exterior and the "A/C Ditch" (Figure 2.1.1c). Building 4023 was serviced by substation Building 4742; however, that building was located southwest of Building 4042, which was located on the other side of B Street. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4023 was a DOE-owned single story structure with galvanized steel walls and roof and a concrete slab floor. The sodium test loop was located in a small partitioned area in the western, or "old," portion of the building, constructed in 1962. This portion of the building has also been used for storage. The "new" building section, constructed in 1976, held an analytical chemistry laboratory and a storage set-up room.[14] A 250-gallon stainless steel waste holdup tank was installed at the facility in 1976 and was located in an exterior sub-grade open-top concrete vault (7.5 feet x 10 feet x 6 feet) at the east end of Building

[11] ORISE, *Verification Survey of Buildings 005, 023, and 064, Santa Susana Field Laboratory, Rockwell International, Ventura County, California*, 94/K-14, October 1994.
[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.
[14] ORISE, *Verification Survey of Buildings 005, 023, and 064, Santa Susana Field Laboratory, Rockwell International, Ventura County, California*, 94/K-14, October 1994.

4023.[15] Approximately 80 feet of 3-inch cast iron drain line and 40 feet of 2.5-inch galvanized pipe vent lines were included in the waste holdup system. The drain lines ran along the outside of the building to a double fixture fitting near the holdup tank vault. The drain line then ran underground approximately 6 feet, through the vault wall and into the tank. Portions of the drain line were covered by a concrete pad that was used to accommodate an air conditioning unit.[16,17]

Former Use(s): Building 4023 served as the Liquid Metals Component Test Building and the Corrosion Test Loop.[18] The first section of Building 4023, constructed in 1962 and known as 023, housed a small sodium loop to conduct studies of radioactive contamination transport. The second section, constructed in 1976 and known as 23A, served as a storage and setup room as well as an analytical chemistry laboratory.[19]

In 1976, a use authorization allowed the use of a small section of activated stainless steel Experimental Boilers Reactor fuel cladding in a small sodium test loop, located in the northwest corner of Building 4023, to gather data on transport characteristics of radiological contamination in sodium loops.[20,21,22] The sodium loop tests were halted in 1983 and the loop was dismantled in 1986.[23] At this point the connections to the tank were sealed and sinks were removed.[24]

In 1982, an Alnor Dew-Point Meter containing a 6.25 µCi Ra-226 source was brought to the facility to be disassembled, but the disassembly was never authorized or attempted and the instrument was removed intact in 1986. A 10 µCi Mn-54-sealed source, which was checked annually to ensure that no leaks had occurred, was stored in the building from 1983 to 1986.[25]

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. The west bay of the building was being used for the storage of powerjet hardware. Additional information regarding these operations in Building 4023 could not be located; however, available information indicates the project included the mechanical and structural design of 24 glove boxes, special manipulators and conveyor systems. This project also included the development of design criteria, definition

[15] Information could not be located to identify the waste disposal practices prior to the installation of the waste holdup tank in 1976. Additionally, a February 17, 1981, Rockwell International internal letter indicates the tank to have been 500 gallons.
[16] Rocketdyne, *Building 023 D&D Operations Final Report*, 023-AR-0002 Rev. A., March 7, 1996.
[17] Rockwell International, *Rocketdyne Division Environmental Monitoring and Facility Effluent Annual Report, De Soto and Santa Susana Field Laboratories Sites 1989*, RI/RD90-132, May 1990. p. II-14
[18] Little information has been located describing the liquid metals component test operations in Building 4023 or when these operations occurred.
[19] DOE, *Certification Docket for the Release of Building 023 at ETEC*, Docket No. DOE/CD-ETEC-023, February 1997.
[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.
[23] Rocketdyne, *Building 023 D&D Operations Final Report*, 023-AR-0002, September 21, 1993.
[24] DOE, *Certification Docket for the Release of Building 023 at ETEC*, Docket No. DOE/CD-ETEC-023, February 1997.
[25] Rocketdyne Report, *Building 023 D&D Operations Final Report*, 023-AR-0002 Rev. A., March 7, 1996.

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.[2627]

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, located in Subarea HSA-5D. Atomics 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 102A. The material used in this experiment was listed as including uranium, neptunium (Np-237), plutonium (Pu-239), and americium (Am-241). The process of transporting the material from Building 4020 to 4023 was identified as follows:[28,29]

> 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 in a similar manner to that described above.

While Building 4023 was owned by DOE, DOE agreed to use the building for this program. The 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.[30,3132] 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

[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.
[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.
[30] Rockwell International, *Safety Analysis for Building T020, Operations, TRUMP-S*, 190ER000011, December 4, 1989.
[31] Rockwell International, *Revised TRUMP-S Project Radioactive Materials Usage Application*, 190TI000001, October 31, 1989.
[32] Rockwell International, *TRUMP-S Test Program – Nuclear Materials Management Plan*, 190NMP000001, October 17, 1989.

"remaining radioactively contaminated systems in and around" Building 4023. These included a disconnected radioactively contaminated hood inside the building and the associated piping and radioactive liquid holdup tank. These surveillance and maintenance activities were to be continued until the facility was to be decommissioned in the Fiscal Year 1993. Activities planned for Fiscal Year 1993 included the decontamination and removal of the radioactive liquid hold-up tank and the associated piping located outside of Building 4023, as well as the removal and packaging of the radioactive fume hood that was reported to contain a contaminated sink. Activities were to include the packaging and disposal of the tank, piping, and sink as radioactive waste.[33] According to the certification docket for Building 4023, the radioactive liquid waste holdup system was removed in 1993.[34]

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 study did not indicate the quantity or nature of the radioactive solutions and containers that were transferred to the RMHF.[35] DOE formally released Building 4023 on April 21, 1997.[36] The State of California Department of Health Services (DHS) concurred with the release of Building 4023 on February 19, 1998. [37]

Information from Interviewees: A summary of the information provided from interviewees is presented below.

Interviewee 101 worked at the SSFL in the Atomics International Engineering Department as a manager of System and Test from 1986 through 1997. The following excerpts were pulled from the interview:

"I managed buildings 133, 005, 006 and 023, as well as some inactive buildings, and a total of perhaps 15 people. . .

Building 023 was used for research in a joint DOE / Japan project, lasting 8 years, dealing with chemical separation for fuel recovery."

Radiological Incident Reports: There have been two incidents associated with Building 4023 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 the incident reports are provided following the table, when available.

[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.

Building 4023 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0084	12/18/1980	R/A Sodium Loop	Activation 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.

* Activation corrosion products have been defined as typically comprising Co-60, Mn-54, Ni-59, Ni-63, and Fe-55).

- On December 3, 1980, after modifications to the Sodium Loop, personnel poured alcohol into the cold leg of the loop to neutralize the residual sodium in the leg. Personnel drained the alcohol and poured new alcohol in, let it set for six hours, and drained the alcohol. Approximately one quart of water was poured into the cold leg of the loop, and reacted with the sodium in the sample line that had not been neutralized by the alcohol. The water and a small amount of sodium surged out of the cold leg of the loop contaminating the ceiling, walls and floor with maximum contamination levels of 1,000 dpm/100 cm^2 of Mn-54 (A0084). The incident report does not provide information to indicate whether and how the contaminated areas were cleaned following the incident.[38]

- On April 22, 1981, there was a minor sodium (approximately 5 grams) leak and fire, with Cs-137, Mn-54, and Co-60 as the principal radioactive isotopes contained in the loop at the time. Compression clamps holding "Conoseal" on the top portions of the loop broke allowing approximately 5 grams of sodium to leak out. The loop was approximately 1,200 degrees Farenheit (^oF), resulting in a sodium fire. The fire was extinguished with calcium carbonate. Smears (also known as wipe samples) of the loop and the floor showed no radioactive contamination. The incident report did not provide any results of the wipe samples but indicated the lack of significant activity would likely have been the result of the source having been recently inserted in the loop (A0257).[39.40]

Current Use: Building 4023 was demolished in 1999.[41] The previous building site has been restored to a natural state, including reseeding with native grasses.[42] Based on available information, the dimensions of the excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- According to the final radiological survey completed in 1994, a comprehensive radiological survey of Building 4023 and its surrounding area was performed in 1988. The 1988 survey recommended remedial efforts be undertaken to remove residual

[38] Bradbury, S.M.,, Internal Letter Re: Radiological Safety Incident Report, Building 023, December 18, 1980.
[39] Bradbury, S.M., Internal Letter Re: Radiological Safety Incident Report, Building 023, April 28, 1981.
[40] 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
[41] DOE, NNSA Service Center, *Environmental Assessment for Cleanup and Closure of the Energy Technology and Engineering Center, Final*, March 2003.
[42] Cabrera Services, Inc., *Final Status Survey Report: Final Status Survey Post Historical Site Assessment Sites, Block 1*, March 2007.

radioactively-contaminated compounds from the building structure and grounds.[43]

- In September 1993, Rocketdyne completed a final report on the decontamination and decommissioning (D&D) operations at Building 4023. According to the report, D&D of the building occurred in three phases, starting in 1986 with the removal of the sodium loop and ending in 1993 following the removal of the radioactive liquid waste holdup system. The 1993 report provided a summary of the D&D activities in 1986 and 1990.[44]

    - In 1986, the sodium test loop was removed and two sinks were disconnected. The sink connections to the liquid waste holdup system were sealed and the sinks removed and dispositioned.

    - In 1990, the high-efficiency particulate air (HEPA) filtered gas exhaust system was removed. The fume hood was disconnected from the liquid waste holdup system and the HEPA exhaust system, and was relocated for storage within the facility. The ducting from the fume hood to the filter plenum was removed and disposed of as low level radioactive waste. The remaining components of the HEPA filtered gas exhaust system, filter plenum, blower and exhaust stack were removed and shipped to the University of Missouri for use on the TRUMP-S project.

  The 1993 D&D activities included the decontamination of the fume hood, removal and disposal of the liquid waste holdup system, including the drain and vent lines, the liquid waste storage tank, and the floor area where the sodium loop had been located. The removal of the liquid waste holdup system included the removal of a portion of the concrete pad of the air conditioning unit to gain access to the drain lines. Following removal of the drain and vent lines, which were cut into waste box lengths, the tank was removed and transported to the RMHF for size reduction.[45]

  During the final survey, fixed contamination of Cs-137 was found on the concrete floor in the old control room where the sodium loop had been installed at levels ranging from 1,289.63 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) to 20,551.21 dpm/100 cm^2 maximum beta. The area was decontaminated by "scabbling" of the concrete surface and vacuuming until no surface contamination above 1993 release limits were located. The 1993 surface contamination limits for beta and gamma emitters was <5,000 dpm/100 cm^2 average, <15,000 dpm/100 cm^2 maximum, and <1,000 dpm/100 cm^2 removable.[46,47,48, 49]

[43] Rocketdyne Report, *Final Radiological Survey Report of Building 023*, 023-ZR-0001, March 1, 1994.
[44] Rocketdyne, *Building 023 D&D Operations Final Report*, 023-AR-0002 Rev. A., March 7, 1996. p. 3-4
[45] Rocketdyne, *Building 023 D&D Operations Final Report*, 023-AR-0002 Rev. A., March 7, 1996. p. 4-5
[46] Rocketydyne, *Final Radiological Survey Report of Building 023*, 023-ZR001, March 1, 1994, p. 65
[47] Rocketdyne, *Building 023 D&D Operations Final Report*, 023-AR-0002 Rev. A., March 7, 1996. p. 5
[48] Rocketdyne, *Building 023 Final Survey Procedure*, 023-SP-0001, August 3, 1993, p.8
[49] According to various documents available on the Department of Energy website, scabbling is the process of removing nuclear surface contamination from concrete surfaces. Industrial methods used for removing contamination by this process include, but are not limited to, high pressure water jets, grit blasting, lasers, and explosives. The document referenced here does not provide detailed information of the process used during the final survey.

- According to an internal letter dated October 13, 1993, two soil samples were collected from soil beneath an underground pipe servicing the underground storage tank, both of which had been previously removed. The purpose of the sampling was to determine if the soil in the area had been impacted from materials transported through the pipe. According to the letter, the soils sample results were "non-detect for all of the constituents analyzed" without specifying what the detection levels were. Constituents analyzed included K-40, Tl-208, Pb-212, Pb-214, Bi-214, Ra-224, Ra-226, Ac-228, Th-227, Th-234, and U-235; however, the letter did not state the detection levels or why the above radiological constituents were analyzed for and did not include Cs-137.[50]

- In 1993, Rocketdyne conducted a final radiological survey to ensure compliance with 1993 acceptable contamination limits for activation products and mixed fission products and for ambient exposure rate. The survey, conducted only within the interior rooms of the building, had the following contamination limit criteria for alpha and beta contamination: average contamination of 5,000 dpm/100 cm^2; maximum contamination of 15,000 dpm/100 cm^2; and removable contamination of 1,000 dpm/100 cm^2. For gamma contamination, the contamination criteria limit was 4 milli roentgen per hour (mR/hr) above background at 1 meter interior and exterior.

  As indicated above in the summary of the September 1993 D&D operations final report, surface scans during final surveys of Building 4023 found elevated levels of Cs-137 on the concrete floor in the old control room requiring additional decontamination. This area was decontaminated and post-remedial action scans reported surface activity to be below the 1993 release limits. The observed detection limit ranges for removable alpha was 2 dpm/100 cm^2 to 9 dpm/100 cm^2. Total beta and removable beta were 252 to 373 dpm/100 cm^2 and 6 to 23 dpm/100 cm^2, respectively. The net ambient gamma exposure rate was measured at 0.49 mR/hr to 0.66 mR/hr. [51]

- In 1994, Oak Ridge Institute for Science and Education (ORISE) conducted a verification survey using surface scans to confirm that remedial actions had been effective in meeting 1994 guidelines. The survey teams, consisting of Environmental Survey and Site Assessment Program (ESSAP) personnel, performed visual inspections and independent measurements and sampling inside the building structure as well as exterior areas. Surface scans were performed using gas proportional, ZnS, GM, and/or NaI detectors coupled to ratemeters or ratemeter-scalers with audible indicators. No soil samples were taken because the entire area around Building 4023 was paved.[52] The report indicated that scans inside the Building 4023 Control Room identified elevated direct radiation with an activity level of 20,000 dpm/100 cm^2 in two areas within the Control Room that required additional investigation. Rocketdyne personnel decontaminated the two areas and ESSAP personnel performed additional scans following the decontamination, and the post-remedial activity was less than 1,400 dpm/100 cm^2. Additional scans of the building by ESSAP personnel showed the total surface activity was comparable to background levels. Final survey results for total surface activity levels inside Building 4023 were less than 66 to 400 dpm/100 cm^2 for alpha and less than 1,400 to 6,700 dpm/100 cm^2 for beta.

[50] Rockwell International, Internal Letter Re: Building 023 Soil Sample Results, October 13, 1993.
[51] Rocketdyne Report, *Final Radiological Survey Report of Building 023*, 023-ZR-0001, March 1, 1994.
[52] ORISE, *Verification Survey of Buildings 005, 023, and 064, Santa Susana Field Laboratory, Rockwell International, Ventura County, California*, 94/K-14, October 1994.

Final survey results for activity levels on exterior surfaces, including the holdup waste tank vault, were reported to have been less than 66 to 120 dpm/100 cm^2 for alpha and less than 1,500 to 1,600 dpm/100 cm^2 for beta.

As indicated above, the 1993 surface contamination limits for beta and gamma emitters was <5,000 dpm/100 cm^2 average, <15,000 dpm/100 cm^2 maximum, and <1,000 dpm/100 cm^2 removable.

- On February 19, 1998, the Radiological Health Branch (RHB) and DHS reported the results of a confirmatory survey of Building 4023 conducted on August 23, 1997. According to the report, a complete qualitative gamma scan of the facility and surrounding area was performed with selected measurements of total and removable beta surface activity and local gamma exposure rates also being conducted.[53] The survey began with background measurements in the north end of the building where no reported handling of radioactive materials occurred. The report provided three background measurements based on three different meter readings as depicted in the following table:

August 1997 RHB Building 4023 Background Measurements

Meter	Reading
Ludlum M-19 Rate meter (µR/hr)	8 µR/hr
Ludlum model 3 survey meter w/ 1x1 NaI probe	2,500 cpm
Ludlum model 3 survey meter w/ Ludlum 44-9 G-M pancake probe	40 cpm

The survey included a complete gamma scan of the floor inside the building and the lower two meters of the interior walls. The survey reported no indications of elevated gamma radiation fields within the building. Additional surveys included using a G-M pancake probe, sensitive to beta and gamma radiation and a NaI detector for gamma, to perform contact measurements at selected locations throughout the structure and the tank sump. The NaI detector for gamma showed a range of 1,600 cpm in the control room to 3,200 cpm at the tank sump. G-M pancake probe measurements ranged from 20 cpm on the west wall of the control room to 60 cpm in the center of the control room. The RHB also collected a soil sample from the bottom of the tank sump on the "south" side of the building. However, a graphic showing the sampling locations shows the sump to be located east of the building, outside of Room 106. This sample was sent to the Sanitation and Radiation Laboratory for analysis; however the results are not provided in the report. The possible contaminants identified in the report included Cs-137, Mn-54, and Co-60; however, a table included in the summary appears to show gamma readings in the tank sump to have included K-40 at 22.8 pCi/g, Cs-137 at 0.953 pCi-g, and Co-60 at 0.068 pCi/g. The summary indicated that the survey results were "all less than twice background for the structure and surrounding area." As a result, the report summarized that the survey results and laboratory analysis results confirmed the results of the final radiological survey in 1993 and the ORISE verification survey in 1994.[54]

[53] Wong, Gerard, DHS Radiologic Health Branch Letter Re: Boeing's Request for Concurrence in Release for Use Without Radiological Restriction, Rocketdyne Santa Susana Field Laboratory, Building T023, February 19, 1998.
[54] DHS/RHB, Letter, "Boeing's Request for Concurrence in Release for Use Without Radiological Restriction, Rocketdyne Santa Susana Field Laboratory Building T023," from Gerard Wong (DHS/RHB) to Phil Rutherford, February 19, 1998.

- According to the 1997 annual site environmental report, D&D activities in 1997 included the removal of asbestos-containing materials, which were disposed of as construction debris. The report did not indicate any radiological surveys during these D&D activities.[55,56]

- In March 2007, Cabrera Services, Inc., presented the findings of the Final Status Survey Report for Post-Historical Site Assessment (HSA) sites located within "Block 1," which included Building 4023. During this survey, samples were collected from 15 random-start systematic sample locations within each of two survey units at Building 4023, survey unit 10 and survey unit 11. Eighteen out of 5,562 gamma walkover survey measurements exceeded a z-score of 3 (<1%). The highest gamma walkover survey results in both survey units were investigated with biased surface soil samples. One subsurface sample was collected to investigate the former sump pit located east of the building. None of the samples reported radionuclide concentrations above their respective 2007 Derived Concentration Guideline Levels (DCGLs). The DCGLs established by Cabrera Services, Inc., were derived, radionuclide-specific activity concentrations within a survey unit corresponding to the release criterion and were based on the most "restrictive" standards between the Boeing DCGL and the 2006 EPA PRG 10^{-4} Risk Level, as indicated below.[57]

DCGLs for Radionuclides of Concern

Constituent	Residential Soil Concentration (pCi/g)	
	Boeing DCGL [1]	EPA PRG 10^{-4} Risk Level [2]
Americium-241	**5.44** [3]	187
Cobalt-60	**1.94**	4
Cesium-134	**3.33**	16
Cesium-137	9.2	**6**
Europium-152	4.5	**4**
Europium-154	**4.1**	5
Tritium	31,900	**228**
Manganese-54	**6.1**	69
Plutonium-238	**37.2**	297
Plutonium-239	**33.9**	259
Plutonium-240	**33.9**	-
Plutonium-241	**230**	40,600
Strontium-90	36	**23**
Thorium-228	**5**	15
Thorium-232	**5**	**5**
Uranium-234	**30**	401
Uranium-235	30	**20**
Uranium-238	**35**	74

[55] The Boeing Company, *Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1997*, A4CM-ZR-0012, November 23, 1998.
[56] Zenco Engineering, Inc., Letter Re: ETEC Demolition Package A, Building 4023, Not to Exceed Estimate for Asbestos Abeatement, May 21, 1999.
[57] Cabrera Services, Inc., *Final Status Survey Report: Final Status Survey Post Historical Site Assessment Sites, Block 1*, March 2007.

[1] Boeing, Approved Sitewide Release Criteria for Remediation of Radiological Facilities at the SSFL, 1998
[2] Source: Based on EPA preliminary remediation goals (PRGs) for residential soil at a 10^{-4} risk level. OSWER 9355.01-83A. "Distribution of OSWER Radionuclide Preliminary Remediation Goals (PRGs) Superfund Electronic Calculator." February 7, 2002. http://epa-prgs.ornl.gov/radionuclides. Data retrieved October 26, 2006.
[3] More restrictive standard for each constituent is bolded.

Radiological Use Authorizations: As indicated above, Use Authorization 105 was issued in November 1976 for Building 4023.[58] It 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.[59]

Former Radiological Burial or Disposal Locations: Building 4023 had its own radioactive liquid waste holdup system that included above- and below-grade drain lines and a below-grade storage tank located in an uncovered concrete vault east of the building. The system serviced two sinks and a fume hood where it was reported that small quantities of radioactive materials were handled. The water was reported to have had "trivial contamination." "All of the drain lines" ran along the exterior of the building to a "double fixture fitting near the holdup tank vault." The drain line then ran underground approximately 6 feet, through the vault wall and into the tank.[6061] Rocketdyne removed the liquid waste holdup tank and associated drain and vent lines in 1993 and transported the tank to the RMHF for size reduction. Information regarding the final disposal of the Building 4023 liquid waste holdup tank could not be located by the research team.[62]

Aerial Photographs: Beginning in 1962, the area comprising the future Building 4023 site is under development and the site contains medium-toned mounded material. By 1965, the building has been constructed and the area surrounding the building appears to be recently paved. There are limited observations at the building until May 1978 when two probable vertical tanks appear on the east side of the building, and a possible overhead pipeline connects Building 4023 to Building 4042. By 1980, the vertical tanks are no longer present on the west side of the building; however, a vertical tank is located north of the building along 12th Street and remains visible until 1995. There are also apparent aboveground pipelines on the north and west sides of the building; however, these pipelines could not be confirmed with historical documents. By June 2005 the building has been removed and the area is vegetated.

Radionuclides of Concern: Operations in Building 4023 resulted in the radiological contamination of the laboratory radioactive sink system, the liquid waste holdup tank, and old sodium loop control room. Possible radionuclides of concern identified in a 2007 Final Status Survey Report at Building 4023 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-

[58] HGL has not yet located the actual use authorization for this building.
[59] DOE, *Certification Docket for the Release of Building 023 at ETEC*, Docket No. DOE/CD-ETEC-023, February 1997.
[60] Tuttle, R.J., Rockwell International Internal Letter Re: Sources of Radioactively Contaminated Water at Santa Susana, February 17, 1981.
[61] Rocketdyne Report, 023-AR-0002, "Building 023 D&D Operations Final Report," September 21, 1993.
[62] Rocketdyne, *Building 023 D&D Operations Final Report*, 023-AR-0002 Rev. A., March 7, 1996. p. 4-5

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).[63,64,65] In the 2005 HSA, Sapere also indentified nickel-63 (Ni-63), iron-55 (Fe-55), and tantalum-182 (Ta-182).[66,67] All radionuclides of concern listed with the exception of Ta-182 are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Ta-182 has a half-life of less than 1 year and thus does not meet the criteria for analysis. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: The 1964 and 1994 plot plans of Building 4023 show an "A.C. ditch" on the northern and eastern side of the building, which is also depicted in aerial photographs.[68,69] The research team did not locate any documented information regarding the construction of this ditch, or the final grading of the ditch when Building 4023 was demolished; however, 1964 plot plans show the ditch to terminate at B Street at a catch basin and then flow into an 18-inch corrugated metal pipe. The corrugated metal pipe then directed flow to a drainage channel along the northeast side of 12th Street to G Street and ultimately southwest to the concrete spill apron at the intersections of 17th Street and G Street to "R-2A Pond." Additionally, a 2-inch drain appears to have directed flow from the southwest corner of the concrete slab to the north of the building to a catch basin located west Building 4023. This drainage then flows into a 12-inch corrugated metal pipe that directs flow south of the building to the same drainage channel along the northeast side of 12th Street to G Street.[70]

Radiological Contamination Potential: Class 1 because of the former use of Building 4023 and gaps in operational information regarding use of building for other non-DOE radiological purposes.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.1 provide a convenient reference for the following recommendations.

Based on the available information, soil sampling is recommended in the Building 4023 area. As discussed above, there were radiological incidents at Building 4023 and documented evidence of radiological releases. Significant information is lacking regarding the excavation activities at Building 4023.

In addition, previous characterization studies for the Building 4023 area were focused on delineating the extent of contamination to standards that were applicable at the time. Therefore, additional characterization is recommended for the Building 4023 area. This includes the following Building 4023 areas and appurtenances:

[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.
[68] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.
[69] ORISE Report, 94/K-14, "Verification Survey of Buildings 005, 023, and 064, Santa Susana Field Laboratory, Rockwell International, Ventura County, California," October 1994. p. 17
[70] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.

- Previous location of underground radioactive holding tank and the associated drain lines. The waste holdup system for Building 4023 included above- and below-grade drain lines and a below-grade storage tank located in an uncovered concrete vault east of the building. "All of the drain lines" ran along the exterior of the building to a "double fixture fitting near the holdup tank vault." The drain line then ran underground approximately 6 feet, through the vault wall and into the tank.[71] Sampling should be conducted along the underground drain line and at the previous location of the vault wall where the drain line entered the vault.

- Former location of "A/C Ditch" north and east of building, as well as the surrounding catch basins as depicted in Figure 2.1.1c. If radioactive materials were released from the handling of any material in the radioactive holding tank, which is located near the ditch, residual contamination above background values may exist.

- Location of unknown 2-inch drain line located at northwest corner of building. Information regarding a 2-inch drain line depicted in a 1964 plot plan of the building could not be located; however the line extends from the northwest corner of the building from the concrete apron to a catch basin located west of the building.

- In 1976, a 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.[72] The sodium loop tests were halted in 1983 and the loop was dismantled in 1986.[73] Sampling at the former sodium loop locations in the northern half of Building 4023 and the former connections to the tank is recommended.

2.1.2 Building 4024 Area

Site Description: The Building 4024 area comprises Building 4024, substation Building 4725, Cooling Tower 4928, and the land surrounding these buildings located on G Street.[74] Constructed in 1959, Building 4024 is a 13,972-square foot facility. Figures 2.1.2a through 2.1.2n provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4024, the SETF, is a 13,972-square foot facility consisting of a "main high-bay superstructure containing a sub grade reactor vault complex, with an open pit access area adjacent to the vault, and two prefabricated steel low-bay buildings attached to opposite sides of the superstructure to provide administrative and operational support areas." The main "superstructure" consisted of a rigid steel-frame building, with insulated metal siding and roofing and continuous concrete floorings. This portion of the building housed the shielded vault complex that included two reactor test cells and a transfer lock, the vault access area adjacent to the vault complex, and the high-bay area, which provided unobstructed access to the vault complex and access area. This complex is constructed of a special type of boron-

[71] Rocketdyne Report, 023-AR-0002, "Building 023 D&D Operations Final Report," September 21, 1993.
[72] DOE, *Certification Docket for the Release of Building 023 at ETEC*, Docket No. DOE/CD-ETEC-023, February 1997.
[73] Rocketdyne, *Building 023 D&D Operations Final Report*, 023-AR-0002, September 21, 1993.
[74] SSFL Area IV, ETEC Industrial Planning Maps, 1962-1992.

impregnated shielded concrete walls ranging from 2 feet to 9 feet thick, penetrated by various through-tubes, conduits and cooling pipes.[75,76,77,78]

The sub-grade test cell complex consists of the three parallel cells (two power test cells and a center transfer cell), a partial rear corridor that interconnects the cells, and the operating gallery. The remote handling operating gallery included a sump pit with pump. To ensure gas tightness, the cells were completely lined on the inside with 3/16-inch thick aluminum plate. This plate was seal welded to T-bar anchors in the structural concrete. The top of the cells' 8-foot thick roof is at ground level and serves as the high bay floor. The subsurface construction of the facility was designed to provide natural shielding for neutron and gamma radiation attenuation provided by the earth and rock on four sides of the complex. The side wall structural concrete is nominally 3 feet thick, the south wall concrete is 2 feet thick and the floor concrete varies from 6.5 to 8 feet thick as the rock elevation varies. The concrete walls separating the three cells are 4.5 feet thick. The front wall of the transfer cell is 4.5 feet thick while the front walls of the two test cells are 9 feet thick. A 3-foot thick concrete partial wall was built across the rear of each test cell, creating the common corridor. Nine floor storage vaults were constructed in the floor of the corridor, three at the rear of each cell.[79, 80] These vaults were used to store various pieces of contaminated equipment.[81]

The operating gallery is at two levels. The lower level is the same elevation as the cell floors, at 28 feet below ground surface. The upper level is formed by a bolted steel floor 14 feet above the lower floor. The west end is partitioned off by a concrete wall that extends from the lower floor to the high bay floor. Personnel access to the gallery floors and equipment rooms is provided by a single stairway. Material and equipment was moved to either floor of the operating gallery by a 5-ton bridge crane.[82]

The low-bay structure on the north side of the high-bay area consisted of the general administrative and operating areas, which included two "standard" prefabricated metal buildings attached to each other and the north wall of the high bay superstructure. One portion of this building, the test mock-up area, was used as a "cold" experimental area and shop area and an office area. The remainder of the building included a control room, a locker room and change room, and a "cold" mechanical equipment room. The low-bay structure on the south side of the

[75] 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.
[76] Atomics International, Document N704FDP990006 Rev. A., "Building T024 (SETF) Facilities Dismantling Plan," July 31, 1981.
[77] Johnson, T., "Action Memorandum for the Decommissioning of the System for Nuclear Auxiliary Power Environmental Test Facility, Building 4024, at the Energy Technology Engineering Center at Santa Susana Field Laboratory, California," May 1, 2007.
[78] Tomlinson, R.L., Atomics International NAA-SR-MEMO-5103, Experimental Shielding Evaluation of the SETF Using SDR-I and SNAP 10 as Radiation Sources, March 29, 1960.
[79] Areva NP, Inc., Survey Package C4024 101C1, SETF, Building 4024, SGTCC Test Cell B-102, April 20, 2007.
[80] Rockwell International, Document N704TI990044, "Radiological Survey Results – Release to Unrestricted Use, Building 024, SSFL," November 28, 1978.
[81] DOE, NNSA Service Center, *Environmental Assessment for Cleanup and Closure of the Energy Technology Engineering Center*, March 2003.
[82] Areva NP, Inc., Survey Package C4024 101C1, SETF, Building 4024, SGTCC Test Cell B-102, April 20, 2007.

high-bay area included service equipment for the facility and a vault complex that consisted of a filter and hot gas compressor room and mechanical and electrical equipment room.[83]

In 1962, modifications to the building included the construction of an additional control room adjacent to the existing control room, as well as the construction of a wall and ceiling to divide a section of the lower access area, forming a room opposite "Vault No. 2". The new room was used to contain vacuum pumps and other heavy equipment associated with one of the experimental reactor programs.[84]

Below-ground radioactive waste storage facilities are located under asphalt in the yard. The buried tanks include three radioactive gas holdup tanks 6 feet in diameter and 40 feet long, eight solid radioactive waste storage vaults 3 feet in diameter and 4 feet deep, and two 500-gallon liquid radioactive waste holdup tanks. These tanks were placed on top of a concrete box filled with gravel designed to contain any accidental leakage.[85,86]

According to facility drawings, the Cooling Tower 4928 included a sump.[87]

Former Use(s): Constructed in 1959, Building 4024 was used for testing SNAP reactors in a simulated operational environment. Power test vault no. 1 (the eastern cell) housed a SNAP-2 Demonstration Reactor (S2DR) that operated for 5,000 hours at 30 and 50 thermal kilowatts (kWt) between April 1961 and December 1962. This experimental program involved a test of the core without power-conversion-system equipment. According to an August 1994 description of the reactor, the S2DR was[88]:

> . . .the second reactor, designed and constructed to demonstrate the operability of a complete power plan system. Fabrication processes were refinements of the SER system. Hastelloy N tubing and end caps were introduced for cladding for better material properties than the 347 stainless steel and better workability than the Hastelloy B . . . The reactor core consisted of a hexagonal array of 37 fuel assemblies eight inches across flats and nine inches across corners surrounded by beryllium reflector shims. The primary coolant was changed from sodium to the eutectic sodium-potassium alloy, NaK-78 (22% sodium, 78% potassium) . . .

The reactor generated 13 MWd of power and contained $390x10^3$ 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 operation. A May 1991 facility report indicated there to have been "no problems of any consequence with the S2DR." Radioisotopes listed as having been used in the S2DR include Sr-90, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Co-60, Eu-152, Eu-154, Th-232, and H-3. Following completion of the S2DR program, the

[83] 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.
[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.
[85] Atomics International Document, N704FDP990006 Rev. A., "Building T024 (SETF) Facilities Dismantling Plan," July 31, 1981.
[86] Remley, M.E., Atomics International, Letter Re: Comments on Draft Reactor Safety Survey Report for Building 024, July 21, 1965.
[87] Ralph Mr. Parsons Company, Drawing 303-024-C1 *Vicinity Map, Site and Utilities Plan*, May 1, 1959.
[88] Lords, R.E., Westinghouse Idaho Nuclear Company, Inc., *SNAP and AI Fuel Summary Report*, Report WINCO-1222, August 1994.

reactor was removed from the building and was sent offsite for disposal.[89,90,91] Additional historical operational information regarding the operation of this reactor could not be located.

According to a 1962 document, power test vault no. 2 was scheduled to provide shielding and containment for the SNAP-10A Flight System (S10A-FS-1) in a vacuum chamber located within the test vault. The reactor system test was scheduled to begin in late 1962 and would be completed and removed some time in 1963.[92,93] The research team has not found any documentation indicating the S10A-FS-1 was tested at Building 4024; however an S10FS-3 reactor was tested in Building 4024.

The Prototype SNAP 10 Flight System (S10FS-3) reactor operated for 10,000 hours at about 40 kWt in the west cell between January 1965 and March 1966. The reactor operated in a simulated space environment on the ground, and set the record for the longest continuous operation of a nuclear reactor system with 10,000 uneventful hours of 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 in a shielded cask 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. According to the radiation engineering analysis, the task of removing the items would be carried out in the following sequence, but does not provide information to indicate the route that may have been followed during the transfer:[94,95]

- The Test Cell 2 shield plug in the Building 4024 high bay floor will be removed and the thru-roof handling system will be installed.
- The vacuum chamber sections will be removed from the test cell by the roof handling system.
- The thru-roof handling system will be removed following the removal of the vacuum chamber sections and a polar manipulator will be mounted in the shield plug opening.
- The plug will be shielded by shield blocks places over the opening on the high bay floor.
- The reactor reflector assembly will be removed and the core will be cut free from the converter section of the FS-3 system by using the polar manipulator and the General Mills manipulator in the test cell.
- The core will be moved to the transfer cell and inserted in the transport cask using the General Mills manipulator.

[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.
[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.

- The transfer cell shield plug in the high bay floor will be removed and the transport cask lid will be inserted in the cell and positioned on the cask utilizing the high bay overhead crane.
- The cask lid will be attached to the cask by installing 15 bolts by means of the General Mills manipulator.
- The cask will be removed from the transfer cell utilizing the high bay gantry crane and will be placed on a wheeled dolly mounted on a fork truck positioned just outside the high bay door.
- The fork truck will transport the cask to Building 4020, at which point the cask and dolly will be transferred to the Building 4020 electric fork truck.
- The fork truck will place the cask in Building 4020 Cell 4 utilizing the wheeled dolly as partial support for the cask.
- The bolts attaching the cask lid to the cask will be loosed and at that time the transfer will be complete.

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 for standby status.[96] A November 1976 document entitled "Dismantling and Removal of 10FS3 (SNAP) Vacuum Vessel from Building T024, Detailed Working Procedure" outlined the working procedures to be used to remove the vacuum vessel from the west cell of Building 4024. The document was in advance of a general radiological survey of the cells. According to the report, the vacuum vessel was slightly activated. While the document outlined the dismantling procedure, the document did not indicate the date of final removal.[97]

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. It was the last reactor to be tested in Building 4024.[98]

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, 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.[99,100] Additional historical information for the termination of each project could not be located.

[96] Wilson R.F., Atomics International Letter Re: Building 024 – FS-3 Vault and Transfer Cell Contamination Levels, July 14, 1966.
[97] Rockwell International Document, N704DWP990024, "Dismantling and Removal of 10FS3 (SNAP) Vacuum Vessel from Building T024, Detailed Working Procedure," November 16, 1976.
[98] Atomics International Document, N704FDP990006 Rev. A., "Building T024 (SETF) Facilities Dismantling Plan," July 31, 1981.
[99] Rocketdyne Environmental Affairs, *Building 4024 – SNAP Environmental Test Facility*, Undated.

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.[101] A document drafted on 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 comprising U-235. Following acceptance testing, the reflectors were replaced with the shipping sleeve and the system was placed in a shipping container for storage in Building 4019. It was determined that the system was to be removed from Building 4019 and transferred to Building 4024 for permanent storage some time in 1973. The reactor was to have been transported from the south end of Building 4019 to the east roll-up door of the high bay of Building 4024.[102] Procedures for the disassembly of the 10FS-5 system were to be reviewed by the Reactors Committee. The permission letter also reported that a nuclear safety analysis (NSA) should be prepared for handling the elements outside the reactor and should be reviewed by the Fuels Committee.[103] Information regarding the final transfer of the system to, and the removal of the system from, Building 4024 could not be located.

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.[104]

According to the 1976 plan, no significant radioactive contamination was ever detected in the radioactive liquid waste retention tanks. The 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. No other long-lived isotopes were reported to have been detected during reactor operations.[105]

Decontamination and disposition of Building 4024 began on August 27, 1977, and concluded some time before September 1, 1978. Within the vaults, all components such as rails, fixtures, surface-mounted conduits and all wires in through-tubes were removed between August 1977 and September 1978. The vacuum system, piping and tanks, and concrete seal door with an 18-

[100] Lords, R.E., Westinghouse Idaho Nuclear Company, Inc., *SNAP and AI Fuel Summary Report*, Report WINCO-1222, August 1994.
[101] Ketzlach, N., Internal Letter Re: New MBA for SNAP 10FS-5 Storage, January 30, 1973. HDMSP001840067.
[102] Heneveld, W.H., NSA-652-160-001 *Transfer of SNAP 10A FS-5 from Bldg 019 to Bldg 024*, December 13, 1972, HDMSP001856104.
[103] Ketzlach, N., Internal Letter Re: New MBA for SNAP 10FS-5 Storage, January 30, 1973. HDMSP001840067.
[104] Rockwell International Document, N704TP99009, "Radiological Survey Plan, Support of D&D Program Operations – T-024 (SNAP 2 and 10), December 9, 1976.
[105] Rockwell International Document, N704TP99009, "Radiological Survey Plan, Support of D&D Program Operations – T-024 (SNAP 2 and 10), December 9, 1976.

inch diameter gas exhaust pipe were removed. The liquid and gas waste holdup tanks and associated piping also were removed. Contaminated or activated components throughout the facility were packaged for offsite burial or decontaminated to meet applicable limits that are presented in the summary of the survey below. The locations of these materials are unknown. All areas of Building 4024 except the two power test vaults were determined by radiological survey by Rockwell International to be suitable for release for unrestricted use.[106,107]

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.[108] According to an undated long-range plan for decommissioning surplus facilities, the upper portion of the building was partially occupied. A remote handling refueling mockup of the CRBR Project was located in the high bay over the operating gallery area, and some surplus equipment was warehoused in the general support area. The remainder of the building was unoccupied. The facility support and operating equipment was intact with the exception that the filter elements in the cell ventilation system were removed and not replaced.[109]

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. The report also reported that sampling of ground water showed no radioactivity above background.[110] In January 1987, samples of water from the pipe chase room 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.[111] Weekly surveillance and maintenance activities were conducted in 1988 and 1989.[112] According to a 1989 factual perspective of the SSFL ETEC 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 that Rockwell would continue surveillance of the facility in the interim.[113]

According to Boeing's 1997 site environmental report for DOE operations, Building 4024 was used as a staging and decontamination area for the Hot Lab concrete blocks. A portable tent was set up with a portable HEPA ventilation system to provide negative pressure within the tent during block decontamination. Weekly monitoring measured airborne releases to the

[106] Rockwell International Document, N704TI990044, *Radiological Survey Results – Release to Unrestricted Use, Building 024, SSFL,* November 28, 1978.
[107] 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
[108] ETEC, *Site Consolidation Assessment*, April 16, 1987. p. 41.
[109] Rockwell International, N001T1000200, *Long-Range Plan for Decommissioning Surplus Facilities at the Santa Susana Field Laboratories*, Undated?
[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.
[112] Gaylord, G.G., *SFMP Weekly Reports*, 1988 through 1989.
[113] Rockwell International, N001ER000017, *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, December 20, 1989.

environment, which are summarized in the yearly site environmental reports. 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. During the course of the monitoring (through 1999), only the natural isotopes Po-210 were detected.[114,115] According to information obtained from Boeing and Authorization No. 112I, the period of staging and decontamination operations at Building 4024 was from 1997 through 1999.[116]

The above-grade structure of Building 4024 has been cleaned, surveyed, and designated as decommissioned materials. The above-grade structures and equipment associated with the general support/operating area and the mechanical/electrical support areas were removed in 2005, leaving the concrete foundations of those portions of the building.[117] According to the 2006 site environmental report, during 2005 and in early 2006, most of the demolished structure was transported to "Kettleman Hills" following certification as decommissioned material by the DHS. The 2006 site environmental report also reported the ventilation stack was removed and a geophysical study supporting the final building demolition of those portions of Building 4024 that were removed was completed. The 2006 site environmental report did not include a summary of the geophysical study.[118]

In 2007, Areva initiated characterization surveys of Building 4024 and began preparing for the demolition of the building and foundations. The results of these surveys are presented below. D&D activities were halted in May 2007 following the issuance of a DOE stop work order.[119]

Information from Interviewees: According to an interviewee (255) who worked for Atomics International from 1967 to 1985 as an atomic inspector and certified x-ray technician:[120]

> *Some tanks were removed from the outside of the Building 4024 years ago and I understand that the tanks were potentially holding radioactive gases at one time. The tanks were pulled out and everything around the tanks was removed. If it was contaminated it was hauled off. The tanks were located between Building 4024 and 4027, just outside and to the east of the Building 4024. The only reason I am aware of the Building 4024 tank is that at that time our department was headquartered at Building 4027 and they came in and took out the 4024 tank while we were nearby in 4027.*[121] *I didn't know what Building 4024 was used for originally, although I think it was for a reactor that went out into space. It's still up there. They may have built that reactor in*

[114] The Boeing Company, Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1997, A4CM-ZR-0012, November 23, 1998.
[115] Tuttle, R.J., Rockwell Internal Letter Re. Exemption from NESHAPs Approval to Construct for Operation of Portable Ventilators for T024 Decon Tent, January 14, 1997.
[116] Barnes, J.G., and Rutherford, P.D., Authorization No. 112I, January 14, 1997.
[117] Johnson, T., "Action Memorandum for the Decommissioning of the System for Nuclear Auxiliary Power Environmental Test Facility, Building 4024, at the Energy Technology Engineering Center at Santa Susana Field Laboratory, California," May 1, 2007.
[118] The Boeing Company, *Site Environmental Report for Calendar Year 2006 DOE Operations at The Boeing Company Rocketdyne Propulsion &* Power, September 2007.
[119] The Boeing Company, *Site Environmental Report for Calendar Year 2007 DOE Operations at The Boeing Company Rocketdyne Propulsion &* Power, September 2008.
[120] Approved DOE/EPA Interview 255, July 9, 2010.
[121] Initially, Interviewee 255 references "tanks" being removed from between Buildings 4024 and 4027; however, the interviewee then later only refers to one tank being removed. The interviewee also does not state whether the tank was an above-ground or below-ground tank.

> *Building 4024 or there was also another reactor that was built up, but never had fuel placed in it, so that reactor could have been in Building 4024 as well, I'm not sure. So, there was the possibility of radioactive material in the basement pit of Building 4024, but I was never down there.*

Radiological Incident Reports: There have been two documented incidents associated with Building 4024 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing. It includes incidents not related to radioactive materials. Summaries of the incident reports are provided following the table, when available.

Building 4024 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0535	3/6/1962	SETF High bay	Activation 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.

*Activation corrosion products have been defined as typically comprising Co-60, Mn-54, Ni-59, Ni-63, and Fe-55).

- 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 of his hands and his coveralls started to burn. The welder removed the coveralls and entered the shower. The Fire Department cleaned up the approximately ¼ 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).[122]

- On February 19, 1970, maintenance workers unknowingly worked on contaminated general mills (A0634).[123]

- 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).[124]

Current Use: Decontamination and decommissioning activities of the Building 4024 activated test vaults are not complete. In addition, a recent 2008 survey recommended the following activities for the interior of the building: completely remove the shield wall; remove up to an 8-inch depth of activated concrete from the west, north, and east walls; remove up to a 10-inch depth of activated concrete from the south wall; remove up to a 6-inch depth of activated

[122] Sessions, S.D., "Radiological Safety Incident Report A0533, SETF High Bay, Building 24," March 21, 1962.
[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.
[124] Liddy, Patricia, "Incident Report File A0686, Worker Concern Over Skin Rash," May 1, 1998.

concrete from the floor and ceiling surfaces. Additionally, the aluminum liner and concrete rubble material generated during decontamination should be packaged and shipped to the Nevada Test Site for disposal. The piping for the former contaminated gas and contaminated liquid waste UST systems, floor drain systems and connecting piping in Room B-101, and "scabbling" dust should also be packaged and shipped to the Nevada Test Site for disposal.[125]

Eight empty vaults, previously used for the storage of solid radioactive waste, remain below the paved yard surrounding the building. These vaults are 3 feet in diameter by 8.5 feet deep with a 4.5-foot thick shield block cover and are located on the east side of Building 4024 in the crane runway area. During the 2008 survey, the vault covers were removed from the storage vaults to conduct characterization and confirmatory surveys but were found to contain approximately 4 feet of water, believed to be from rain events and surface water infiltration. The water was left as found and the vault covers were replaced following sampling activities, which are summarized below.[126, 127]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as 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 varied 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.[128]

- 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 0.055 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.[129]

- 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

[125] Areva NP, Inc., Report of Radiological Characterization and Confirmatory Survey Results for the SNAP Environmental Test Facility – Building 4024, January 2008.
[126] Johnson, T., "Action Memorandum for the Decommissioning of the System for Nuclear Auxiliary Power Environmental Test Facility, Building 4024, at the Energy Technology Engineering Center at Santa Susana Field Laboratory, California," May 1, 2007.
[127] Areva NP, Inc., Report of Radiological Characterization and Confirmatory Survey Results for the SNAP Environmental Test Facility – Building 4024, January 2008.
[128] Owen, R.K. Atomics International Letter Re: Radiation Survey of SNAP 10FS-3 Reactor in Test Cell 2, Building 024, April 12, 1966.
[129] Owen, R.K., Atomics International Letter Re: Remote Radiation Survey of Transverse Corridor of Test Cell 2, Building 024, May 3, 1966.

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.[130] 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.[131]

- 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 research team did not find any additional information on the "storage hold lid" or its location, and, as a result, cannot, at this time, determine if this is in contact with groundwater.[132]

  The floor of test vault 2 was randomly smear checked following the removal of the vacuum vessel. The letter does not provide information to indicate how many smears were performed; however, the smears found no contamination above 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: [133, 134]

  - Low level waste tank water
    - alpha – 1.2×10^{-9} µCi/mL
    - beta – 1.7×10^{-8} µCi/mL

[130] Owen, R.K., Atomics International Letter, Re: Radiation Survey #2, SNAP 10FS-3 Reactor in Test Cell 2, Building 024, May 4, 1966.
[131] Wilson R.F., Atomics International Letter Re: Building 024 – FS-3 Vault and Transfer Cell Contamination Levels, July 14, 1966.
[132] Owen, R.K., Rockwell International, Re: Preliminary Survey Results – Building 024, February 11, 1977.
[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.

- Suspect tank water
  - alpha – 2.1 x 10^{-9} µCi/mL
  - beta – 1.4 x 10^{-8} µCi/mL

- Sump water
  - alpha – 8.8 x 10^{-10} µCi/mL
  - 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 project included the removal of radioactive waste storage vaults and tanks located below grade outside the building and removing contaminated components within the support and test cell complex, including test equipment, rails, fixtures, wiring in surface-mounted conduit, and wiring in the through-tubes. The vacuum system piping and tanks, as well as a concrete seal door, were also removed. The contaminated items removed were packaged and sent to an unidentified licensed, commercial burial site for disposal or were decontaminated to Rockwell International's "acceptable limits" for unrestricted use. The source document does not indicate how the items were decontaminated or where the decontamination took place.[135] The acceptable limits for residual radioactivity for surface contamination were reported 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.[136]

- 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 found, and no alpha activity was detected for all 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 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

[135] The summary document does not provide information to indicate how the items were decontaminated.
[136] Rockwell International Document N001T1000200, *Long-Range Plans for Decommissioning Surplus Facilities at the Santa Susana Field Laboratories*, Date Unknown.

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 picocuries per gram (pCi/g). The soil samples were counted on a Nuclear Chicago automatic counting system with a KCl 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 int eh operating gallery, the hot waste storage vaults, the 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 that all of the samples were below 2.2×10^{-7} µCi/ml, which is below the limit of 3×10^{-7} µCi/ml for Sr-90. Water that was found to be contaminated above this limit during decommissioning and disposal work was transferred to the RMHF for disposal. This report did not indicate the volume of water that was found to be contaminated above this limit during decommissioning and disposal work.[137, 138]

- According to the 2005 HSA and the report, "Long-Range Plan for Decommissioning Surplus Facilities at the Santa Susana Field Laboratories," a facilities dismantling plan provides data on additional sampling of Building 4024. 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 contains systems for gas and exhaust filtering, shield cooling water and a vacuum cleaner, all of which were potentially contaminated. As a

[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.

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 "Long-Range Plan for Decommissioning Surplus Facilities at the Santa Susana Field Laboratories," also identified the following activation products as contributing to contamination at Building 4024: Fe-55, Mn-54, and Eu-154.[139, 140]

- According to a December 1992 safety review report regarding tritium production and release at the SSFL, production of tritium by the operation of the S2DR, and later the S10FS3, occurred by the following ways[141]:
    - 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.
    - 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.
    - 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.
    - Neutron absorption by lithium-6 present as an impurity in NaK coolant – Tritium produced in this manner was negligible for both reactors.
    - 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

[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.
[141] Tuttle, R.J., Rockwell International Report RI/RD92-186, *Tritium Production and Release to Groundwater at SSFL*, December 1, 1992.

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.[142]

Surface Contamination Guidelines from DOE Order 5400.5 (1990) and NRC Regulatory Guide 1.86 (1974)

Allowable Total Residual Surface Contamination (dpm/100 cm^2)			
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	5,000α	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/h.			

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 cm^2 for alpha and ranged from less than 1,400 to 33,000 dpm/100 cm^2 for beta. Removable alpha measured less than 12 dpm/100 cm^2, and removable beta measured less than 16 dpm/100 cm^2. The maximum beta-gamma total surface activity guideline (15,000 dpm/100 cm^2) was 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.[143]

[142] ORISE Report, 96/C-5, "Verification Survey of Buildings T019 and T024, Santa Susana Field Laboratory, Rockwell International, Ventura County, California," February 1996.
[143] ORISE Report, 96/C-5, "Verification Survey of Buildings T019 and T024, Santa Susana Field Laboratory, Rockwell International, Ventura County, California," February 1996.

- An August 1996 Rockwell/Rocketdyne Area IV Radiological Characterization Survey provides results of over 10,000 stationary ambient gamma radiation measurements, walk-about surface gamma radiation scans and 149 scheduled soil samples. Building 4024 was included as one of the randomly selected sampling locations. Elevated soil activity was located in Sample ID 95-0105 located northeast of Building 4024 with Cs-137 measured at 0.37 pCi/g. Sample ID 95-0106 also contained Cs-137 at 0.34 pCi/g and was located west of Building 4024 in a dirt area. This is above the survey's local background average of 0.09 pCi/g and Area IV background average of 0.15 pCi/g, but within the average U.S. background range of 0.8 pCi/g and the U.S. Department of Energy, U.S. EPA, and U.S. Nuclear Regulatory Commission cleanup standards of 9.2 pCi/g, 9.0 pCi/g, and 9.0 pCi/g, respectively. The cleanup standards were based on uniform contamination and an annual dose limit of 15 millirem per year.[144]

- According to a 2003 site environmental report, as well as a January 2008 survey, additional concrete core data taken in 2003 indicate activation with a maximum of 9.3 pCi/g of Co-60 and a maximum of 105 pCi/g of Eu-152. Measurable activation exists only within the inner 16 inches of concrete of the two power test cells. According to the report, it would take 61.5 years for the 105 pCi/g of Eu-152 to decay to just below the derived concentration guide limit (DCGL) of 4.51 pCi/g. And the Co-60 would have decayed to 0.15% of its DCGL of 1.94 pCi/g.[145,146,147]

- A 2004 site environmental report indicated that during 2004, a survey procedure was prepared for releasing the upper portion of Building 4024. The upper portion of the building was found to be free from contamination. Soil samples were also taken in 2004 to support various site remediation activities. These included three samples from geological core sampling around Building 4024. The report indicated the samples did not have any detectable man-made gamma emitting radionuclides. The 2004 report did not provide any additional information on these field efforts.[148]

- On May 27, 2005, DHS confirmed that the portion of Building 4024 north of the high bay and the lead shield blocks are at 2005 background radiation levels and do not pose significant radiologic health risk.[149] On September 26, 2005, DHS confirmed the high bay, high bay vault, high bay mezzanine, HEPA filter room, electro-mechanical room, and associated plant equipment of Building 4024, plus the leaded glass window, are at 2005 background radiation levels and pose no significant radiologic health risk.[150] On

[144] Rocketdyne, A4CM-ZR-0011, Area IV Radiological Characterization Survey, Final Report, Volume I, August 15, 1996. pgs. 39, 108, 109.
[145] The Boeing Company, RS-00025, *Building 4024 Concrete Sampling*, December 15, 2004.
[146] The Boeing Company, RD04-170, *Site Environmental Report for Calendar Year 2003 DOE Operations at The Boeing Company Rocketdyne Propulsion & Power*, September 2004.
[147] Areva NP, Inc., Report of Radiological Characterization and Confirmatory Survey Results for the SNAP Environmental Test Facility – Building 4024, January 2008.
[148] The Boeing Company, RD05-176, *Site Environmental Report for Calendar Year 2004 DOE Operations at The Boeing Company Rocketdyne Propulsion &* Power, September 2005.
[149] Bailey, Edgar D., Response to 2005RC002061 Request to Perform Confirmatory Surveys of the Office Areas of Building 4024, Santa Susana Field Laboratory, May 27, 2005.
[150] Bailey, Edgar D., Response to 2005RC001000 Request to Perform Confirmatory Surveys of the Upper Portion of Building 4024, Santa Susana Field Laboratory, September 26, 2005.

June 13, 2007, DHS confirmed the stack, lead shot, and diesel generator at Building 4024 pose no significant radiological health risk and no further radiological control is necessary for those items.[151]

- In January 2008, Areva NP Inc., reported the results of a radiological characterization and confirmatory survey on Building 4024. The characterization and confirmatory surveys were completed to prepare for the decontamination of the two activated test cell vaults, the removal of contaminated liquid waste drain system piping, the removal of the facility floor drain system, and the demolition and removal of Building 4024. The findings of the report indicated there were no alpha, beta, and gamma radiation measurements outside of the activated test cells showing contamination above surface contamination limits. The limits are presented in the table entitled Surface Contamination Guidelines from DOE Order 5400.5 (1990) and NRC Regulatory Guide 1.86 (1974), above.

  Building 4024 measurements were generally within the range of background measurements, except for two locations where fixed alpha and beta activity was above background and minimum detectable concentration of 60 dpm/100 cm^2 alpha and 343 dpm/100 cm^2 beta. At the northeast corner, a survey measurement measured 360 dpm/100 cm^2 alpha and 684 dpm/100 cm^2 beta, while a southwest corner survey measurement measured 179 dpm/100 cm^2 alpha and 551 dpm/100 cm^2 beta. Sampling and isotopic analysis of the locations showed Th-232, U-234, U-235, and U-238 present and detectable, but at levels a fraction of the derived concentration guideline level of 1,000 dpm/100 cm^2 for Th-232 and 5,000 dpm/100 cm^2 for U-234, U-235, and U-238. Smear sampling did not indicate the presence of removable contamination.

  Based on the result of the characterization and confirmation surveys, it was concluded that the D&D activities planned for Building 4024 activated test cells should continue as planned but should incorporate the following:

  - Completely remove the shield wall;
  - Remove up to an 8-inch depth of activated concrete from the west, north, and east walls;
  - Remove up to a 10-inch depth of activated concrete from south wall; and
  - Remove up to a 6-inch depth of activated concrete from floor and ceiling surfaces.

  Additionally, the aluminum liner and concrete rubble material generated during decontamination should be packaged and shipped to the Nevada Test Site for disposal. The piping for the former contaminated gas and contaminated liquid waste UST systems, floor drain systems and connecting piping in Room B-101, and scabbling dust, should also be packaged and shipped to the Nevada Test Site for disposal.[152]

Radiological Use Authorizations: A review of a database documenting the use authorizations related to the SSFL, the research team identified two use authorizations relating to Building

[151] Butner, Gary W., Response to Request to Perform Confirmatory Surveys of Building 4024 Stack, Lead shot, and Facility Penetrations, Santa Susana Field Laboratory, June 13, 2007.
[152] Areva NP, Inc., Report of Radiological Characterization and Confirmatory Survey Results for the SNAP Environmental Test Facility – Building 4024, January 2008.

4020. 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 on August 5, 1971, and expired on September 5, 1971. As indicated 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.[153] 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. Atomics International indicated that the source would be placed 6 inches to 30 feet away from the sensor, and sensor readings would be taken. The application noted that there would be no contaminated materials since the sources are encapsulated.[154]

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 on 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.[155] 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 schedule for the duration of the 1992 annual authorization), and storage of empty radioactive materials containers.[156] By 1994, Authorization No. 112F included required environmental monitoring at Building 4024. This monitoring included quarterly radiation surveys and quarterly contamination survey.[157]

Authorization No. 112H, dated January 30, 1996, added the storage and survey of contaminated waste materials from Building 4020 decontamination and decommissioning operations. The requirements of these storage activities were that an inventory of Building 4020 materials stored in Building 4024 be maintained. No additional controls for these operations were identified in the authorization.[158] The 1997 authorization, Authorization No. 112I, added operations to include the decontamination of Building 4020 materials. These decontamination operations included the following controls:[159]

- Decontamination activities shall be conducted as described in Controlled Work Permits issued by Radiation Safety personnel.
- Decontamination shall be conducted in containment structures approved by Radiation Safety personnel.
- Decontamination activities shall be conducted under the surveillance of Radiation Safety personnel.

[153] Baumesh, L., and Heine, W., Authorization No. 46., August 5, 1971.
[154] Keshishian, V., Letter Re: Use Application for the Use of Cs-137 Source and a Pu-Be Neutron Source in Bldg. 24 in Santa Susana Facility, August 3, 1971.
[155] Tuttle, R., Authorization No. 112, January 16, 1978.
[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.

Additionally, while active decontamination work was occurring, personnel were to perform weekly routine surveys of radiation levels and contamination levels. During periods when decontamination activities did not occur, personnel were instructed to perform monthly surveys.[160]

On March 15, 1999, Authorization No. 112L further expands Building 4024 operations to include the storage of radioactive sources pending transfer to a third party recycling or disposal vendor. 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 laydown area." The authorization does not provide additional detail to describe what is meant by "L-85 laydown area."[161]

On April 7, 2008, a final authorization, Authorization No. 112U, was issued with no expiration date. The operation for Building 4024 in this authorization states "within the scope of any work restrictions imposed by the Department of Energy during 'safe shutdown' periods, preparation for, oversight of, or performance of decontamination, decommissioning, and razing of SSFL Building 24." The required facility monitoring includes monthly radiation surveys during decontamination and decommissioning activities (quarterly when no work is being performed). Other monitoring includes weekly contamination surveys, airborne sampling during decontamination and decommissioning in contaminated areas and effluent sampling when sump water is present. The authorization did not identify the location of the sump to be sampled.[162]

Former Radiological Burial or Disposal Locations: Below-ground radioactive waste storage facilities are located under asphalt in the yard surrounding Building 4024. The buried tanks include three radioactive gas holdup tanks 6 feet in diameter and 40 feet long, eight solid radioactive waste storage vaults 3 feet in diameter and 4 feet deep, and two 500-gallon liquid radioactive waste holdup tanks. These tanks were placed on top of a concrete box filled with gravel designed to contain any accidental leakage.[163] The eight empty vaults were last reported to still be present below the paved yard surrounding the building.[164]

Aerial Photographs: The development of the Building 4024 area is first visible in the 1959 aerial photograph with a large excavation occupying a majority of the area. The 1962 aerial photographs show a building foundation; however, the development in the area does not support that the building was constructed and operational in 1960. By 1965 the site has been fully developed and there is no evidence of construction activities. In 1967 and 1972, an open storage area is visible just west of Building 4024 with drainage trending west, southwest. The open storage area is no longer present in 1978 and the drainage channel has been replaced by an escarpment.[165] In 1980, the open storage area west of the building has returned and dark-toned material is visible at the southeast corner of the building. Additionally, the 1980 aerial photograph appears to show probable container leakage to the northeast on the east side of the

[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.
[162] Barnes, J.G., and Rutherford, P.D., Authorization No. 112U, April 7, 2008.
[163] 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 provided to HGL.)
[164] Johnson, T., "Action Memorandum for the Decommissioning of the System for Nuclear Auxiliary Power Environmental Test Facility, Building 4024, at the Energy Technology Engineering Center at Santa Susana Field Laboratory, California," May 1, 2007.
[165] The term escarpment appears to refer to a steep slope.

building. Possible leakage is also visible on the west side of the building in the 1983 aerial photographs and two possible stains are visible on the northeast corner of the building where the previous probable container leakage had been visible. In 1988, an open storage area is again present on the west side of the building but is no longer visible in 1995, when open storage is visible on the east side of the building and is accompanied by a vertical tank. The vertical tank is no longer present in 2005 and portions of the building have been removed.[166]

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.[167,168] 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).[169] All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: There are a number of drainage pathways at Building 4024 including a subsurface drainage trench, storm drain, and sanitary sewer connection. The building also included a number of underground waste tanks. A 1959 grading and drainage plan references a number of these tanks.[170] According to a 1991 evaluation of tritium production and release to groundwater at the SSFL Site, a French drain surrounds Building 4024 and is automatically pumped to the surface; however, the document does not provide a complete description of this system.[171] A 1959 utilities plan of Building 4024 shows a subsurface drainage trench surrounding the perimeter of the original Building 4024 footprint. A sump pump is located at the west side of the building and appears to discharge to a storm drain located north of the building; however this could not be confirmed from the utilities plan drawing. The subsurface drainage trench extends to and surrounds the underground gas holdup tanks. The plan also shows a subsurface drain well to be located on the east side of the building directly north of the crane runway area.[172] A 1959 detailed drawing provides an isometric view of the subsurface drain surrounding Building 4024. It also shows the location of the cooling tower sump at the south side of the building.[173] A 1959 piping plan provides schematic details on the drainage trench along the east side of Building 4024.[174]

[166] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[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.
[170] Ralph M. Parsons Company, *SNAP-II Facility, Santa Susana, California, Phase II, Grading and Drainage Plan*, May 1, 1959.
[171] Rockwell International, Document N001SRR140120, "Tritium Production and Release to Groundwater at SSFL," December 6, 1991.
[172] Ralph M. Parsons Company, *SNAP-II Facility, Vicinity Map, Site and Utilities Plan*, May 1, 1959
[173] Ralph M. Parsons Company, *SNAP-II Facility, Santa Susana, California, Phase II, Miscellaneous Details No. 3*, May 1, 1959.
[174] Ralph M. Parsons Company, SNAP-II Facility, Santa Susana, California, Phase II, Environmental Test Building, Details, Piping, May 1, 1959.

A 1959 piping diagram provides detailed information on the low-level liquid waste system at Building 4024. This system included two tanks, Tank 103 and 104. Tank 103 was an 850-gallon waste tank for liquid waste suspected of potential contamination. The tank was 4 feet in diameter and 6 feet long. Tank 103 captured waste from subsurface drainage as well as the shower and toilets in Room 102 and the floor drain in Room 112. This waste could be collected and sampled and then released to a drainage ditch if found to be free of contamination. Tank 104 was a 550-gallon waste tank for low-level contaminated waste. The tank was 4 feet in diameter and 5 feet long. Tank 104 had a connection for a tank truck for the transfer of contaminated waste.[175] Tanks 103 and 104 were located east of the Building 4024 subsurface test cell complex in an underground 9-foot by 15-foot liquid waste retention basin.[176]

1959 drawing provides a sewer profile for the line connecting to Building 4024. This drawing also includes septic tank and leach field plans, but a note in the drawing states that these plans are deleted.[177] Piping details for the first floor and basement of Building 4024 are provided in another 1959 drawing.[178]

All non-radioactive sewage wastes are collected by a sanitary sewer system and all wash-down water and emergency releases from the cooling systems are routed to the underground liquid waste holdup tanks via floor sinks and buried drain lines. The liquid waste tanks were removed; however, according to the January 2008 Report of Radiological Characterization and Confirmatory Survey Results for the SNAP Environmental Test Facility – Building 4024, the piping for the former contaminated gas and contaminated liquid waste UST systems and floor drain systems remain at the building and were scoped to be packaged and shipped to the Nevada Test Site for disposal. [179, 180] Additionally, the eight empty vaults, previously used for the storage of solid radioactive waste, remain below the paved yard surrounding the building. These vaults are 3 feet in diameter by 8.5 feet deep with a 4.5-foot thick shield block cover and are located on the east side of Building 4024 in the crane runway area.[181, 182]

As indicated above, aerial photographs show evidence of a short drainage channel west of the building in 1967 and 1972 from an open storage area toward Building 4010. The drainage channel is no longer present in 1978 and has been replaced by an escarpment.[183]

[175] Ralph M. Parsons Company, *SNAP-II Facility, Santa Susana, California, Phase II, Environmental Test Building, Legend Schedules, Details and Flow Diagrams*, May 1, 199.
[176] Ralph M. Parsons Company, *SNAP-II Facility, Vicinity Map, Site and Utilities Plan*, May 1, 1959
[177] Ralph M. Parsons Company, *SNAP-II Facility, Santa Susana, California, Phase II, Miscellaneous Details No. 2,* May 1, 1959.
[178] Ralph M. Parsons Company, *SNAP-II Facility, Santa Susana, California, Phase II, Environmental Test Building, First Floor Plan and Toilet Room Details Piping*, May 1, 1959.
[179] Atomics International Document, N704FDP990006 Rev. A., "Building T024 (SETF) Facilities Dismantling Plan," July 31, 1981.
[180] Areva NP, Inc., Report of Radiological Characterization and Confirmatory Survey Results for the SNAP Environmental Test Facility – Building 4024, January 2008.
[181] Johnson, T., "Action Memorandum for the Decommissioning of the System for Nuclear Auxiliary Power Environmental Test Facility, Building 4024, at the Energy Technology Engineering Center at Santa Susana Field Laboratory, California," May 1, 2007.
[182] Areva NP, Inc., Report of Radiological Characterization and Confirmatory Survey Results for the SNAP Environmental Test Facility – Building 4024, January 2008.
[183] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

A 1964 paving drawing indicates a surface drainage channel located north of Building 4024 and a culvert at the south end of a paved area between Buildings 4024 and 4025.[184]

Radiological Contamination Potential: 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.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.1 provide a convenient reference for the following recommendations.
Based on the available information, soil sampling is recommended in the Building 4024 area. As discussed above, there were radiological incidents at Building 4024 and documented evidence of radiological releases. Significant information is lacking regarding the excavation activities at Building 4024.

In addition, previous characterization studies for the Building 4024 area were focused on delineating the extent of contamination to standards that were applicable at the time. Therefore, additional characterization is recommended for the Building 4024 area. This includes the following Building 4024 areas and appurtenances:

- The locations of the two August 1996 Area IV Radiological Characterization Survey samples northeast of Building 4024 and west of Building 4024 in a dirt area. Elevated soil activity was located in Sample ID 95-0105 located northeast of Building 4024 where Cs-137 measured at 0.37 pCi/g. Sample ID 95-0106 also contained Cs-137 at 0.34 pCi/g and was located west of Building 4024 in a dirt area.[185]

- The location of the gas holdup tanks and liquid waste tanks. Interviewee 255 made reference to the removal of tanks that were "potentially holding radioactive gases at one time"; however, it is unclear whether the tanks being referred to include those identified as possible sampling locations.

- The outside storage area west of Building 4024. In 1967 and 1972, an open storage area is visible just west of Building 4024 with drainage trending west, southwest. The open storage area is no longer present in 1978 and the drainage channel has been replaced by an escarpment. In 1980, the open storage area west of the building has returned and dark-toned material is visible at the southeast corner of the building. Possible leakage is visible on the west side of the building in the 1983 aerial photographs. In 1988, an open storage area is again present on the west side of the building but is no longer visible in 1995.[186]

- The Cooling Tower 4928 sump and the footprint of Site 4927 (nitrogen storage tank) should be sampled due to limited information on cooling tower operation and sump use during building operations.

[184] Asph. Conc. Paving, S.E.T.F. Building 024 Santa Susana, 1964.
[185] Rocketdyne, A4CM-ZR-0011, Area IV Radiological Characterization Survey, Final Report, Volume I, August 15, 1996. pgs. 39, 108, 109.
[186] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

- The area east of the building where reactors were brought in and removed from the facility. This area also includes the waste storage tanks. Below-ground radioactive waste storage facilities are located under asphalt in the yard. The buried tanks include three radioactive gas holdup tanks 6 feet in diameter and 40 feet long, eight solid radioactive waste storage vaults 3 feet in diameter and 4 feet deep, and two liquid radioactive waste holdup tanks. These tanks were placed on top of a concrete box filled with gravel designed to contain any accidental leakage.[187,188]

- The former location of the apparent leakage of an unknown container at Building 4024 that appears to leak north-northeast toward the northwest corner of Building 4027 in 1980 aerial photographs. In the 1983 aerial photographs two possible stains are visible on the northeast corner of the building where the previous probable container leakage had been visible.[189]

2.1.3 Building 4027 Area

Site Description: The Building 4027 area includes Building 4027, Building 4625, substation Building 4727, and the land surrounding these buildings. Building 4027 was one of a series of buildings that supported the 1950- and 1960-era SNAP program and was located along B Street, south of 12th Street and west of G Street.[190] Figures 2.1.3a through 2.1.3e provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4027 was constructed in 1961 and was expanded in 1963 to include Building 4625. Building 4625 initially measured approximately 1,240 square feet. Building 4027 was expanded approximately 2,842 square feet, filling the space between Buildings 4027 and 4625.[191] The expanded building measured 9,240 square feet and included a 4,589-square foot high bay laboratory area. The remainder of the building included offices and shop support. The building was reported as being steel frame with steel siding and roof. The high bay measured 37 feet in height and included a 6-ton bridge crane.[192] In the interior of the building, the building featured a pipe trench and sump pit.[193] A large darkroom was located in Building 4027 at one time; however, the exact period is unknown.[194]

Former Use(s): According to a 1988 radiological survey of Building 4027, Building 4027 was constructed in 1961 and served as one of many buildings that were used as engineering

[187] Atomics International Document, N704FDP990006 Rev. A., "Building T024 (SETF) Facilities Dismantling Plan," July 31, 1981.
[188] Remley, M.E., Atomics International, Letter Re: Comments on Draft Reactor Safety Survey Report for Building 024, July 21, 1965.
[189] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[190] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[191] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[192] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[193] Atomics International, Drawing 303-027-S6, Expansion of Non-Nuclear Mechanical Vibration and Shock Testing Building 027 Expansion, January 16, 1963.
[194] Approved DOE/EPA Interview 255, July 9, 2010.

development and test sites for the SNAP program.[195] Building 4625 operated as a Non-Nuclear Component Storage Building.[196] Vibration and shock tests were performed in Building 4027 in support of the SNAP launch schedule.[197] According to an August 15, 1963, incident report, the building conducted acceleration tests on the S10FS-1 system. These tests included the use of 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. Additional information regarding these acceleration tests could not be located in historical site documents.[198]

According to an August 6, 1964, Atomics International internal letter, the use of cyclohexane and/or cycloheptane in the NaK system of the SNAP 10FS-3 in Building 4027 was authorized.[199] In 1965, such tests included the testing of the SNAP 8 drum drive mechanism and the 10FS-5.[200] Launch vehicle simulation testing was conducted at the building through 1968. In 1970, the equipment was removed from the building and the building was used for quality assurance and materials and components acceptance. The 1988 radiological survey indicated sealed, fully-encapsulated, radiography sources and/or equipment may have been stored in Building 4027; however, no known loose radioactive or nuclear material was handled.[201]

According to an April 1987 Site Consolidation Assessment, Building 4027 was inactive; however, a 1988 radiological survey indicated Building 4027 was being used for storage purposes.[202,203] In 1989, R.J. Tuttle indicated that sealed sources for gamma-radiography were stored in Building 4027.[204] In 2001, according to a radioactive waste certification plan, Building 4027 served as a hazardous (non-radioactive) waste storage area.[205] Additional information regarding these operations could not be located. The research team has been unable to determine the operations in Building 4027 from 1988 to 2003, when the building is reported to have been demolished. It is important to note that an undated listing of SSFL Site waste generators, as well as a 2003 Environmental Assessment for Cleanup and Closure, identifies Building 4027 as a weld shop.[206,207]

[195] It is important to note that 1962 aerial photographs do not show the presence of any structures at the Building 4027 area. The exact date of construction and start of operations at Building 4027 is unknown.
[196] Drawing 303-027-A4, "Expansion of Non-Nuclear Mechanical Vibration and Shock Testing, Building 027 Expansion, Floor Plan, as built," 1964.
[197] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[198] Busick, D.D., Internal Letter North American Aviation, Inc., Re: Water Supply in Building 027, August 15, 1963.
[199] Atomics International Internal Letter, Letter Re: SNAP 10FS-3, Building 027, Santa Susana, August 6, 1964.
[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.
[201] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[202] ETEC, *Site Consolidation Assessment*, April 16, 1987. p. 22.
[203] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[204] Tuttle, R.J., Listing of Locations in SSFL Area IV Associated With Radioactive Materials," September 1989.
[205] Boeing, *Radioactive Waste Certification Plan (WCP) for ETEC Facilities*, EID-04758, February 21, 2001. p. 5.
[206] Unknown, SSFL Waste Generators, Undated.
[207] DOE, *Environmental Assessment for Cleanup and Closure of the Energy Technology Engineering Center*, DOE/EA-1345, March 2003. p. 2-10

Information from Interviewees: According to an interviewee (255) who worked for Atomics International from 1967 to 1985 as an atomic inspector and certified x-ray technician, Building 4027 included a large dark room where the interviewee developed photographs for reports.[208]

Radiological Incident Reports: There have been no known radiological incidents at Building 4027 that may have resulted in a release of contamination to the environment. The only incident on file at Building 4027 is summarized in the table below.

Building 4027 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0023	8/13/1963	SSFL, Building 4027	None identified	Improper use of drinking water bottles for storage of chemicals.

- 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 to simulate NaK in the S10FS-1 system during acceleration tests in Building 4027. The employee removed the bottle from the water cooler because employees 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 10FS-1 assembly into two 5-gallon water bottles of the type used for drinking water supply at Santa Susana. 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 contents of the bottle had been consumed by approximately 30 people. Tests of the contents of the water showed beta and gamma contamination of less than 5×10^{-8} uc/cc, alpha contamination of less than 1×10^{-8} 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 (A0023).[209]

Current Use: Buildings 4027 and 4625 were demolished in 2003 by American Wrecking, Inc. The action included the demolition and removal of Building 4625, Building 4027, and an "amplifier room;" the removal of asphalt parking areas and walk ways; and the removal of existing sub-station and underground utilities. The dimensions of the excavations made during building demolition are unknown.[210] Boeing reported the demolition of the building to the DOE on March 22, 2004.[211]

[208] Approved DOE/EPA Interview 255, July 9, 2010.
[209] Busick, D.D., Internal Letter North American Aviation, Inc., Re: Water Supply in Building 027, August 15, 1963.
[210] American Wrecking, Inc., *Demolition Proposal*, November 3, 2003.
[211] Lee, Majelle, Letter Re: Contract No. DE-AC03-99SF21530, Notification of Completion of GFY 2004 Contract Milestone "Demolish Buildings 4027, 4487 and 4641 per Multi-Year Work Plan 1st and 2nd Quarter GFY2004, RD01-269-03," March 22, 2004.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): As part of the DOE SSFL Site Survey, Building 4027 was surveyed to determine if any residual radioactivity was accidentally left behind as a result of operations in support of the SNAP program. 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." The high bay and storage portions of Building 4027 were surveyed as separate units due to variations in "ambient background." 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.[212]

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.[213]

Radiological Use Authorizations: Based on the review of currently available documents, there was no radiological use authorizations associated with Building 4027.

Former Radiological Burial or Disposal Locations: None found.

Aerial Photographs: 1959 aerial photographs show light-toned mounded material in the area surrounding the future location of Building 4027. As indicated above, according to a 1988 radiological survey of Building 4027, Building 4027 was constructed in 1961; however, the 1962 aerial photographs do not show a building to be present. By 1965, the building is clearly visible and has already been expanded to include Building 4625. There are no notable features surrounding the building until 1980 when the apparent leakage of a container at Building 4024 appears to leak north-northeast toward the northwest corner of Building 4027. By 2005, the building is no longer visible in aerial photographs.[214]

Radionuclides of Concern: Building 4027 is located in proximity to the RMHF; therefore, direct radiation and skyshine from RMHF affects ambient radiation conditions in the area.[215] 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,

[212] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[213] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[214] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[215] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.

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.[216] All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Little information could be located regarding the drainage surrounding Building 4027. An "A.C. Ditch" (asphaltic concrete ditch) was located around the north and northeast perimeter of the building and led to an underground culvert located just east of the Building 4036/4037 stairway located south of Building 4036/4037.[217] In general, water runoff in the area of the building is directed to the south to the retention reservoirs that are part of the SSFL industrial effluent control system. Liquid effluent discharge from the final retention pond into the Bell Canyon drainage occurs only after controlled effluent hold-up and sampling.[218]

Radiological Contamination Potential: 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.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.1 provide a convenient reference for the following recommendations.

Based on the available information, soil sampling is recommended in the Building 4027 area. Significant information is lacking regarding the possible storage of sealed sources for gamma radiography in Building 4027 and excavation activities at Building 4027.

There have been limited characterization studies for the Building 4027 area and they were focused on delineating the extent of contamination to standards that were applicable at the time and only included gamma exposure rate measurements. Therefore, additional characterization is recommended for the Building 4027 area. This includes the following Building 4027 areas:

- Former location of the ditch north and northeast of building. An "A.C. Ditch" was located around the north and northeast perimeter of the building and led to an underground culvert located just east of the Building 4036/4037 stairway located south of Building 4036/4037.[219] If radioactive materials from the RMHF were released and drained into the Building 4027 area, residual contamination above background values may exist to the north and northeast of the building.

- The former location of the apparent leakage of an unknown container at Building 4024 that appears to leak north-northeast toward the northwest corner of Building 4027 in 1980

[216] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[217] Atomics International, Drawing No. 303-027-C2 Expansion of Non-Nuclear Mechanical Vibration and Shock Testing Building 027 Expansion, Topographic Plan, February 4, 1963.
[218] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[219] Atomics International, Drawing No. 303-027-C2 Expansion of Non-Nuclear Mechanical Vibration and Shock Testing Building 027 Expansion, Topographic Plan, February 4, 1963.

aerial photographs. Because the contents of the unknown container cannot be confirmed to be non-radioactive material, it is possible radioactive materials may have been released from this container toward the northwest corner of Building 4027.

- As indicated above, in the interior of the building, the building featured a pipe trench and sump pit.[220] The use or purpose of the trench and sump pit is unknown, as a result, it is recommended this area of the former building be included for sampling.

2.1.4 Building 4032 Area

Site Description: The Building 4032 area includes Building 4032, substation Building 4727, and the surrounding area. Located on B Street, Building 4032 was constructed between 1962 and 1965 near Building 4027.[221, 222] Figures 2.1.4a through 2.1.4c provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4032 measured 4,580 square feet and had a steel frame, steel sides, and steel roof. It contained approximately 4,200 square feet of laboratory space in support of the SNAP program.[223] The building appears to have had a single below-ground sodium drain tank (UT-23) with a capacity of 5,500 gallons; however, the former location of the drain tank is unknown. In 1997, the drain tank was removed and cleaned using a water-vapor-nitrogen process.[224,225] Building 4032 was serviced by Substation 4727.[226]

Former Use(s): According to an August 1988 radiological survey of the building, Building 4032 was used as a space environmental test facility for thermal vacuum systems. Vacuum chamber equipment was installed in the building and heaters were used for the SNAP system's thermal simulation testing. Following completion of thermal vacuum testing in 1970, the vacuum equipment was removed and the facility was redesignated as an ETEC General Test Building. The facility was used for component and instrumentation testing. From 1978 through 1983, mock-ups in the building used a radiological source to determine the positioning of non-radioactive rods for use in developing the fuel rod control system. A June 1975 site development plan indicated that small sodium test facilities in Building 4032 were involved with tests associated with the "FFTF program." The site development plan did not define the "FFTF program." The radiological survey indicated that in 1988, the building was still an "active

[220] Atomics International, Drawing 303-027-S6, Expansion of Non-Nuclear Mechanical Vibration and Shock Testing Building 027 Expansion, January 16, 1963.
[221] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[222] 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.
[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.

sodium test loop," with many pipes occupying the premises.[227, 228] According to the May 2005 HSA, after support work for SNAP tests ceased, Building 4032 was used as a sodium component and instrumentation test facility.[229]

Building 4032 also housed the Liquid Metal Development Laboratory 1 (LMDL-1), which carried out applied research in support of liquid metal cooled reactors. In 1996, during environmental restoration activities, approximately 15,390 pounds of sodium were removed from a below-ground drain tank and was transferred to a sodium supplier for reuse. In 1997, the drain tank was removed and cleaned. Approximately 1,542 pounds of sodium were converted to sodium hydroxide during the cleaning process and were recycled. The tank was cut up and sold as scrap. By 1998 the sodium piping had been removed and the facility was being used for storage and component size reduction in support of water-vapor-nitrogen (WVN) cleaning. WVN cleaning of all piping and components was completed in 1998 and the sodium hydroxide generated was recycled and the clean steel was sold as scrap.[230]

After 1998, the building was being used for storage and component size reduction in support of the WVN cleaning.[231,232] The research team has been unable to determine the building operations from 1998 until 2003 when the building was reportedly demolished.

Information from Interviewees: According to an interviewee (255) who worked for Atomics International from 1967 to 1985 as an atomic inspector and certified x-ray technician:[233]

> We had a couple of mishaps up there with an x-ray technician that wasn't paying attention. An example occurred in Building 4032. I was in Buildings 4036 and 4037, which served as office areas near Building 4032. A guy was x-raying in Building 4032 with a cobalt source and I was up there to make sure the people in the office were in a safe area because cobalt splatters all over and can go through 7 inches of steel and 1 inch of lead. I noticed the radioactivity went up as the x-ray technician was running the pill back into the "pig," as we called it. The pill went up and never came down. The technician tried to lock the source up in the pig, but it was still hanging out of the pig a little bit. So the technician got exposed to a little bit of radiation. That was what I called clean radiation.[234,235]

[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.
[230] The Boeing Company, Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1998, RD99-115, September 22, 1999.
[231] The Boeing Company, *Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1999*, RD00-159, September 2000.
[232] The Boeing Company, *Sodium Component Test Installation (SCTI) Demolition Final Report*, EID-08336, October 1, 2003. p. 36.
[233] Approved DOE/EPA Interview 255, July 9, 2010.
[234] The research team has been unable to confirm whether this incident is related to Incident No. A0299. The interviewee did not provide information on when the incident occurred during his employment at the SSFL.
[235] It should be noted that radiography was often called "x-raying" because the resultant film image looks like an x-ray. The use of the term "x-ray" by the interviewee is slang. Personnel did not use "x-rays" and the personnel were referred to as radiography technicians.

Radiological Incident Reports: There have been several incidents associated with Building 4032 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 the incident reports are provided following the table, when available.

Building 4032 Incident Report Summary

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 building.
A0586	4/20/1974	Welded pipe	Ir-192	Unattached collimator allowed gamma graph source to fall out of guide tube.
A0058	6/29/1977	East End Building 4032	Ir-192	Employee walked through barrier and approached exposed gamma graph source.
A0319	8/13/1981	Test area	Co-60	Gamma graph source failed to return and went undetected.
A0098	2/16/1982	High bay	Ir-192	Off scale dosimeter response.
A0310	3/17/1987	High bay	None identified	Security, on rounds, entered radiation area of field radiography set up.

- On March 27, 1971, during the performance of field radiography on pipe welds located just outside Building 4032, an Liquid Mental Engineering Center (LMEC) employee entered the building through a posted door. The employee was not observed by the radiographer who exposed the 27 Ci of Ir-192 in a "60^{o} 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 determined that the LMEC employee was exposed to a maximum radiation level of 6 mR/hr (A0299).[236]

- 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 12 mrem as indicated by pocket dosimeter readings. The area was secured approximately 2 hours following the incident (A0586).[237]

- On June 29, 1977, a pipe joint weld was being radiographed in Building 4032. The source, Ir-192, was in an Iriditron Model 520 source projector with a collimator (70o

[236] Heine, W.F., Internal Letter Re: Radiography Incident Report A-0299, April 2, 1971.
[237] Klostermann, J.P., Rockwell International Internal Letter Re: Gammagraph Source Incident Building T032, April 24, 1974.

beam) oriented vertically upward. The source had an activity of 81.3 Ci on June 29, 1977. The radiographic operation was conducted near the east end of Building 4032 when unauthorized personnel entered the building on the west. His presence within the building was not observed by the radiographer until he was approximately 20 feet from the source for approximately 15 seconds before being instructed to vacate the premises. The investigation of the incident estimated the total dose to the employee to have been less than 10 mrem (A0058).[238]

- 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 X10 and X100 scale. Following investigation, it was found the source "did not crank completely into the projector after the exposure. It has apparently hung up approximately ¼ to ½-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).[239]

- 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 employee shut down radiographic operations immediately. Investigation of the occurrence found the dosimeter to be defective (A0098).[240]

- 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 any environmental contamination.[241]

Current Use: Building 4032 appears to have been demolished in 2003. According to soil and compaction reports dated May 1, 2003, the area was excavated 5 feet into firm compact material.[242] Based on available information, the dimensions of the excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- During a 1988 beta survey, a stainless steel catch pan was found to be contaminated with Co-60 at a level of about 25,000 dpm/100 cm^2. According to the survey, the catch pan

[238] Tuttle, R.J., Rockwell International Internal Letter Re: Radiography Incident A-0058, July 5, 1977.
[239] Breese, J.W., Rockwell International Internal Letter Re: Radiation Exposure Occurrence, August 20, 1981.
[240] Breese, J.W., Rockwell International Internal Letter Re: Off-Scale Reading of Personal Dosimeter, February 19, 1982.
[241] Unknown Author, Industrial Security Preliminary Investigation Report, Incident A-0310, March 17, 1987.
[242] The Soil Guys, Letter Re: Soil Engineering Testing of Soil Compacted at SSFL Area IV Facility, Building B-4032, Ventura County, California, May 1, 2003.

was most likely from Building 4059 or related to the SNAP facility and ended up in Building 4032 accidentally. The radioactivity was fixed in the steel and did not spread to surrounding areas. The pan was reported to have been disposed of as radioactive waste; however, the report did not indicate the method of disposal.[243]

As part of the DOE SSFL Site Survey, Building 4032 was surveyed to determine if any residual activity was accidentally left behind as a result of operations in support of the SNAP program. Gamma exposure rate measurements were made at 63 locations inside Building 4032. The maximum gamma exposure rate (corrected for background and statistically tested against an NRC acceptance limit of 5 μR/hr) in Building 4032 was 4.4 μR/hr. The average value was 0.43 μR/hr. Based on the median value of exposure rate measurements in the vicinity of Building 4032, the ambient background value for gamma was determined to be 7.27 μR/hr. All beta surface activity measurements made "for indication" showed no detectable activity, except for the stainless steel catch pan described above. Based on the results of the survey of Building 4032, the conclusion was made that Building 4032 passed the 1988 NRC criteria for unrestricted use.[244]

Radiological Use Authorizations: As indicated above, Building 4032 was used for mock-ups using a radiological source to determine the positioning of non-radioactive rods for use in developing the fuel rod control system from 1978 to 1983. On June 29, 1978, by internal letter, Rockwell International personnel submitted an application for use to R.J. Tuttle, the Radiation and Nuclear Safety Manager, for the purchase of 80 to 100 μCi Co-60 source. The purpose of which was for use in the assembly of the "articulated rod for ISSS [Inherently Safe Shutdown System] Test Program." According to the application, the source was stated to be intergral to a measuring technique to determine the free-fall time of the rod during loss of flow. According to the letter, the source was to be installed in Building 4032 for the intended use of 1,050oF and was to experience "free-fall" mechanical shock. The source was reported to be sealed and clad in stainless steel and had a source qualification radiation level of less than 2 MR/hr at 1 foot.[245]

On August 22, 1978, Rockwell International received Authorization No. 118. The authorization listed the operation as being "shutdown rod measurement" and approved the use of 100 μCi of Co-60 in Building 4032.[246] According to correspondence with the source vendor, Isotope Products Laboratories, Rockwell International received two 100 μCi C-60 sources. It appears one may have been for use in Building 4032, while the other was for use in Building 4059, under Authorization No. 117.[247][248]

According to the test procedure for the ISSS test program, the ISSS-Articulated Control Assembly (ACA) was assembled and installed in the Static Sodium Test Facility (SSTF) Building 4032 Test Rig 2.[249] On August 22, 1979, Rockwell International received a renewed

[243] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[244] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[245] DeVita, V., Rockwell International Internal Letter Re: Application for Use, Purchase Requisition No. 43182, June 29, 1978.
[246] Tuttle, R.J., Authorization No. 118, August 22, 1978.
[247] Marsh, Richard, Isotope Products Laboratories, Letter No Subject Line, October 31, 1978.
[248] Tuttle, R.J., Authorization No. 117, August 22, 1978.
[249] Bryan, R.L. Document P-067E-B01-AM032, "SSTF (032) Assembly and Installation – Inherently Safe Shutdown System-Articulated Control Assembly," August 28, 1978.

authorization, Authorization No. 118A, for the continued shutdown rod measurement operations in Building 4032. This authorization expired August 22, 1980.[250] Authorization No. 118B was issued on August 22, 1980, and the test article was renamed the Self Actuated Shutdown System-Articulated Control Assembly (SASS-ACA).[251] The final authorization, Authorization No. 118D, for these operations was issued on August 22, 1982, and expired on August 22, 1983. At the conclusion of these operations, the source was 97.2 μCi of Co-60. The form was sealed source S/N 43014, which was checked annually to ensure no leakage occurred.[252,253, 254]

Incident reports show that Ir-192 was also used as a source under Use Authorization 18.[255]

Former Radiological Burial or Disposal Locations: No former radiological burial or disposal locations have been associated with this building, although the building appears to have had a single below-ground sodium drain tank (UT-23) with a capacity of 5,500 gallons; however, the former location of the drain tank is unknown. In 1996, approximately 15,930 pounds of sodium was removed from the stainless steel vaulted tank. In 1997, the drain tank was removed and cleaned using a water-vapor-nitrogen process. During this process, approximately 1,542 pounds of sodium was converted to sodium hydroxide.[256, 257]

Aerial Photographs: Prior to the construction of Building 4032, the area was used for open storage during construction activities. Building 4032 appears in aerial photographs in 1965. Between 1972 and 1978, Building 4032 is expanded on the northwest corner of the building. In the 1978 aerial photographs a pipeline is visible directly east of the building leading from Building 4023 south to Building 4042. A possible horizontal tank appears to be located immediately north of Building 4032 in 1995 aerial photographs. By 2005 the building has been removed and minor ground scarring remains visible.[258]

Radionuclides of Concern: Based on incident reports alone, Co-60 and Ir-192 would be the radionuclides of concern at Building 4032; however, Ir-192, with a half life of 74.2 days is not included in the August 2009 Final Field Sampling Plan. Co-60 is included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: A 2-inch drain line was located on the north end of the building and extended east to a 12-inch corrugated metal drain pipe. Storm drains were located on the west and east sides of the building.[259]

[250] Tuttle, R.J., Authorization No. 118A, August 22, 1979.
[251] Tuttle, R.J., Authorization No. 118B, August 22, 1980.
[252] Remley, M.E., Authorization No. 118D, August 22, 1982.
[253] Authorization Series 118, Shutdown Rod Measurement, J. V. Menteer, August 1978.
[254] The research team is awaiting receipt of Use Authorization 118. The information presented above was summarized 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.
[255] Tuttle, R.J., Rockwell International Internal Letter Re: Radiography Incident A-0058, July 5, 1977.
[256] The Boeing Company, *Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1998*, RD99-115, September 22, 1999.
[257] Rockwell Aerospace, *Rocketdyned Division Annual Site Environmental Report Santa Susana Field Laboratory and De Soto Sites 1993*, RI/RD94-126, October 21, 1994.
[258] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[259] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4032 area is Class 2 based on the building's location within ETEC and incident history.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.1 provide a convenient reference for the following recommendations.
Based on the available information, soil sampling is recommended in the Building 4032 area. Incident reports involving Co-60 occurred at Building 4032. Information is lacking regarding the excavation activities at Building 4032 during building demolition.

There have been limited characterization studies for the Building 4032 area and they were focused on delineating the extent of contamination to standards that were applicable at the time. Therefore, additional characterization is recommended for the Building 4027 area. This includes the following Building 4027 areas:

- The 2-inch drain located along the northern exposure of Building 4032. Incident reports indicate that a radiographer performed exposures on the exterior of the building; however, the nature of these operations is unknown. If radioactive materials were released during these operations, residual contamination above background values may have been released into the 2-inch drain, which drained to the corrugated metal pipe located east of the building. Sampling is recommended at the former location of the 2-inch drain and the in-fall at the corrugated metal pipe.

- Storm sewer lines located south of the Building 4032 footprint. If radioactive materials were released into the sewer system, residual contamination above background values may exist in the materials surrounding the sewer lines.

- Sanitary sewer line located west and east of the Building 4032 footprint. If radioactive materials were released into the sewer system, residual contamination above background values may exist in the materials surrounding the sewer lines.

- The former Building 4032 footprint. While the extent of the excavations during building demolition are unknown, soil and compaction reports dated May 1, 2003, indicate the area was excavated 5 feet into firm compact material.[260] Building 4032 measured 4,580 square feet.[261] Past contamination may have left residual contamination above background values in the area.

- The building appears to have had a single below-ground sodium drain tank (UT-23) with a capacity of 5,500 gallons; however, the former location of the drain tank is unknown. In 1996, approximately 15,930 pounds of sodium was removed from the stainless steel vaulted tank. In 1997, the drain tank was removed and cleaned using a water-vapor-nitrogen process. During this process, approximately 1,542 pounds of sodium was

[260] The Soil Guys, Letter Re: Soil Engineering Testing of Soil Compacted at SSFL Area IV Facility, Building B-4032, Ventura County, California, May 1, 2003.
[261] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.

converted to sodium hydroxide.[262, 263] Should the former location of the tank be determined, sampling at the tank would be warranted.

2.1.5 Building 4036/4037 Area

Site Description: The Building 4036/4037 area includes Building 4036/4037, substation Building 4727, and the surrounding area. Building 4036/4037 was constructed between 1962 and 1965 and consisted of two one-story metal buildings joined together, each with a concrete slab floor and concrete foundation. The building had approximately 7,380 square feet of floor space.[264,265,266] Buildings in proximity to Building 4036/4037 include Buildings 4027 and 4032, which are discussed above. Figures 2.1.5a through 2.1.5c provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: The support structure of Building 4036/4037 consisted of steel beams with corrugated steel siding and roof. The building contained numerous internal partition walls with wood framing and drywall surfaces.[267] A March 15, 1962, layout of the building shows there to be approximately 40 offices in the building.[268] The building included an ambient radiation dosimeter at the east side of Building 4036/4037.[269]

Former Use(s): As indicated above, Building 4036/4037 was constructed between 1962 and 1965. A review of industrial planning maps shows that Building 4037 appears distinctly only on the 1962 map; thereafter, it is labeled as part of Building 4036.[270] Building 4036/4037 operated as a non-nuclear office building for the SNAP program.[271,272,273]

Information from Interviewees: There have been no interviews to date with personnel familiar with operations in Building 4036/4037.

Radiological Incident Reports: None found.

[262] The Boeing Company, *Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1998*, RD99-115, September 22, 1999.
[263] Rockwell Aerospace, *Rocketdyned Division Annual Site Environmental Report Santa Susana Field Laboratory and De Soto Sites 1993*, RI/RD94-126, October 21, 1994.
[264] Boeing Document, EID-04366, "Removal of DOE Buildings, Demo Pak A," May 18, 1999.
[265] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[266] ETEC, *Site Consolidation Assessment*, April 16, 1987. p. 13.
[267] Boeing Document, EID-04366, "Removal of DOE Buildings, Demo Pak A," May 18, 1999.
[268] Unknown, *Room and Area Numbering Plan Santa Susana Building 0036-0037, Snap Office Building*, March 15, 1962.
[269] Rocketdyne, *Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1997*, November 23, 1998. p. 59.
[270] SSFL Area IV, ETEC Industrial Planning Maps, 1962-1992.
[271] 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
[272] Approved DOE/EPA Interview 255, July 9, 2010.
[273] Rockwell International, *Site Development Plan 1977-1981, United States Energry Research and Development Administration, Liquid Metal Engineering Center*, June 1975.

Current Use: Building 4036/4037 appears to have been demolished in 1999. Based on available information, the dimensions of the excavation made during building demolition are unknown, and radiological controls were not required during building demolition.[274]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): To date, the research team has not located any radiological investigations at or near the Building 4036/4037 area.
Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: There have been no radiological burial or disposal locations identified in relation to the operations of Building 4036/4037. It is important to note, however, that Building 4036/4037 is located close to the RMHF and Buildings 4021 and 4022.

Aerial Photographs: Prior to the building's construction, the 1962 aerial photographs show minor staging activities occurring at the site area. By 1965, the building has been fully constructed and the area is operational. The building is no longer present in 2005 aerial photographs and the surrounding area is vegetated.[275]

Radionuclides of Concern: The research team did not find evidence that high activity radioactive materials were used or stored within Building 4036/4037. However, Building 4036/4037 is located in proximity to RMHF; therefore, direct radiation and skyshine from RMHF may affect ambient radiation conditions in the area.[276] Radionuclides of concern at the RMHF include all radionuclides addressed in the background study plus any additional radionuclides identified during the HSA. All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: The general slope of Area IV, including Building 4036/4037, is in a southerly direction. Water runoff is directed to the retention reservoirs which are part of the SSFL industrial effluent control system. Liquid effluent discharge from the final retention pond into the Bell Canyon drainage occurs only after controlled effluent holdup and sampling.[277] The Building 4036/4037 elevation appears to be higher than buildings located immediately south of the building. Based on aerial photographs, it appears drainage from the building would be to the south-southwest.[278] Corrugated metal pipes located south of the building at the base of the stairway leading from the building likely directed surface drainage to the retention reservoirs.[279]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4036/4037 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.

[274] Boeing Document, EID-04366, "Removal of DOE Buildings, Demo Pak A," May 18, 1999.
[275] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[276] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[277] Map located at: http://dtsc-ssfl.com/files/maps/SSFL%20-%20Western%20Half.pdf.
[278] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[279] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.1 provide a convenient reference for the following recommendations.

Based on the available information, soil sampling is recommended in the Building 4036/4037 area. To date, the research team has not located any characterization studies for the Building 4036/4037 area. Therefore, characterization is recommended for the Building 4036/4037 area. This includes the following Building 4036/4037 areas:

- Due to the proximity of RMHF Buildings 4021 and 4022 to Building 4036/4037, there is a high probability that radionuclide concentrations in soil will exceed background values. It is recommended that the soil characterization at Building 4036/4037 be conducted in conjunction with characterization activities that will be conducted for the facilities comprising the RMHF. It is also recommended this characterization include the Building 4036/4037 footprint.

- The storm sewer line located south of Building 4036/4037, east and west of the stairway.[280] If radioactive materials from the RMHF were released and drained into the Building 4036/4037 area, residual contamination above background values may exist to the south of the building.

2.1.6 Site 4927 Area

Site Description: The Site 4927 area is located along B Street, southwest of Building 4024. The area comprises Site 4927 and the surrounding area. The building appears to have been constructed sometime between 1962 and 1965 to serve as a nitrogen gas storage tank.[281] Plate 1 presents a summary of all identified features for this site.

Building Features: Based on a 1969 plot plan, it appears Site 4927 comprised a concrete pad and did not include a physical structure other than the nitrogen gas storage tank.

Former Use(s): The precise date of construction of this site is unknown. Building 4927 was identified on industrial planning maps as a nitrogen storage tank. Documents outlining which buildings the storage tank serviced could not be located; however, a Facility Area Plan of inert gas shows that the adjacent Building 4025 was serviced by a high-pressure nitrogen system. Most likely, Site 4927 serviced Building 4025 for the time period before the high-pressure nitrogen system was installed.[282] Site 4927 was most likely demolished in the 1970s, when Area IV began using the high-pressure nitrogen system. This involved piping in nitrogen from Area III, eliminating the need for most Area IV nitrogen storage tanks.[283,284]

[280] Atomics International, Drawing No. 303-027-C2 Expansion of Non-Nuclear Mechanical Vibration and Shock Testing Building 027 Expansion, Topographic Plan, February 4, 1963.
[281] 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.
[282] Drawing, 303-GEN-C254, "Santa Susana Facility Area Plan Inert Gas Master East," As Built to Date, February 22, 1991, Ref # PEWR 75184.
[283] Personnel Interview, Randy Ingersoll, September 23, 2003.
[284] 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.

Information from Interviewees: To date, there have been no interviews with personnel familiar with operations at Site 4927.

Radiological Incident Reports: There have been no incident reports relating to Site 4927; however, incidents associated with Building 4024 may have impacted the area surrounding Site 4927. Incidents associated with Building 4024 are presented above in Section 2.1.2.

Current Use: Site 4927 was likely demolished in the 1970s, sometime between 1972 and 1978 as evidenced in aerial photographs.[285,286]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): Radiological surveys specific to Site 4927 have not been conducted; however the building site was included in the Area IV Radiological Characterization Survey, conducted in 1994 through 1995. The survey was designed to locate and characterize any previously unknown areas of elevated radioactivity in Area IV. Background was determined to be 15.6 μR/hr, and the acceptable limit was less than 5 μR/hr above background. The survey found the area to be below acceptable limits in 1995.[287]

Radiological Use Authorizations: None.

Former Radiological Burial or Disposal Locations: None.

Aerial Photographs: The development of the Site 4927 area is first visible in the 1959 aerial photograph with a large excavation occupying a majority of the area. In 1962 the area is still being developed. By 1965 the site has been fully developed and there is no evidence of construction activities; however, it is difficult to discern whether Site 4927 is present. In 1967 and 1972, a structure is visible at the Site 4927 location. By 1978, the structure appears to be gone with a foundation being the only sign of a building's presence. The foundation remains visible in aerial photographs until 2005.[288]

Radionuclides of Concern: None.

Drainage Pathways: Aerial photographs show evidence of a short drainage channel west of Building 4024 in 1967 and 1972 from an open storage area toward Building 4010. The drainage channel is no longer present in 1978 and has been replaced by an escarpment.[289] The research team did not locate any other drainage information for the area. It is possible however, that drainage from the area entered the drainage channel that ran along 17th Street in relation to the operations at Building 4005.

Radiological Contamination Potential: Based on historical site operations, it is unlikely radiological contamination resulted from the operations as a nitrogen storage tank. However, the site's proximity to Building 4024 and the sump associated with Cooling Tower 4928 may have

[285] Personnel Interview, Randy Ingersoll, September 23, 2003.
[286] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[287] Rocketdyne Document, A4CM-ZR-0011, Rev. A, Area IV Radiological Characterization Survey, August 15, 1996.
[288] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[289] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

resulted in contamination at or around Building 4927. As a result, this site has been designated MARSSIM Class 1.

Recommended Locations for Soil/Sediment Sampling: It is recommended this area be included in the sampling plan for Building 4024, discussed above in Section 2.1.2.

2.2 GROUP 2

The Group 2 index map is presented in Figure 2.2. Following Figure 2.2, the site photograph and layout drawings for each building area within HSA-5A Group 2 are presented. HSA-5A Group 2 includes nine building areas including Building 4073, the Kinetic Experiment Water Boiler (KEWB) reactor, and Building 4093, the AE-6/L-85 reactor and their associated buildings.

2.2.1 Building 4073 Area

Site Description: The Building 4073 area includes Building 4073 and the surrounding area. Constructed in 1955, Building 4073 served as the KEWB reactor building and consisted of an underground concrete structure and an above-ground wood and metal changing/workroom. Other buildings within the vicinity of Building 4073 include Building 4123, Building 4643, and Building 4793 discussed below. Figures 2.2.1a through 2.2.1g provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: The Interim Radiological Survey Report indicated the KEWB reactor facility consisted of the reactor test building (Building 4073), an exhaust blower building (Building 4643), an electrical control building (Building 4793), and a waste storage building (Building 4123).[290] It should be noted that Building 4123 is also identified as a "fuel" storage building in some survey layout drawings. The KEWB reactor test building consisted of an underground concrete structure and an above-ground wood and metal changing/workroom. The underground portion of the reactor building measured 15 by 26 feet and was 10 feet tall and contained four rooms. The reactor test building housed the reactor test core, control rods, gas handling and fuel storage systems, and the necessary detection instrumentation. The facility included a waste disposal system west of Building 4073 comprising three underground tanks and a 60-foot exhaust stack with a 2,000-cubic foot per minute blower system. A 300-gallon collection tank was used to collect gas directly from the reactor system. A 1,000-gallon storage tank buried beneath floor level and adjacent to the test building retained all liquid waste from the facility. The tank was equipped with pump-out connections for removal of the liquid waste when necessary. Another 1,000-gallon tank was originally used to retain the reactor cooling water so that it could be checked for activity prior to release. The tank appears to have drained through a 2-inch line to the west to an open drainage channel along the northern boundary of 12th Street and then south of the KEWB facility. This drainage channel continues along 12th Street to G Street and flows southwest along G Street to the 17th Street drainage channel, where flow is directed below G Street to a concrete spill apron for discharge to the "R-2A" pond in Area

[290] 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.

III.[291,292,293] The ventilation system for Building 4073 was housed in Building 4643, which was connected to the reactor building.[294]

Former Use(s): Initial construction of the facility was completed in 1955, and operations began in July 1956. The KEWB reactor was a small graphite-encased research reactor that used a water solution of uranyl sulfate as fuel. Transient testing of the first core began in the fall of 1956 and was concluded in the summer of 1959. During this period, 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; the majority of reactor operations were conducted at a power level of 1 kWt or less.[295] In May 1962, the reactor was operating as a neutron burst facility with 30% of KEWB's 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 Space Technology Laboratory, University of California, and North American Aviation Space and Information Systems Division.[296] 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.[297] Operations in the building halted in November 1966. All control consoles and reactor instrumentation were removed following closure, and the fuel was drained from the fuel storage tank and shipped to a recovery plant.[298]

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. The fuel, according to the nuclear safety analysis, was to be transferred to polyethylene bottles prior to being places in 912 containers that were reported to have water tight steel tubes to serve as secondary containment. Following storage, and in preparation for final shipment for the purpose of recovery, the five 912 containers were to be repackaged into polyethylene bottles for

[291] Rockwell International Report, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[292] Flora, J.W., Atomics International, *KEWB Radiological Emergency Plan*, January 14, 1960. HDMSP01637672
[293] Atomics International, FDP-704-990-002, *Dismantling Plan for KEWB Facility (Bldgs 073,123 and 793)*, October 17, 1974.
[294] 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.
[295] Rocketdyne Report, N001ER000017, "Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective," September 1991.
[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.
[297] Atomics International, Internal Letter Re: Tour and Inspection of AI Fuel Handling and Storage Facilities, August 8, 1966.
[298] Atomics International, Document PP-704-990-002, *Decontamination and Disposition of Facilities Program Plan*, January 23, 1975.

shipment in DOT SP 5061 shipping containers. This repackaging was to occur in the decontamination room of Building 4021.[299]

The KEWB reactor facility, including Building 4073, was demolished in 1975. Contaminated or activated equipment and materials were removed and sent to the RMHF for decontamination and disposal for unrestricted use, or package 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 established as "acceptable" for unrestricted use of the site. These levels were identified in Rockwell International's dismantling plan as follows:[300,301302]

Contamination Limits for Decontamination and Disposition of the KEWB Facility

	Total	Removable
Beta-gamma Emitters	0.1 mrad at 1 cm with 7 mg/cm2 absorber	100 dpm/100 cm2
Alpha Emitters	100 dpm/100 cm2	20 dpm/100 cm2

The reactor room was dismantled by removing, surveying and salvaging the overhead wiring and cable trays and hot water heaters. The control rod drivers and controls were removed, surveyed, and placed in containers for shipment to a burial site. The north and west plates of the reactor enclosures were unbolted to permit removal of the graphite logs that surrounded the reactor vessel. The decontamination and disposition report noted that six of the graphite logs located directly beneath the reactor vessel on the floor of the enclosure 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 for final packaging and shipment to Beatty, Nevada, for burial.[303]

Following removal of the logs, the pipe lines to the reactor vessel were crimped to contain any residues and then were cut with a saw. The vessel was spray painted to fix the contamination (360 to 40,555 dpm/100 cm^2) and was then removed, wrapped in a 55-gallon bag, and placed in a shipping container for transport to Beatty, Nevada. The remainder of the reactor enclosure was cut out using a welding machine and carbon rod. Smear surveys of the concrete pad directly below the reactor and the concrete wall adjacent to the reactor revealed no removable contamination. However, concrete samples from these areas did indicate induced radioactivity.

[299] Schumann, G., Atomics International Document NSA-001-14-001, *KEWB Deactivation Nuclear Safety Analysis*, June 4, 1969.
[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.
[303] Rockwell International Report, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.

All concrete contained detectable induced activity was removed so the levels documented in the table above became the natural radiation level of the concrete.[304]

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. All system components of the fuel handling room were removed, package, and shipped to the RMHF for disposal. The walls, ceiling, and floor were lined with sheet metal and the seams in the panels were soldered to form a leak-tight barrier. Beta and alpha contamination in the walls were decontaminated by foaming, wet vacuuming, and wiping to allow the removal of the sheet metal room liner without spreading contamination to the bare concrete walls and floor. The liner was placed in boxes for shipment to Beatty, Nevada, for burial.[305]

The instrumentation piping passing through the 2-foot thick concrete wall was highly contaminated. Enough contamination remained following wet swabs that removal of the pipes was necessary. A total of twelve pipes were removed. A fuel storage tank located in a 5-foot deep, 1-foot diameter pit in the fuel handling room was removed. The pit had a metal liner that was found to be contaminated. Because decontamination of the liner was impractical due to the inaccessibility of the inner surfaces, the liner was removed by demolishing the floor adjacent to the pit and lifting the liner out with a crane. The liner was transferred to the RMHF for disposal.[306]

The final demolition of the KEWB facilities included the removal of the asphalt paving over the entire KEWB area, the removal of the concrete foundations for the exhaust and electrical buildings; the removal of the concrete pads for the air conditioners, compressor and filter plenum wooden structure at the KEWB entrance; the removal of the concrete roof over the KEWB; the removal of the above-grade portions of the retaining wall; the removal of three underground tanks and their associated fill and drain lines; and the removal of the waste storage building, Building 4123.[307]

Following the confirmation by a final survey of Building 4073 that contamination levels were within "prescribed limits," the Building 4073 rooms were backfilled with concrete and asphalt rubble and covered with soil. The prescribed limits, as defined in the 1974 dismantling plan, were 100 dpm/100 cm2 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.[308,309,310] The site was released for unrestricted use on March 3, 1976, by the ERDA.[311]

[304] Rockwell International Report, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[305] Rockwell International Report, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[306] Rockwell International Report, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[307] Rockwell International Report, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[308] Rockwell International Report, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.

Information from Interviewees: Interviewee 5 had extensive knowledge on the operations of the KEWB and Building 4073. Interviewee 5 served as the responsible engineer for the KEWB and was one of three operators that ran the reactor. The following are excerpts from that interview:

> The KEWB reactor was a water-boiler type reactor. The originally designed reactor was a solution-fueled reactor designed for university research. It was a steady-state reactor and was very low-powered, 50kW. The purpose of the KEWB program was to demonstrate that the reactor was completely safe and that anything they could do to it in a college environment would be safe. We would run tests to try and simulate the worst kinds of accidents we could imagine and the reactor would always shut itself down as a safety feature. All of the experiments we did were designed to test the safety of the KEWB reactor. KEWB was used solely for safety demonstrations. Subsequent to the KEWB program, we used the reactor as a pulse reactor for pulse neutron radiation experiments…
>
> …There were radioactive gases and liquids associated with KEWB. The KEWB did generate fission gases. The fission gases were held in an underground storage tank and then vented up to a stack after a decay period. The only contamination that might still remain from that would be in the underground storage tank[312]…We had fission gases that were generated and sent to the underground tank. Then we had argon-41 that was generated in the reactor vault, but this was not held in the underground tank, it was just vented up the stack. We would have to ventilate the room anytime we had to do work in the reactor room because of the radioactive argon gas…
>
> …The reactor fuel was liquid, uranyl sulfate. The coolant was water. There were cooling coils. I think the coolant was recycled. There was essentially no radioactivity in the coolant and none was discharged to the environment. There were two different reactor core vessels at KEWB. The first was a 12-inch spherical core that used highly enriched (93%) uranium, U-235. There was a stack on the reactor that was an overflow chamber. When we pulsed the reactor, gas would form and it would expel the fuel solution up and it would become subcritical… There was a fuel and gas handling system for the reactor located in an adjacent room in the KEWB Building.
>
> …There were three rooms in the concrete vault below grade. One room was the reactor vault, one room was the valve control room, and the third room was where the gas holdup tank, liquid drain tank, and associated plumbing were located. There was a hydrogen recombiner located in that room as well that we ran a few tests on. The radiation levels in the fuel and gas handling room became very high. We hardly went into that room. The fuel would end up there and the piping would get highly contaminated…
>
> …When the fuel was drained out of the reactor it went into the below-grade drain tank. We also had a precipitate material in the lines and we did some chemical flushing to try and recover the precipitate material. That process generated a lot of liquid that ended up getting stored in glass carboys. We would flush the pipes and drain the rinse into the

[309] Rocketdyne Report, N001ER000017, "Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective," September 1991.
[310] Rockwell International, FDP-704-990-002, *Dismantling Plan for KEWB Facility (Bldgs 073, 123 and 793)*, October 17, 1974.
[311] Stamp, Stanley, Letter Re: "Decontamination and Disposition of ERDA Facilities," March 3, 1976.
[312] The 1975 D&D report confirms that the underground storage tank was removed during disposal activities.

carboy containers. The containers were stored outside Building 4123 across from the KEWB reactor building…[313]

…Halfway through the KEWB program we changed the reactor vessel shape. We took the original 12-inch spherical vessel out and replaced it with a 12-inch cylindrical vessel. We cut the spherical vessel out and stored the reactor in Building 4123, which was a storage building designed for holding the reactor vessel…There are vents located in the bermed area of Building 4073, which were the vents that allowed us to draw fresh air into the building and blow the argon gas out of the stack…

…An incident report (A0504) associated with the KEWB reactor building noted that between April 1 and June 30, 1961, a research engineer received quarterly exposures to gamma and neutron radiation at levels greater than 3 rem. This occurred while conducting core experiments required for termination of the KEWB program and resulted in high radiation in the reactor room. The engineer was aware of his high cumulative exposure in early May, but because of the importance of the tests and lack of other qualified operators, he continued to conduct "unreflected" core experiments without prior approval to exceed the 3 rem quarterly limit. That incident report is referring to me. I was that research engineer referenced…

…We did very little on-site storage of waste. I mentioned the first KEWB reactor vessel and the rinse solution, but there was little else. The reactor vessel stayed on site until the area was decontaminated and the rinse solution was eventually taken to RMHF…

…We used sulphurous acid H_2SO_3, once over a period of a few days to chemically flush the plumbing lines at KEWB… The whole idea was to dissolve fuel that had precipitated out into the gas lines or other lines. The acid also took off a bit of the steel from the piping. We were tense when we flushed the lines with sulphurous acid because the 1/8" drain lines coming out of the 1/4" piping were getting plugged up and it wasn't draining fast enough. We didn't want the sulfurous acid to be in the system very long so we wanted to get it out fast. I never did learn exactly what caused the plugging of the lines. We had to go into the gas handling room that was highly contaminated to unplug the drain lines. We went in very quickly and closed the valves and cleaned out the drain lines with a wire. The drain lines went into the glass carboy containers so that is where the rinse solution was contained. We got our gloves contaminated on that work. We would take our gloves and overalls and anything contaminated from our work on the KEWB and throw the items in the radioactive waste. We were a good customer of the RMHF…

…The reason we had to flush the system was because when the reactor was pulsed and the foam solution that included the liquid uranium fuel would rise in the overflow chute and it would splash and go into the gas piping. We were trying to recover the fuel, which is why we used the sulphurous acid. Using the sulphurous acid was a one-time situation. It was driven by material accountability. Since the fuel was highly enriched uranium, it had to be fully accounted for. Every so often we would have to calculate the amount of uranium in the core and things like that. We discovered that we had to add a little bit of fuel and our calculations weren't finding all the fuel. That's when we realized that a small amount was splashing into the gas lines. So our calculations of fuel in the core were always a bit low because some of the fuel was in the piping. So then we got into

[313] The research team has not located any information to indicate that carboys were used to collect and store material that was flushed from the pipes. There is also no evidence of any containers larger than carboys (i.e. 55-gallon drums) being used for this purpose.

> discussion about how to recover the fuel. We talked to "Mad Chemist" and came up with the idea to use sulphurous acid to recover the fuel. The fuel was recovered, but was not recycled. It was contained in the carboys. The first couple of carboys were pretty hot and went to the RMHF. We flushed the system pretty heavily to make sure we got all the sulphurous acid out, so we generated a lot of liquid waste from that process. The carboys were stored temporarily at Building 4123, but eventually it was all sent to RMHF…
>
> …There were no restroom facilities in Building 4073, so nothing was drained down any toilets. We used the AE-6 building restrooms. The general rule was that once anything was inside the fence it stayed there. I don't recall any problems with underground sumps, pumps, tanks, or piping. I can't recall any leaking tanks or pipes in our system. Most of the piping was welded, stainless steel…

Interviewee 104 also had experience with Building 4073. Interviewee 104 worked for Atomics International beginning in 1956 and was an engineer. Of Building 4073, the former employee stated:

> The only other reactor at SSFL that I reviewed was a little boiling water reactor – I believe it was the Kinetic's Experiment Water Boiler (KEWB). The fuel was uranyl sulfate dissolved in water in a 12- to 15-inch spherical core and was a prototype and test reactor used to prove the safety for the AE-6 reactor. The design was from Los Alamos. We referred to the experiments done on this reactor as BURP experiments because during the tests, the power was increased rapidly so that the liquid appeared to boil and then the reactor would automatically shut down. I believe that AI sold several of the AE-6 reactors to universities and other research institutions that needed a neutron source for the production of radioisotopes and to perform other reactor experiments.

Interviewee 2 began working for Atomics International in November 1955, transferred to Rocketdyne in 1965 or 1966, and worked there until March 1968. Interviewee 2 also had knowledge of Building 4073 operations and provided the following information.

> I do remember doing some work on the hill at the KEWB reactor. I remember testing a piece of electronic equipment with a pulse of nuclear radiation from the reactor. The KEWB reactor is a water boiler reactor, which is essentially a big pot with water and a solution of uranium in it. If you pull the control rod part of the way it, the reactor goes critical and starts to generate power. If you pull the control rods all of the way out, the reactor goes supercritical and then "poof." It explodes and puts out a lot of nuclear radiation in a very short time and then of course it shuts itself down automatically. Then you have to wait 45 minutes before you can set it up again. I spent one day doing that. We eventually discovered a much easier piece of equipment to use for our tests that gave equally useful results to the reactor, it was a flash x-ray machine. We had the flash x-ray machine at DeSoto. It doesn't rely on a nuclear reactor. It is an x-ray tube with a cold cathode. The cathode has a lot of tiny spikes on it to generate intense electric fields at the points of the spike and draw electrons out of the cathode. Then the electrons slam into an anode and generate x-rays. It was a lot simpler to use than the KEWB and cheaper as well…
>
> . . .Going back to my one day at the KEWB reactor, I remember that the technician that was supposed to make sure the cameras had film in them forgot to load the cameras and we missed the first shot. We didn't get any data on our first pulse of the reactor. I was waiting outside the KEWB building when we ran a test. It was a safety precaution. We didn't want to be near the thing when it went "poof." We would set everything up and get

> it ready to go. I went outside. I don't know how they got the reactor to go off, maybe there was a timer or something. I don't remember that detail. Maybe there was a timer with a delay so that we could leave the building before the control rods were pulled out. The system would pull the control rods out then put them back in. When the control rod came out you would get this "explosion" and then you would drop the control rod back in and wait for things to cool down. Then you set it up and do it again. The measurements would be recorded on an oscillograph or camera. An oscillograph was an oscilloscope with a camera looking at it. The "poof" is the release of radiation from the removal of the control rod. The reactor liquid is completely contained in the tank, it just expands to a greater volume when the reactor goes supercritical. The KEWB itself was below grade level and the reactor itself was in the cellar of the building. This provided additional shielding. The KEWB was a stand-alone experiment and not related to the other experiments at the SSFL except that AI was running all of them. I don't recall what the other buildings surrounding the KEWB building were used for. I was doing this in 1964 or 1965, so it was at least 45 years ago. I left in 1966, and this was one of the last things I did before I left.

Interviewee 291 began working at SSFL in 1956 and also had some experience working with the KEWB and stated that:

> I also worked at the KEWB (Kinetics Experiment Water Boiler). It simulated an atomic bomb with a very short, very intense period of radiation. We were working on experiments to see what would happen to insulators exposed to high level fast radiation. I never did get to operate the reactor… When I first went up to Santa Sue I was working on instrumentation in tents because, oh my gosh, they hadn't yet built the buildings!

Of Building 4073, Interviewee 296, who began working at SSFL in 1956, stated the following:

> I transferred up to the Liquid Metals Engineering Center in 1959. I was an engineer and I worked on the Kinetic Experiments for Water Boilers (KEWB). I designed a water boiler reactor. I had worked on a very similar reactor on a project in the 200 Area at Hanford before moving to California. The KEWB was underground. They eventually filled it in and put a cover on it. I assume it was cleaned up before it was filled in, although I have no knowledge that this was done.
>
> I didn't have to wear a film badge in the beginning because we were just designing the facility. Film badges weren't necessary until the reactor went critical. The KEWB was the first reactor to go critical at SSFL, even before the Sodium Reactor Experiment. That was in about 1957. The SRE furnished power to the city of Moorpark for a little while. SRE was a lot bigger than the KEWB. I did not work on the SRE design.
>
> I never handled any radioactive materials at SSFL. I handled radioactive materials at Hanford before I moved here, but I never handled any at SSFL.
>
> KEWB was an experimental reactor. Once I had finished my job, contributing to the design of the reactor, I worked on other projects. My involvement was really only during design and construction. I wasn't involved once the reactors were operational.

Radiological Incident Reports: There have been several incidents associated with Building 4073 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 the incident reports are provided following the table, when available.

Building 4073 Incident Report Summary

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.

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

- 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).[314]

- 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 without prior approval to exceed the 3 rem quarterly limit (A0504 and A0291).[315, 316, 317]

Based on log book entries for the KEWB there may have been other incidents associated with the operations of the KEWB. 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 Rm. 3 100 dpm. Decontaminate 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 bldg. All equipment packed and sealed for shipment to EG&G Boston, Mass." At 1330 hours on the same day, the

[314] Gerber, L.A., Atomics International Inter-Office Letter Re: Personnel Radiation Exposures, Incident A0522, March 5, 1958.
[315] Hickey, E.C., Atomics International Inter-Office Letter Re: Radiation Exposure, Incident A0504, August 1, 1961.
[316] Remley, M.E., Letter Re: Quarterly Radiation Over-Exposure, Incident A0291, October 13, 1961.
[317] These two incident reports appear to reference the same employee and relate to the same time period of increased radiation exposure.

test building was cleaned and decontaminated. The log book did not provide the results of any additional surveys in relation to this incident.[318,319]

Current Use: The KEWB reactor facility, including Building 4073, was demolished in 1975. The ERDA released the facility and surrounding area for unrestricted use in 1976, and aerial photographs do not show any disturbances at or near the Building 4073 area.[320]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- According to the 1975 decontamination and disposition of facilities program plan, Building 4073 had a number of moderately contaminated or activated structures, including, the reactor core vessel, the graphite reflector, the recombiner and gas handling system, the fuel storage tank, and contaminated underground lines and tanks including the exhaust and liquid waste systems. According to the plan, the excavation of the underground lines and tanks would eliminate the potential for soil contamination and the removal of the remaining contaminated system would eliminate the need for continued surveillance of the facility. The plan did not include specific information regarding the level of contamination within Building 4073.[321]

- In 1975, Rocketdyne performed a final radiological survey during decontamination and demolition of the facility and published results in the final D&D report.[322] Survey results found that all remaining surfaces were decontaminated to levels as low as reasonably achievable; in all cases below the levels for future unrestricted use (removable contamination of 20 dpm/100 cm^2 α or 100 dpm/100 cm^2 β). According to the report, survey results were below the 1976 acceptable limits identified above.

- In July 1975, Rocketdyne performed a surface scan of the KEWB site following demolition to confirm that no radiological contamination remained.[323] The survey found no levels of beta-gamma surface contamination above the measured background (0.15 – 0.25 mrad/hr). The report did not provide information to indicate how background was measured. According to the report, survey results were below 1975 background limits and were, as a result, below acceptable limits.

- In May 1983, Argonne National Laboratories performed a post-remediation radiological survey.[324] The survey included a surface scan to determine ambient gamma exposure rate

[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.
[320] Stamp, Stanley, Letter Re: "Decontamination and Disposition of ERDA Facilities," March 3, 1976.
[321] Atomics International, PP-704-990-002, Decontamination and Disposition of Facilities Program Plan, January 23, 1975.
[322] Rockwell International Report, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[323] Letter from R.K. Owen (Rockwell International) to R.J. Tuttle, "Radiation Survey T073 (KEWB) Site," July 17, 1975.
[324] 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.

and low-level radiation level. Additionally, soil samples were taken and analyzed for gamma radiation and uranium. The survey found no measurements above background. According to the report, the 1983 background levels were relatively high (40 μR/hr and 8,000 cts/min) due to shine from nearby RMHF buildings, Building 4021 and Building 4022. The survey concluded that the site could be released for unrestricted use.

- In August 1988, Rocketdyne performed a surface scan measuring ambient gamma exposure rate to ensure no contamination existed as a result of radioactive materials movement in a "field" between Building 4073 and the RMHF. The mean exposure rate was 17.4 ± 0.96 μR/hr (–0.2 ± 0.96 μR/hr when corrected for background). And background was measured as 17.0 μR/hr. The acceptable limit was 5.0 μR/hr above background. As a result, the survey results were below the 1988 acceptable limits.[325] As indicated above, the Argonne National Laboratories report determined background levels to be 40 μR/hr.[326] The research team has been unable to locate any documentation addressing this discrepancy.

- In 2000, Rocketdyne conducted vegetation sampling in Area IV at the SSFL that included Buildings 4073 and 4093. The report summarized that the only radionuclide found in the vegetation samples was naturally occurring K-40. The report stated that no man-made radionuclides were found in either on- or off-site vegetation samples. The report provided minimum detectable activities of various radionuclides from the sample (ENV00102) collected near Buildings 4073 and 4093. These were Mn-54 at 0.0467 pCi/g, Co-60 at 0.0699 pCi/g, Cs-137 at 0.0606 pCi/g, Eu-155 at 0.0887 pCi/g, Pb-210 at 0.434 pCi/g, and Ra-226 at 0.794 pCi/g.[327] The report did not provide an approximate location of the sample taken near Buildings 4073 and 4093.

Radiological Use Authorizations: 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 facility. The plan noted; however, that in the event the facilities and the associated U.S. Energy Research and Development Administration-optioned land would be reverted to Atomics International, the regulations of the State of California Bureau of 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."[328]

As a result, Authorization No. 84 was issued on January 16, 1975, for the decontamination and disposition of the KEWB facility. The authorization listed enriched uranium, activation products, and mixed fission products of unknown quantity as being distributed throughout the facility. Authorization No. 84 identified the limits and requirements of the authorization as being

[325] ETEC Document, GEN-ZR-0009, "Radiological Survey of the T513 Parking Lot; Old R/A Laundry Area; Plot 333; and Areas Between the SRE to RMHF, and KEWB to RMHF," August 26, 1988.
[326] 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.
[327] Boeing, RD01-152, *Site Environmental Report for Calendar Year 2000, DOE Operations at the Boeing Company Rocketdyne Propulsion & Power*, September 2001.
[328] Atomics International, Document PP-704-990-002, *Decontamination and Disposition of Facilities Program Plan*, January 23, 1975.

those identified in the decontamination and disposal procedure for Building 4073.[329]

Former Radiological Burial or Disposal Locations: There have been no on-site radiological burial or disposal locations identified during the operational period of Building 4073 operations. However, it is important to note that asphalt and concrete from D&D activities were used as backfill at the site in 1975. While the concrete was decontaminated to levels presented above that were "as low as practicable," these levels are not in compliance with the requirements of SB-990.

Aerial Photographs: Aerial photographs do not show any staining or unusual site operations in the Building 4073 area. The only feature visible in the area, other than the buildings, is a water pipeline that extends from 12th Street across the area to Building 4003 in Subarea HSA-6.[330,331]

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.[332] All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Drainage at the site is to the south-southwest to a "paved ditch" adjacent to a dirt road that leads to 12th Street. Here the flow of drainage proceeds southeast along 12th Street to G Street and continues southwest to 17th Street.[333] Building 4073 and the surrounding buildings were not serviced by any other storm drains or sanitary sewer lines. An undated photograph shows a "KEWB-area cave-in" with rebar and cement exposed. Additional information regarding this cave-in could not be located.[334]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4073 area is Class I because of previous site use, incident reports, and radioactive material use during building operations.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.1 provide a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the Building 4073 area. As discussed above, previous investigation found radiological contamination in Building 4073. In addition, previous characterization studies for the Building 4073 area were focused on delineating the extent of contamination to standards that were applicable at the time. Therefore, additional characterization is recommended for the Building 4073 area. This includes the following Building 4073 areas and appurtenances:

[329] Heine, W., Authorization No. 84, January 16, 1975.
[330] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[331] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.
[332] Rocketdyne Report, N001ER000017, "Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective," September 1991.
[333] Atomics International, Drawing 303-00C-C2, "Misc. Paving, Patching & Drainage Improvements – KEWB," Date illegible, circa 1969. HDMSE00457545.
[334] Rockwell International, Photo 7704-621252, Undated, HDMS00015748.

- The former locations of the underground storage tanks and their drain lines associated with building operations. Located west of Building 4073, the tanks comprised three underground tanks and a 60-foot exhaust stack with a 2,000-cubic foot per minute blower system. A 300-gallon collection tank was used to collect gas directly from the reactor system. A 1,000-gallon storage tank buried beneath floor level and adjacent to the test building retained all liquid waste from the facility. The tank was equipped with pump-out connections for removal of the liquid waste when necessary. Another 1,000-gallon tank was originally used to retain the reactor cooling water so that it could be checked for activity prior to release. That tank appears to have drained through a 2-inch line to the west and then south of the KEWB facility.[335,336,337] Removal of the tanks and lines, as well as their operation, may have left residual contamination above background values in the area.

- The former Building 4073 footprint. Asphalt and concrete from D&D activities were used as backfill at the site in 1975. While the concrete was decontaminated to levels presented above that were defined "as low as practicable" in 1975, these levels are not in compliance with the requirements of the AOC. These samples should be taken at depths greater than 6 feet below ground surface.

- The ditch adjacent to the former dirt road. The ditch leads to 12th Street where the flow of drainage proceeds southeast along 12th Street to G Street and continues southwest to 17th Street.[338] . If radioactive materials were released the ground surface near Building 4073, residual contamination above background values may exist in the materials surrounding the ditch.

2.2.2 Building 4074 Area

Note: To date, the research team has been unable to locate many documents relating to the construction and operation of Building 4074. As a result, the information provided below is limited.

Site Description: The Building 4074 area comprises Building 4074 and the surrounding area, and is located between 11th and 12th Streets. Numerous other buildings surround Building 4074, including Buildings 4083, 4093, 4103, 4633, and 4893. These buildings are discussed in sections below. Constructed in 1958, Building 4074 was a storage building consisting of a steel frame covered in sheet metal located near Parking Lot 4523.[339] Figures 2.2.2a through 2.2.2c provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

[335] Rockwell International Report, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[336] Flora, J.W., Atomics International, *KEWB Radiological Emergency Plan*, January 14, 1960. HDMSP01637672
[337] Atomics International, FDP-704-990-002, *Dismantling Plan for KEWB Facility (Bldgs 073,123 and 793)*, October 17, 1974.
[338] Atomics International, Drawing 303-00C-C2, "Misc. Paving, Patching & Drainage Improvements – KEWB," Date illegible, circa 1969. HDMSE00457545.
[339] Atomics International, AI-70-73, *Safety Analysis Report for L-85 Nuclear Examination Reactor*, November 25, 1970.

Building Features: Very little information could be located regarding the features of Building 4074. Constructed in 1958, Building 4074 was a storage building consisting of a steel frame covered in sheet metal located near Parking Lot 4523. The building contained two rooms and was connected to Building 4083 by a walkway.[340,341] Environmental reports indicate the building had a sampling station for measuring the ambient air radioactivity concentration on a quarterly basis. The sampling station was located at the south side of Building 4074. See the summary of previous radiological investigations below for additional information.[342]

Former Use(s): Building 4074 was constructed in 1958 to serve as a storage and film processing building where personnel processed photographic oscillograph paper for the KEWB. The building stored emergency supplies and did not contain radioactive materials.[343] According to the May 2005 HSA, Building 4074 was demolished in 1995; however, recent site photographs show the foundation of the building to still be present.[344]

Information from Interviewees: To date, there have been no interviews with personnel familiar with operations at Building 4074.

Radiological Incident Reports: There have been no incident reports associated with the operations of Building 4074 located to date.

Current Use: Building 4074 appears to have been demolished in 1995 with the foundation of the building left in place.[345]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- As indicated above, environmental reports indicate Building 4074 had a ground sampling station for measuring ambient air radioactivity concentration on a quarterly basis. The following table presents the annually averaged ambient air radioactivity concentration from 1971 to 1975. [346]

[340] Rocketdyne, N001SSR140087, *Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility*, March 6, 1986.
[341] Atomics International, AI-70-73, *Safety Analysis Report for L-85 Nuclear Examination Reactor*, November 25, 1970.
[342] Rockwell International, *Environmental Impact Assessment of Operations at Atomics International Under Special Nuclear Materials License No. SNM-21*, AI-76-21, April 30, 1976.
[343] Rocketdyne, N001SSR140087, *Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility*, March 6, 1986.
[344] 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.
[345] 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.
[346] Rockwell International, *Environmental Impact Assessment of Operations at Atomics International Under Special Nuclear Materials License No. SNM-21*, AI-76-21, April 30, 1976.

Building 4074 Ground Sample Station
Annually Averaged Ambient Air Radioactivity Concentration (1971-1975)

Year	α (pCi/m^3)	β (pCi/m^3)
1971	<0.0087	0.33
1972	<0.0085	<0.14
1973	<0.0066	<0.037
1974	<0.0056	<0.15
1975	<0.0061	<0.072

Source: Rockwell International, *Environmental Impact Assessment of Operations at Atomics International Under Special Nuclear Materials License No. SNM-21*, AI-76-21, April 30, 1976.

Additional air sample results were not identified during the drafting of this TM.

- In 1985, Rocketdyne conducted a final radiological survey, releasing the final report in March 1986. (The survey included buildings 4073, 4074, 4083, 4084, 4093, 4453 and 4453). Because radioactive materials were not reported to have been used in Building 4074, the survey applied reduced sampling with a 1-square meter sample being measured from every other 9-square meter grid, rather than every 3-square meter grid.[347]

  Average contamination measurements were taken with an alpha (Ludlum Model 43-1 or equivalent) or beta (Ludlum, Model 44-9 or equivalent) probe. According to the survey results, soil samples showed no evidence of radioactivity due to facility operations. The maximum average alpha detected was 17.2 dpm/100 cm^2 (limit is 5,000 dpm/100 cm^2) and the maximum average beta detected was 1,987 dpm/100 cm^2 (limit is 5,000 dpm/100 cm^2). According to the report, the limits for the release for unconditional use of Building 4074 were taken from the U.S. Nuclear Regulatory Commission Regulatory Guide 1.86 and the U.S. Nuclear Regulatory Commission Dismantling Order, Docket No. 50-375. The report indicated that these criteria were in agreement with the guidance found in the January 1985 version of the American National Standards Institute/Health Physics Society Standard ANSI N13.12, and in the DECON-1 document issued by the State of California in 1977.
  The maximum ambient exposure rate presented in the report was for Buildings 4083, 4074 and 4453 and 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 to not represent residual contamination. Additionally, the survey found that measured radiation levels were below 1985 acceptable limits, making the site acceptable for unrestricted use. [348]

Radiological Use Authorizations: There have been no radiological use authorizations identified for Building 4074.

Former Radiological Burial or Disposal Locations: None.

[347] Rocketdyne, N001SSR140087, "Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility," March 6, 1986.
[348] Rocketdyne, N001SSR140087, "Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility," March 6, 1986.

Aerial Photographs: Aerial photographs do not show any disturbances near Building 4074, with the exception of a water pipeline that crosses the site from 12th Street to Building 4003.[349,350] The pipeline remains present today.

Radionuclides of Concern: None.

Drainage Pathways: A ditch was located between Buildings 4074 and 4083/4103. Drainage in the ditch appears to have been directed by a 6-inch galvanized pipe southwest to a "paved ditch" adjacent to a dirt road that leads to 12th Street. Here the flow of drainage proceeds southeast along 12th Street to G Street and continues southwest to 17th Street.[351] Building 4074 does not appear to have been serviced by any other storm drains or sanitary sewer lines.[352]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4074 area is Class 1 because of the building's proximity to Building 4093 and the limited operational information available for the building.

Recommended Locations for Soil/Sediment Sampling: Recommended sampling locations based on historical and site information include the following:

- The former Building 4074 footprint and the passageway and ditch between Building 4074 and Building 4083. If radioactive materials were released into the ditch as a result of operation in Building 4093, residual contamination may exist in the materials surrounding the ditch.

2.2.3 Building 4083/4103 Area

Note: To date, limited historical documents relating to the construction and operation of Buildings 4083 and 4103 has been located. As a result, the information provided below is limited.

Site Description: The Building 4083/4103 area includes Building 4083, Building 4103, and the surrounding area. Building 4083 was constructed around 1958 and is separated from the KEWB reactor test building by approximately 200 feet. In the early 1970s, the building was modified to include Building 4103. Other building surrounding these two structures include Building 4074, discussed above, and Buildings 4093 and 4893, discussed below.[353] Figures 2.2.3a through 2.2.3c provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4083 was a 12- by 20-foot, prefabricated, sheet-steel building comprising six rooms, located near Building 4073. A separate structure, Building 4103, was attached to the building for office functions. Building 4083 housed all recording and control instrumentation necessary to operate the KEWB reactor located in Building 4073. The building

[349] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[350] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.
[351] Atomics International, Drawing 303-00C-C2, "Misc. Paving, Patching & Drainage Improvements – KEWB," Date illegible, circa 1969. HDMSE00457545.
[352] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.
[353] 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.

also included the special instrumentation needed for initiating and recording transient operation.[354]

Former Use(s): Constructed in 1958, Building 4083/4013 served as the office and control building for the KEWB reactor in Building 4073.[355] The May 2005 HSA summarized that Building 4083/4103 was included in an NRC license, dated January 5, 1972 (R-118 Docket No. 50-375); however, the research team has not been able to locate any documentation indicating that Building 4083/4103 was included in the license for the L-85 reactor located in Building 4093.[356]

The May 2005 HSA lists two different dates for when Building 4083/4103 was demolished, 1980 and 1995. Aerial photographs show the building to still be present in 1983 and 1988 aerial photographs, but no longer present in 1995. [357,358]

Information from Interviewees: Interviewee 5, who provided information regarding Building 4073 and the KEWB reactor, indicated during his interview that "Building 4083 is probably the KEWB office building and Building 4103 is the control building."

Radiological Incident Reports: There have been no radiological incident reports associated with the operations in Building 4083 located to date.

Current Use: Building 4083/4103 appears to have been demolished sometime between 1988 and 1995.[359] The foundations of Building 4083/4103 remain at the site today.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- In 1985, Rocketdyne conducted a final radiological survey, releasing the final report in March 1986. (The survey included buildings 4073, 4074, 4083, 4084, 4093, 4453 and 4453). Because radioactive materials were not reported to have been used in Building 4083, the survey applied reduced sampling with a 1-square meter sample being measured from every other 9-square meter grid, rather than every 3-square meter grid. [360]

  Average contamination measurements were taken with an alpha (Ludlum Model 43-1 or equivalent) or beta (Ludlum, Model 44-9 or equivalent) probe. According to the survey results, soil samples showed no evidence of radioactivity due to facility operations. The maximum average alpha detected was 17.2 dpm/100 cm^2 (limit is 5,000 dpm/100 cm^2) and the maximum average beta detected was 1,987 dpm/100 cm^2 (limit is 5,000 dpm/100

[354] 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.
[355] Rocketdyne, N001SSR140087, *Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility*, March 6, 1986.
[356] 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.
[357] 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.
[358] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[359] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[360] Rocketdyne, N001SSR140087, "Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility," March 6, 1986.

cm^2). According to the report, the limits for the release for unconditional use of Building 4074 were taken from the U.S. Nuclear Regulatory Commission Regulatory Guide 1.86 and the U.S. Nuclear Regulatory Commission Dismantling Order, Docket No. 50-375. The report indicated that these criteria were in agreement with the guidance found in the January 1985 version of the American National Standards Institute/Health Physics Society Standard ANSI N13.12, and in the DECON-1 document issued by the State of California in 1977.

The maximum average ambient exposure rate presented in the report was for Buildings 4083, 4074 and 4453 and was found to be 23.1 μR/hr. It is important to note the findings were the average of the three buildings. The report does not provide the findings of each building individually. 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 to not represent residual contamination. Additionally, the survey found that measured radiation levels were below 1985 acceptable limits, making the site acceptable for unrestricted use.[361]

- On February 2, 1987, a letter from Rockwell International to the U.S. Nuclear Regulatory Commission presented the findings of a post-repair survey to determine the ambient exposure rate following the repair of the reactor floor in Building 4093. As part of this survey, Rockwell International performed readings with a Reuter-Stokes RS-111 high-pressure ion chamber in Building 4083 to provide "a concurrent determination of natural background." The average ambient exposure rate of Building 4083 measured 10.9 uR/hr, while the maximum ambient exposure rate measured 12.0 uR/hr.[362]

Radiological Use Authorizations: None.

Former Radiological Burial or Disposal Locations: None.

Aerial Photographs: Aerial photographs do not show any disturbances near Building 4083/4103, with the exception of an unknown pipeline that crosses the site from 12th Street to Building 4003.[363]

Radionuclides of Concern: None.

Drainage Pathways: A ditch was located between Buildings 4074 and 4083/4103. Drainage in the ditch appears to have been directed by a 6-inch galvanized pipe southwest to a "paved ditch" adjacent to a dirt road that leads to 12th Street. Here the flow of drainage proceeds southeast along 12th Street to G Street and continues southwest to 17th Street.[364] Building 4083/4103 does not appear to have been serviced by any other storm drains; however, a 6-inch vitrified clay pipe appears to provide sanitary sewer service to the building. The outfall of this pipe is outside of

[361] Rocketdyne, N001SSR140087, "Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility," March 6, 1986.
[362] Rockwell International, "Summary Report of Ambient Exposure Rate Measurements at the L-85 Research Reactor Facility After Repair of Concrete Floor," February 2, 1987.
[363] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[364] Atomics International, Drawing 303-00C-C2, "Misc. Paving, Patching & Drainage Improvements – KEWB," Date illegible, circa 1969. HDMSE00457545.

Building 4083/4103, and in 1964 appears to combine with the flow from the ditch between Building 4074 and 4083/4103.[365]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4083/4103 area is Class 1 because of the building's proximity to Building 4093.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.1 provide a convenient reference for the following recommendations.

Soil sampling is recommended in the Building 4083/4103 area. Previous characterization studies for the Building 4083/4103 area were focused on delineating the extent of contamination to standards that were applicable at the time. Therefore, additional characterization is recommended for the Building 4083/4103 area. This includes the following Building 4083/4103 areas and appurtenances:

- The former Building 4083/4103 footprint. Because of the building's proximity to Building 4093 and the limited information available regarding building operations, sampling is recommended in and outside the footprint of the building. Radionuclides originating from Buildings 4093 may have migrated to the area between buildings via surface water flow or airborne releases.

- The passageway and ditch between Building 4074 and Building 4083/4103, as well as the former 6-inch galvanized pipe that directed drainage to a "paved ditch" adjacent to the dirt road that leads to 12th Street. Radionuclides originating from Buildings 4093 may have migrated to the area between buildings via surface water flow or airborne releases.366
- The 6-inch vitrified clay pipe that originated from within Building 4083/4103. This pipe appears to have provided sanitary sewer service to the building. The outfall of this pipe was outside of Building 4083/4103, and in 1964 appears to combine with the flow from the ditch between Building 4074 and 4083/4103.[367]

2.2.4 Building 4093 Area

Site Description: The Building 4093 area comprises Building 4093, Pad 4893, a sanitary leach field, and the land surrounding these features located on 11th Street. Building 4093 was constructed in approximately 1958 to house the AE-6 Reactor. The building was constructed of steel beam frames, wood frames, sheet metal and concrete.[368] Figures 2.2.4a through 2.2.4f provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: 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

[365] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.
[366] Atomics International, Drawing 303-00C-C2, "Misc. Paving, Patching & Drainage Improvements – KEWB," Date illegible, circa 1969. HDMSE00457545.
[367] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.
[368] Atomics International Document, AI-70-73, "Safety Analysis Report for L-85 Nuclear Examination Reactor," November 25, 1970.

4643, discussed below. Building 4093 contained a 12- by 31-foot control room and a 31- by 38-foot high bay. The high bay was a steel-framed superstructure covered with sheet metal siding and roofing. The high bay was serviced by a ½-ton overhead crane. The floor comprised 6 inches of concrete, except under the reactor and concrete shield enclosure, where 30 inches of reinforced concrete was provided.[369,370]

The reactor bay had an open ceiling approximately 10 meters high with an overhead crane.[371] The reactor was situated in the center of the high-bay area and consisted of a spherical core, a graphite reflector and thermal column, a mild steel reflector enclosure, the gas handling systems, the control and safety rod systems, the cooling systems, and the concrete shield enclosure. The core and gas handling system were contained in a stainless-steel system that provided the primary barrier against release of radioactivity. Secondary containment was provided by the mild-steel graphite reflector enclosure tank and the concrete shield walls that completely surrounded the primary system, except on top, where the neutron beam from the thermal column entered a tank containing subcritical lattice assemblies. When the neutron beam was not used, shielding was provided. Channels were also provided in the reflector, through which the neutron flux was available in various magnitudes for experimental purposes.[372] In 1974, polyethylene shielding was 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 1972 acceptable limits were.[373]

A concrete fuel storage vault was provided adjacent to the critical assembly for storage of assembled fuel elements to be used in exponential experiments. Additional concrete blocks were available for stacking around the reactor or walls of the high-bay area. The building did not include a stack.[374]

A metal safe was provided within the reactor room for the storage of small quantities of fuel solution (no more than 200 grams of U-235). Other fissile materials were to be stored in approved safe-geometry containers in an array no more reactive than authorized for containers.[375]

The control room included a lavatory that initially drained to the Building 4093 leach field prior to the addition of a sanitary sewer system.[376] During a 1996 Area IV survey of Building 4093, an exploratory trench in the expected area of the leach field uncovered a 4-inch diameter clay pipe supplying the leach field at a depth of approximately 4 feet below ground surface. The pipe

[369] Atomics International Document, AI-70-73, "Safety Analysis Report for L-85 Nuclear Examination Reactor," November 25, 1970.
[370] Atomics International, NAA-SR-7300, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.
[371] Oak Ridge Associated Universities, *Confirmatory Radiological Survey of the L-85 Reactor Facility, Rocketdyne Division, Rockwell International Corporation, Santa Susana, California*, December 1986.
[372] Atomics International, NAA-SR-7300, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.
[373] Felten, L.D. Internal Letter Re: Review of L-85 Reactor-Building 093, May 19, 1972.
[374] Atomics International, NAA-SR-7300, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.
[375] United States Atomic Energy Commission, Docket No. 50-375 Facility License No. R-118, January 5, 1972.
[376] Oak Ridge Associated Universities, *Confirmatory Radiological Survey of the L-85 Reactor Facility, Rocketdyne Division, Rockwell International Corporation, Santa Susana, California*, December 1986.

connected to a 90-degree clay pipe elbow angled down. The elbow connected to a tee pipe section that was positioned transverse to the supply pipe. One end of the tee was plugged. Extending horizontally from the other end of the tee across the top of the leach field on a bed of gravel was a row of butt-end clay pipe sections about 8 inches long.[377]

Former Use(s): Building 4093 was constructed in 1958 to house the AE-6 Reactor. The AE-6 Reactor was originally called the Water Boiler Neutron Source (WBNS) reactor. Built in 1952 in Downey, California, the WBNS had a maximum power of 0.5 Wt. The WBNS was modified to produce a maximum power of 3 kWt and moved to the SSFL site, where it was 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." From 1956 through 1972, the facility operated under an AEC contract; however, as of August 1966, inspection of Building 4093 indicated that activities at the building had been reduced to "caretaker status" and out-of-reactor fuel inventories had been reduced accordingly. In 1972, ownership of the building and reactor was transferred from AEC to Rockwell in 1972, and the reactor was renamed L-85. The NRC licensed the facility in 1972 under License R-118 (Docket No. 50-375).[378,379,380,381, 382] 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.[383]

The fuel required to maintain the operating characteristics of the L-85 reactor included uranyl sulfate having a U-235 enrichment of at least 90 percent dissolved in a 0.3 to 0.4 molar sulfuric acid solution. The use of fully enriched uranium minimized the critical mass and the sulfuric acid retarded the precipitation of uranyl peroxides. The hydrogen-to-uranium atom ratio was between 400 and 450 to minimize the mass coefficient of reactivity. The fuel solution contained about 30 ppm of copper (as copper sulfate) and about 200 ppm of iron (as iron sulfate) to catalyze the decomposition of hydrogen peroxide that was formed during the radiolytic decomposition of the water. The chloride content of the fuel solution was below 10 ppm to minimize corrosion of the reactor vessel.[384]

[377] Rockwell International, *Area IV Radiological Characterization Survey, Final Report, Volume 1*, A4CM-ZR-0011, August 15, 1996.
[378] Rocketdyne Report, N001SSR140087, *Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility*, March 6, 1986.
[379] Atomics International, *Atomics International: A Division of North American Aviation, Inc. Facilities Capabilities*, December 31, 1959.
[380] Oak Ridge Associated Universities, *Confirmatory Radiological Survey of the L-85 Reactor Facility, Rocketdyne Division, Rockwell International Corporation, Santa Susana, California*, December 1986.
[381] Atomics International, NAA-SR-7300, *Evaluation of the Atomics International Nuclear Development Field Laboratory as a Location for Reactor Facilities*, May 25, 1962.
[382] Atomics International, Internal Letter Re: Tour and Inspection of AI Fuel Handling and Storage Facilities, August 8, 1966.
[383] Atomics International, AI-75-31, *Atomics International Environmental Monitoring and Facility Effluent Annual Report 1974*, 1975.
[384] United States Atomic Energy Commission, Docket No. 50-375 Facility License No. R-118, January 5, 1972.

The fuel solution was contained in a 1-foot diameter, spherical, stainless steel vessel that was surrounded by a graphite reflector. Two safety rods and two control rods were also inserted.[385] The reactor had a homogeneous solution-type core and operated at up to 3kWt. It was used as a neutron source for many different tests, and was used for reactor operator training. The reactor operated off and on for 24 years, from November 1956 to February 1980.[386]

According to a May 1980 document titled "Procedure for Dismantling and Decontaminating the L-85 Reactor Facility," the detailed working procedure provided instruction for dismantling the L-85 reactor, decontaminating the facility to levels suitable for unrestricted use, and disposing all materials and equipment. The procedures provided that all items be checked for contamination prior to removal from the facility. Any equipment or material released from the facility for unrestricted use had to have radiation or contamination levels below the pre-determined contamination limits presented in the table below. All contaminated or radioactive components that were to be shipped off site were to be packaged and labeled in accordance with state and federal regulations for hazardous materials.[387]

L-85 Contamination Limits

	Total	Removable
Beta-Gamma Emitters	0.1 mrad/hr at 1 cm with 7 mg/cm^2 absorber	100 dpm/100 cm^2
Alpha Emitters	100 dpm/100 cm^2	20 dpm/100 cm^2

Source: Rockwell International, *Procedure for Dismantling and Decontaminating the L-85 Reactor Facility*, N001DWP000002, May 21, 1980.

On February 22, 1983, the NRC issued an order authorizing Rockwell International to dismantle the L-85 reactor in accordance with their application dated March 10, 1980. According to the order, the NRC prepared an environmental impact appraisal for the dismantling of the reactor and found the action would not result in any significant environmental impact and that an environmental impact statement was not required.[388]
During disposition of the facility the reactor was dismantled and the fuel was transferred to Exxon Nuclear Idaho, a DOE contractor, on September 28, 1982. Radioactively contaminated components were transferred to U.S. Ecology, Richland, and a state-licensed radioactive material disposal site. The Radium-Beryllium neutron source was transferred to Rockwell Richland for disposal at the DOE facility.[389] In December 1982, Rockwell International submitted an amended application for dismantling that indicated that about 1.3 Ci of total residual activity remained in the core vessel, steel reflector tank, and the control rods of the L-85 reactor. The dismantling plan indicated the removal of all components and activated structural materials would be conducted in a manner such that radioactivity readings would be consistent with NRC guidelines. Decontamination activities would reduce contamination to a level of 5 µR/hr above

[385] NRC, N001SRR140087, *Safety Evaluation by the Office of Nuclear Reactor Regulation Supporting Order Authorizing Dismantling of Facility and Disposition of Component Parts, Rockwell International Corporation, L-85 Reactor, Docket No. 50-375*, February 22, 1983.
[386] Rockwell International, *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, December 20, 1989.
[387] Rockwell International, *Procedure for Dismantling and Decontaminating the L-85 Reactor Facility*, N001DWP000002, May 21, 1980.
[388] Eisenhut, Darrell, Letter Re: Docket No 50-375, February 22, 1983.
[389] Garcia, E.M., U.S. Nuclear Regulatory Commission, Inspection Conducted September 30 through October 31, 1986, December 2, 1986.

background, "or the occupancy of the facility must be limited so that no person will receive more than 10 mRem/year." However, Rockwell International indicated no plans for using the building following D&D efforts.[390]

The site was released for unrestricted use by NRC and the NRC license was terminated March 19, 1987.[391] The rest of the building, excluding the foundation, was demolished in 1995; however, D&D records from 1995 could not be located. The sanitary leach field for Building 4093 was removed in 1999; however, detailed information of the removal could not be located.[392,393]

Information from Interviewees: Interviewee 1 indicated that the majority of his experience was working at Canoga Park beginning in 1958, but he did have some experience working at the SSFL, and more specifically, at Building 4093. According to the interviewee:

> I did work a few times at Building 4093, the AE-6 reactor. There was a nuclear reactor there and because I was a licensed reactor operator I went up there just a couple of times to run the reactor. It was subcritical at the time. As I recall, they were running experiments on the core and they needed a licensed reactor operator at the console. This was probably prior to 1965, probably 1963 or 1964…
>
> … Going back to the AE-6 reactor, I would be at the console because they needed a licensed reactor operator. The console was separated from the reactor core by a wall or building or something. I would essentially just run the reactor. As I recall, it was all subcritical. I would just run it up a little bit and they would do their experiments or move things around. I don't really know what they were doing. I think it was an open core with graphite. I ran the controls one or two times for about a half-day. It wasn't a part of my everyday routine. My time on the hill was very limited.

Interviewee 196 worked at SSFL from 1959 to 1981 and again from 1991 to 1995. Of Building 4093 and the AE-6 reactor, Interviewee 196 stated the following:

> The AE-6 reactor was a small water boiler, in which the moderately enriched uranium was in an aqueous solution in a shielded sphere. This solution was drained into a shielded container and replaced with a fresh solution. This was in about 1959, and as far as I know was the only time a refueling was done. The shielded container was transferred to the Area IV fuel storage building. The AE-6 reactor was the neutron source for a series of sub-critical arrays of uranium slugs (about 1/2-in. diameter by 6-in. long) in aluminum tubes. The uranium used included natural and enriched forms, as I recall. The enrichment was moderate, I think, but we did get some enriched uranium that required locked storage. (The shipment had an armed guard during transport.)…
>
> …We had on-site storage. Radiological materials were not transferred between buildings, except for transport of the low-level radiation and short half-life foils for counting their activity. The material used in connection with the operation of the facilities was kept either in a reactor, including the small critical assemblies, or it was solid materials, U-235

[390] Eisenhut, Darrell, Letter Re: Docket No 50-375, February 22, 1983.
[391] Letter from F.J. Miraglia (NRC) to M.E. Remley, "Order Terminating Facility License R-118, for the Rockwell International L-85 Nuclear Examination Reactor," April 8, 1987.
[392] 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.
[393] Unknown, *Santa Susana Field Laboratory – Radiological Facility Status*, August 12, 2007.

> and U-238. We had a storage building (Building 4096) at the AE-6 for the enriched uranium that required locked storage…
>
> …Between 1959 and 1995 the way materials were handled was basically the same, except there were different configurations. For example, in building 4093 there was a water boiler neutron source – a little reactor about a foot and a half in diameter. There would be a matrix of moderators and aluminum tubes that held uranium slugs, and I guess that's where we would take samples. (My memory is all very vague. It was a long time ago.) This was generally depleted uranium and you'd put the slugs in the tubes.
>
> The only fuel handling at the AE-6 I can remember involved depleted uranium slugs in aluminum tubes. The diameter of the slugs was about the same as the inner diameter of the tubes. Eventually we would have to cut them out because they were too tight to slide them out. We wore respirators; there was a lot of dust. It was a dirty job. I'm sure I must have inhaled some uranium dust…

Radiological Incident Reports: There have been several incidents associated with Building 4093 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 the incident reports are provided following the table, when available.

Building 4093 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0275	3/25/1959	AE-6 Reactor	Mixed Fission Products*	Fission gas release contaminated employees and part of 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 4 kWt. The reactor was shut down when the power level was recognized. The operation at the higher power level lasted approximately 1 minute; however, a small amount of fission gas was released into the air, contaminating 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 (A0275).[394,395]

- 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).[396]

[394] Unknown, Building 4093 – L-85 (AE-6) Research Reactor, Unknown Date.
[395] Blackshaw, G.L., NAA-SR-Memo 3757, "Release of Fission Gases from the AE-6 Reactor on March 25, 1959," April 15, 1959.
[396] Sessions, S.D., Atomics International Inter-Office Letter Re: Radiological Safety Incident Report A0512, November 17, 1960.

- 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 flowed through the system to dry it out. Mor moister was in the system than anticipated and 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 time and fully decontaminated during facility decommissioning. The incident report does not document how the area was partially decontaminated (A0106).[397][398]

- 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 300 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 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).[399]

Current Use: The NRC released the site for unrestricted use March 19, 1987.[400] The facility was demolished leaving only the foundation in 1995. Based on available information, the dimensions of any excavations made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- In order to determine the need for access restrictions in the area surrounding Building 4093, a radiation survey of the perimeter of the AE-6 reactor was conducted on August 13, 1970. The reactor was at a power level of 2 kW, and was operating with the shield

[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.
[399] Rutherford, P.D., Rockwell Internal Letter Re: Radiological Incident Report A0661, June 7, 1995.
[400] Letter from F.J. Miraglia (NRC) to M.E. Remley, "Order Terminating Facility License R-118, for the Rockwell International L-85 Nuclear Examination Reactor," April 8, 1987.

doors on the east side open and a plastic Lucite rod, approximately 6 feet long, inserted in the one-inch diameter beam hole. A "Technical Associates Lo-Range June" was used for measuring the gamma radiation levels, and a "Ludlum tissue-equivalent neutron detection instrument" was used for the neutron dose rates. Gamma radiation measurements ranged from 1 mr/hr at the operators position at the console to 1,000 mr/hr at the east side of the building directly opposite the core. Neutron dose rates varied from 2.0 mrem/hr at the operators position to 2,500 mrem/hr at the east of the building directly opposite the core.[401]

- On December 9, 1977, Rockwell International completed a routine bi-monthly contamination survey of the L-85 reactor facility. One hundred smears were taken throughout the control room/office and reactor rooms. All smears were less than 50 dpm/100 cm^2 beta and less than 5 dpm/100 cm^2 alpha.[402] These surveys appear to have continued through the end of the reactor's operations. A routine bi-monthly survey on August 13, 1981, included sixty smears throughout the building that showed less than 30 dpm/100 cm^2 beta.[403]

- In 1985, Rocketdyne conducted a final radiological survey of Building 4093, releasing the final report in March 1986. (The survey included buildings 4073, 4074, 4083, 4084, 4093, 4453 and 4453). The sampling inspection plan during the survey was based on a uniform 3-meter square grid that was superimposed on the area, including floors, walls, and ceilings. Within each square defined by the grid, a single 1- meter square area was selected according to the surveyor's judgment and surveyed. The report indicated that the surveyor was to select the area that was most likely to have retained the most residual contamination. The sampling plan for this survey required the inspection of one 1-meter square area out of every 3-meter square grid throughout the area.[404]

  Average contamination measurements were taken with an alpha (Ludlum Model 43-1 or equivalent) or beta (Ludlum, Model 44-9 or equivalent) probe. The maximum average alpha measured was 63.0 dpm/100 cm^2 (limit is 5,000 dpm/100 cm^2), and the maximum average beta measured 3,102 dpm/100 cm^2 (limit is 5,000 dpm/100 cm^2). The survey did not detect any hot spots and, as a result, no maximum alpha or beta measurements were made. It is important to note; however, the report indicated that one location in the Reactor Room that had not been included in the established inspection locations showed beta contamination of 4,923 dpm/100 cm^2. While the value did not exceed the acceptance limit, the area was scabbled and remeasured and was found to have beta contamination of 2,542 dpm/100 cm^2.

  According to the report, the limits for the release for unconditional use of Building 4093 were taken from the U.S. Nuclear Regulatory Commission Regulatory Guide 1.86 and the U.S. Nuclear Regulatory Commission Dismantling Order, Docket No. 50-375. The report indicated that these criteria were in agreement with the guidance found in the

[401] Johnson, B.I., Internal Letter Re: Radiation Survey of the AE-6 Reactor, Building 093, August 13, 1970.
[402] Abbott, M.R., Internal Letter Re: Bi-Monthly Routine Radioactive Contamination Survey of Building 093, L-85 Facility, December 9, 1977.
[403] Owen, R.K., Internal Letter Re: Bi-Monthly Routine Radioactive Contamination Survey of Building 093, L-85 Facility, October 14, 1981.
[404] Rocketdyne Report, N001SSR140087, "Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility," March 6, 1986.

January 1985 version of the American National Standards Institute/Health Physics Society Standard ANSI N13.12, and in the DECON-1 document issued by the State of California in 1977.

In addition to the above, samples of soil were also taken during this survey outside of Building 4093 to "determine if any environmental release had occurred that could have resulted in soil contamination." According to the report, two samples were taken from the open dirt area directly across the driveway from the large door to the Reactor Room. Three other samples were taken from the drainage ditch leading away from the facility.[405] The report summarized that all five soil samples showed similar amount of "naturally occurring radionuclides associated with natural uranium and natural thorium and K-40." The report also stated that three samples showed "small" amounts of Cs-137 (an average of 0.20 ± 0.13 pCi/g), and may have been the result of "global fallout from weapons testing."[406] Rocketdyne summarized that soil samples showed no evidence of radioactivity due to facility operations.

The maximum ambient exposure rate in the Reactor Room was originally found to be 21.3 μR/hr. The limit was determined to be 18.9 μR/hr because the mean ambient exposure rate in the Reactor Room was found to be 13.9 μR/hr. The concrete was removed from areas in the Reactor Room measuring over the limit and the re-survey showed them all to be under the limit, with the highest measurement at 18.2 μR/hr. Survey results were below the 1985 acceptable limits.

- Oak Ridge Associated Universities conducted a confirmatory radiological survey in 1986; the final report was released in December 1986. The purpose of the survey was to verify the adequacy and accuracy of Rocketdyne's final survey and to confirm the radiological condition of the facility relative to the decommissioning guidelines. The survey included surface measurements, exposure rate measurements, and gamma spectroscopy measurements of the interior of the building. Additionally, random samples of paint were collected by ORAU personnel in the reactor bay area and the control room, in addition to samples of residue on horizontal surfaces, concrete dust and chips, standing water located in "electrical chase", and drain residues. Exterior sampling included walkover surface scans up to 80 meters from the building and soil sampling east, south, and west of the building.. The soil and miscellaneous residue samples were analyzed by gamma spectroscopy for Co-60, Cs-137, Eu-152, Eu-154, U-238, U-235, and "other identifiable photopeaks."[407]

  Building 4453 was used to establish the baseline for gamma exposure rate measurements of 12 μR/hr. According to ORAU, Building 4453 had a similar construction history as Building 4093 and was located in a non-restricted area that had no history of non-sealed source radioactive materials use. ORAU personnel collected exposure rate measurements and gamma spectra using the "pressurized ionization chamber and the gamma spectroscopy system."

[405] The report does not indicate the direction of the samples from the drainage ditch.
[406] The report did not elaborate on the meaning of "global fallout from weapons testing."
[407] Oak Ridge Associated Universities, *Confirmatory Radiological Survey of the L-85 Reactor Facility, Rocketdyne Division, Rockwell International Corporation, Santa Susana, California*, December 1986.

Alpha and beta-gamma scans of the interior of the building identified two areas of elevated alpha activity on the floor of the reactor bay. The areas did not exceed "release guidelines," but according to the report, Rockwell elected to perform additional remedial action to ensure that residual contamination was "as low as reasonably achievable." Surface contamination levels on 56 random floor and lower wall grid blocks contained non-removable activity, as well as removable activity. The total alpha activity range from the minimum detectable activity of 11 dpm/100 cm2 to 460 dpm/100 cm2. The removable alpha activity ranged from a minimum detectable activity of 3 dpm/100 cm2 to 14 dpm/100 cm2. Total beta activity ranged from a minimum detectable activity of 400 dpm/100 cm2 to 4,900 dpm/100 cm2, removable beta activity ranged from 7 dpm/100 cm2 to 12 dpm/100 cm2.

In addition, radionuclides in trace amounts were identified in several samples of dust residues. One sample collected along the west wall ledge indicated the presence of Co-60, Cs-137, Eu-152, Eu-154, and U-238. Two paint samples were collected from the reactor bay and one sample contained Cs-137 and U-238 in trace amounts. A smear from the sink trap of the control room lavatory had no detectable radionuclides. Concrete chips taken from the "scabbled" area of the Reactor Bay contained 11 pCi/g of Eu-152.[408]

The exposure rate levels in Building 4093 measured by ORAU personnel ranged from 12 to 18 µR/hr. A review of the gamma spectra collected at each exposure rate measurement location in Building 4093 identified the presence of Co-60 and Eu-152 in the elevated exposure rate areas. These areas were attributed to the close proximity of the hot spots from the scabbled floor.

Surface measurements of the exterior of the building found no locations of elevated direct radiation levels within 10 meters of the buildings, parking lots, and access roads or drainage ditches. Exposure rates measured at one meter from the ground surface at the soil sampling locations ranged from 16 to 18 µR/hr. The six random soil sampling locations around Building 4093 contained radionuclide concentrations "typical of concentrations in four baseline samples collected offsite."[409]

The survey concluded that the L-85 reactor building (4093) had been remediated to the existing Nuclear Regulatory Commission criteria with the exception of exposure rate criteria. The Nuclear Regulatory Commission guidelines are presented in the table below.

1986 Nuclear Regulatory Commission Contamination Limits

	Average	Maximum	Removable
Beta-Gamma Emitters	1,000 dpm/100 cm2	3,000 dpm/100 cm2	200 dpm/100 cm2
Alpha Emitters	5,000 dpm/100 cm2	15,000 dpm/100 cm2	1,000 dpm/100 cm2

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

The survey summarized that restoration of the remediated area would reduce the exposure rate to the levels established by a Dismantling Order.[410]

- On March 19, 1987, the Nuclear Regulatory Commission submitted the findings of a Nuclear Regulatory Commission inspection to Rockwell International. The inspection occurred in September and October 1986. The results of the inspection determined the maximum exposure rate to be below the 1987 limit of 5 μR/hr above background, with the exception of one location. This area was located in the former Reactor Room where a hole had been generated from previous scabbling activities. According to the report, the licensee was to conduct additional exposure rate measurements when the hole was filled with concrete.

  A second inspection took place on March 13, 1987, that included an in-office review of the findings of a February 3, 1987, licensee report. According to the inspection summary, as part of the decontamination of the facility, a portion of the concrete floor of Building 4093 was excavated to depths ranging from 2 to 22 inches. For "practical" use of the facility, Rockwell International proposed to repair the excavated floor with concrete. Following the repair, Rockwell International conducted additional surveys to determine the radiation exposure rate. These results were submitted to the Nuclear Regulatory Commission on February 3, 1987. According to the inspection report, the maximum radiation exposure rate after the hole was filled with concrete was below the 5 μR/hr above background at a meter from the floor surface. The inspection found that no violations or deviations of the Nuclear Regulatory Commission requirements had been identified.[411]

- In 1996, Rockwell International performed a survey of various area of Area IV, including the Building 4093 leach field. The first leach field sample was collected from an area under the joint between the tee fitting and the first pipe section. The second sample was collected approximately 5 feet "downstream" at the edge of the exploratory trench. Because of the depth of the trench, the soil and gravel mixtures of the leach field were raised to the surface for sample collection from the backhoe bucket.[412] The report did not include any results for the Building 4093 leach field.

- In 1999, confirmatory samples collected after the removal of the septic tank found no detectable activity (limit was 20 dpm/100 cm^2 for alpha and 100 dpm/100 cm^2 for beta).[413]

- In 2000, Rocketdyne conducted vegetation sampling in Area IV at the SSFL that included Buildings 4093 and 4073. The report summarized that the only radionuclide found in the vegetation samples was naturally occurring K-40. The report stated that no man-made radionuclides were found in either on- or off-site vegetation samples. The report

[410] Oak Ridge Associated Universities, *Confirmatory Radiological Survey of the L-85 Reactor Facility, Rocketdyne Division, Rockwell International Corporation, Santa Susana, California*, December 1986.
[411] Letter from Frank Wenslawski (NRC Region V) to Herbert Berkow, *Closeout Inspection for Rockwell International L-85 Reactor, Docket No. 50-375*, March 19, 1987.
[412] Rockwell International, *Area IV Radiological Characterization Survey, Final Report, Volume 1*, A4CM-ZR-0011, August 15, 1996.
[413] Boeing Radiation Survey Reports, L-85 Facility Septic Tank Area, July and September 1999.

provided minimum detectable activities of various radionuclides from the sample (ENV00102) collected near Buildings 4073 and 4093. These were Mn-54 at 0.0467 pCi/g, Co-60 at 0.0699 pCi/g, Cs-137 at 0.0606 pCi/g, Eu-155 at 0.0887 pCi/g, Pb-210 at 0.434 pCi/g, and Ra-226 at 0.794 pCi/g.[414] The report did not provide an approximate location of the sample taken near Buildings 4093 and 4073.

Radiological Use Authorizations: On January 5, 1972, the Atomic Energy Commission granted Atomics International Facility License No. R-118, authorizing Atomics International to possess and operate the L-85 Nuclear Examination Reactor at power levels up to 3 kW (thermal). In addition to issuing the license, the Atomic Energy Commission also amended Indemnity Agreement No. B-13 to include the L-85 Reactor. The license authorized the North American Rockwell Corporation to possess and operate the reactor as a utilization facility, and to receive, possess and use up to 830 grams of contained U-235 in connection with the operations of the reactor. Additionally, the license permitted the North American Rockwell Corporation to possess, but not to separate, such byproduct material that has been produced or as may be produced by operation of the reactor. [415]

Former Radiological Burial or Disposal Locations: None.

Aerial Photographs: Aerial photographs do not show any disturbances near Building 4093, with the exception of a water pipeline that crosses near the site from 12th Street to Building 4003. In addition, 1995 aerial photographs show an area of disturbed ground at what is thought to be the former leach field location southwest of the building foundation. The area of disturbed ground is vegetated by 2005.[416]

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 0.35 molar H_2SO_4 solution.[417] 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. All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Surface drainage extends from the northeast side of the building next to the retaining wall to southeast and then flows southwest toward the paved area southwest of the building. The drainage likely continues to the ditch located along the roadway leading to Building 4093 and then flows southeast toward G Street where the flow continues down G Street to 17th Street.[418]

Building 4093 was connected to a sanitary leach field that was removed in 1999.[419] During a 1996 Area IV survey of Building 4093 an exploratory trench in the expected area of the leach field uncovered a 4-inch diameter clay pipe supplying the leach field at a depth of approximately

[414] Boeing, RD01-152, *Site Environmental Report for Calendar Year 2000, DOE Operations at the Boeing Company Rocketdyne Propulsion & Power*, September 2001.
[415] United States Atomic Energy Commission, Docket No. 50-375 Facility License No. R-118, January 5, 1972.
[416] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[417] Atomics International Document, AI-70-73, "Safety Analysis Report for L-85 Nuclear Examination Reactor," November 25, 1970.
[418] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.
[419] Boeing Radiation Survey Reports, L-85 Facility Septic Tank Area, July and September 1999.

4 feet below ground surface. The pipe connected to a 90-degree clay pipe elbow angled down. The elbow connected to a tee pipe section that was positioned transverse to the supply pipe. One end of the tee was plugged. Extending horizontally from the other end of the tee across the top of the leach field on a bed of gravel was a row of butt-end clay pipe sections about 8 inches long.[420]

The leach field was reported to comprise 234 total linear feet, receiving flow from a 750-gallon septic tank associated with Building 4093. The leach field was located approximately 100 feet south of Building 4093.[421]

Radiological Contamination Potential: 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.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.2 provide a convenient reference for the following recommendations.

Extensive soil sampling is recommended in the Building 4093 area. Building 4093 served as the AE-6 and L-85 reactor facility. Consequently, potential radioactive material migration via surface water flow or airborne release from this facility may affect the Building 4093 area. Previous characterization studies for the Building 4093 area were focused on delineating the extent of contamination to standards that were applicable at the time. Therefore, additional characterization is recommended for the Building 4093 area. This includes the following Building 4093 areas:

- The location of the sanitary leach field. Building 4093 was connected to a sanitary leach field that was removed in 1999.[422] If radioactive materials were released into the septic system, residual contamination above background values may exist in the materials surrounding the former leach field. The sampling should include the former location of the 4-inch diameter clay pipe supplying the leach field at a depth of approximately 4 feet below ground surface.[423] The leach field was reported to comprise 234 total linear feet, receiving flow from a 750-gallon septic tank associated with Building 4093. The leach field was located approximately 100 feet south of Building 4093.[424]

- The former location of the 4-inch vitrified clay pipe leading from the west corner of the building to the sanitary sewer. It is possible this line is part of the line that led to the former leach field. If radioactive materials were released into the septic system, residual contamination above background values may exist in the materials surrounding the former pipe.

[420] Rockwell International, *Area IV Radiological Characterization Survey, Final Report, Volume 1*, A4CM-ZR-0011, August 15, 1996.
[421] MWH, *DOE Leach fields (Area IV AOC) RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Draft*, October 2003.
[422] Boeing Radiation Survey Reports, L-85 Facility Septic Tank Area, July and September 1999.
[423] Rockwell International, *Area IV Radiological Characterization Survey, Final Report, Volume 1*, A4CM-ZR-0011, August 15, 1996.
[424] MWH, *DOE Leach fields (Area IV AOC) RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California, Draft*, October 2003.

- The drainage area on the northeast side of the building. Surface drainage extends from the northeast side of the building next to the retaining wall to southeast and then flows southwest toward the paved area southwest of the building.[425] If radioactive materials were released to surface at or around Building 4093, residual contamination above background values may exist in the soils surrounding the surface drainage areas within the Building 4093 area.

- The east side of the building where 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 in the area surrounding Building 4093, a radiation survey of the perimeter of the AE-6 reactor was conducted on 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 6 feet long, inserted in the one-inch diameter beam hole. Gamma radiation measured 1,000 mr/hr on the east side of the building directly opposite the core.[426] The research team has been unable to determine if the building operated with the shield doors open frequently. If the shield doors were opened frequently during reactor operations, it is possible that residual contamination above background values may exist on the east side of the former building.

- The location of the former 750-gallon septic tank. If radioactive materials were released into the septic system, residual contamination above background values may exist in materials surrounding the former septic tank.

2.2.5 Building 4123 Area

Note: To date, the research team has located limited historical documents relating to the construction and operation of Building 4123. As a result, the information provided below is limited.

Site Description: The Building 4123 area includes Building 4123 and the surrounding area. Located north of 12th Street, Building 4123 was a small above-ground concrete block structure constructed sometime between 1957 and 1962.[427] Surrounding buildings include Building 4073, discussed above, and Buildings 4643 and 4793, discussed below. Figures 2.2.5a through 2.2.5d provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4123 was a small above-ground concrete block structure with two steel-lined concrete wells (6 feet deep and 2 feet wide) in the floor.[428] Additional information regarding the building features were not located.

Former Use(s): Constructed sometime between 1957 and 1962, Building 4123 was used for the temporary storage of radiological waste material associated with the operations of Building

[425] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.
[426] Johnson, B.I., Internal Letter Re: Radiation Survey of the AE-6 Reactor, Building 093, August 13, 1970.
[427] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[428] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.

4073, the KEWB reactor building. This included the storage of uranyl sulfate and mixed fission products.[429,430]

The building was demolished in 1975 as part of the decontamination and disposition of KEWB facilities, and was completely removed, including foundations and storage pits. Prior to D&D, the building was surveyed and found free of contamination. Several small casks stored in the facility were sent to the RMHF for future use.[431] Information indicating how the storage pits were demolished and with what materials the storage pits were backfilled could not be located. On March 3, 1976, the ERDA released the land on which Building 4123 had been located for unrestricted use.[432]

Information from Interviewees: Interviewee 5 had extensive knowledge on the operations of the KEWB and Building 4123. Interviewee 5 served as the responsible engineer for the KEWB and was one of three operators that ran the reactor. The following are excerpts from that interview:

> When the fuel was drained out of the reactor it went into the below-grade drain tank. We also had precipitate material in the lines and we did some chemical flushing to try and recover the precipitate material. That process generated a lot of liquid that ended up getting stored in glass carboys. We would flush the pipes and drain the rinse into the carboy containers. The containers were stored outside Building 4123 across from the KEWB reactor building. Building 4123 had two underground cells or holes in the ground - two concrete-line holes in the ground. And over in that area is where we stored all those bottles of liquid. Did some of it leak out onto the ground? Probably some, I would guess, but probably not a signification amount…
>
> … Halfway through the KEWB program we changed the reactor vessel shape. We took the original 12-inch spherical vessel out and replaced it with a 12-inch cylindrical vessel. We cut the spherical vessel out and stored the reactor in Building 4123, which was a storage building designed for holding the reactor vessel. It was highly radioactive, highly contaminated. We all received significant radioactive exposures, getting our yearly dose just taking that spherical vessel out and moving it to storage…
>
> …The primary thing that went in Building 4123 was the first KEWB reactor. I'm sure some of that liquid that we drained out from flushing the pipes was probably stored inside as well, although most of it was stored outside the building. One thing I would look at is the underground part of Building 4123 because I don't know what they did with it in the D&D process. Building 4123 was not very big, maybe 8 feet by 8 feet or 8 feet by 10 feet. It was a small building. It was strictly a storage building and was built specifically to hold the first KEWB reactor when it was removed from the reactor building. There were two below-grade, concrete-lined cells. The cells were cylindrical and about 2 feet in diameter. Because the reactor was maybe a foot in diameter, the 2-foot diameter cells held the reactor vessel easily…

[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.
[431] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[432] Stamp, Stanley, Letter Re: "Decontamination and Disposition of ERDA Facilities," March 3, 1976.

> …As I recall, we never had a spill outside the building, but I would check the area at Building 4123 where the glass carboy containers were stored outside.[433] I think it would be prudent to reexamine Building 4123…
>
> …The carboys were stored temporarily at Building 4123, but eventually it was all sent to RMHF.
>
> At Building 4123, some carboys, the "hotter" ones, were probably stored in the building. But most were stored outside on an asphalt pad on the southern side of the building, near the road. I am not sure how long the bottles were stored here. That would be something log books would be able to tell you. The draining occurred before the spherical reactor vessel was removed, so it would have been sometime in the early- to mid-1959. I don't think you will see any residual contamination from this area, but it would be something to look at…

Radiological Incident Reports: There have been no incident reports associated with the operations in Building 4123 located to date.

Current Use: As indicated above, Building 4123 was demolished in 1975. The entire building, including foundations, was removed.[434] The ERDA released the land on which Building 4123 had been located and the surrounding area for unrestricted use in 1976.[435]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- In 1975, Rocketdyne performed a final radiological survey during D&D of the KEWB facilities, including Buildings 4073, 4123, 4643, and 4793, and published the results in a final D&D report in 1976.[436] According to the report, Rocketdyne surveyed Building 4123 and found the building to be free of contamination. The survey found that all remaining surfaces of Building 4072 were decontaminated to levels as low as reasonably achievable, and in all cases below the 1975 levels for future unrestricted use (removable contamination of 20 dpm/100 cm^2 α or 100 dpm/100 cm^2 β). The survey concluded that the site was free of radioactivity except for normal background.

- In July 1975, Rocketdyne performed a surface scan of the KEWB site, including Buildings 4073, 4123, 4643, and 4793, to validate that no radiological contamination remained.[437] The survey found no levels of beta-gamma surface contamination above the measured background (0.15 – 0.25 mrad/hr) in 1975.

[433] It is important to note the interviewee did not provide a specific location for where the glass carboy containers were stored outside of Building 4123.
[434] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[435] Stamp, Stanley, Letter Re: "Decontamination and Disposition of ERDA Facilities," March 3, 1976.
[436] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[437] Letter from R.K. Owen (Rockwell International) to R.J. Tuttle, "Radiation Survey – T073 (KEWB) Site," July 17, 1975.

- 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.[438] The survey performed a surface scan to determine the ambient gamma exposure rate and low-level radiation level. Also soil samples were collected and analyzed for gamma radiation and uranium. The survey found no measurements above 1983 background levels. Argonne National Laboratories determined that background is relatively high (40 μR/hr and 8,000 cts/min) due to the "shine" from nearby Buildings 4021 and 4022. The report did not provide any sources for this summary of background levels. The survey concluded that 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.[439] The mean exposure rate was 17.4 ± 0.96 μR/hr (–0.2 ± 0.96 μR/hr when corrected for background). And background was measured as 17.0 μR/hr. The acceptable limit was 5.0 μR/hr above background. As a result, the survey results were below the 1988 acceptable limits. The findings are inconsistent with the findings of the 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 to provide any reasons for the discrepancy.[440]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: Building 4123 included two steel-lined concrete wells (6 feet deep and 2 feet wide) in the floor that were used for the temporary storage of radiological waste material associated with the operations of Building 4073.[441] As indicated above, the research team did not locate any information to indicate how the wells were treated during the D&D of KEWB facilities. It was noted the building was completely removed, including foundations.[442]

Aerial Photographs: Aerial photographs do not show any disturbances near Building 4123, with the exception of a water pipeline that crosses near the site from 12th Street to Building 4003. The presence of Building 4123 is difficult to discern in early photographs (1957 through 1965); however, the building is visible in 1967 aerial photographs. The building appears to remain in 1972, but is no longer visible in 1978 photographs.[443]

[438] 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.
[439] ETEC Document, GEN-ZR-0009, "Radiological Survey of the T513 Parking Lot; Old R/A Laundry Area; Plot 333; and Areas Between the SRE to RMHF, and KEWB to RMHF," August 26, 1988.
[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.
[441] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[442] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[443] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

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.[444] All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Drainage at the site is to the south-southwest to a "paved ditch" adjacent to a dirt road.[445] The Building 4093 leach field was located east of Building 4123.

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

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.2 provide a convenient reference for the following recommendations.

Due to the storage of the first KEWB reactor and the storage of radioactive materials at and around Building 4123, there is a possibility of elevated radionuclide concentrations in soil. Therefore, additional characterization is recommended for the Building 4123 area. This includes the following Building 4123 areas:

It is recommended that sampling at the Building 4123 area be included in the Building 4073 sampling plan.

- The former Building 4123 footprint. As indicated by an interviewee, Building 4123 had two concrete-lined holes in the ground that were used to store containers containing radioactive fuel and the original 12-inch spherical reactor vessel. It was highly radioactive, highly contaminated. The primary thing that went in Building 4123 was the first KEWB reactor. Additionally, the interviewee indicated that the "hotter" carboys were probably stored in Building 4123. As a result of these storage operations, it is possible residual contamination above background values may exist in the materials surrounding the former Building 4123 footprint.

- The outside storage area located south of the building where carboys containing radioactive material were stored prior to being transported to the RMHF. According to an interviewee with knowledge of the KEWB reactor operations, the carboys were stored temporarily outside on an asphalt pad on the southern side of the building, near the road. The interviewee indicated that leaks would have been possible during these storage activities. As a result, it is possible residual contamination above background values may exist in the materials surrounding the former outside storage area.

[444] Rocketdyne Report, N001ER000017, "Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective," September 1991.
[445] Atomics International, Drawing 303-00C-C2, *Misc. Paving, Patching & Drainage Improvements – KEWB*, Date illegible, circa 1969. HDMSE00457545.

2.2.6 Building 4453 Area

Site Description: Located approximately 165 feet southeast of Building 4093, the L-85 reactor, the Building 4453 area comprises Building 4453 and the land surrounding it located on 11th Street. Building 4453 was constructed in approximately 1958 and consisted of a steel frame covered in sheet metal.[446] Buildings 4093, 4083/4103, and 4074 are located northwest of Building 4453 and have been discussed above. Figures 2.2.6a through 2.2.6c provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Very little information has been located regarding the building features of Building 4453. As indicated above, Building 4453 consisted of a steel frame covered in sheet metal. The building appears to have been a single room. A 1986 inspection of the L-85 reactor by the NRC indicates that Building 4453 was used for measuring background for facilities associated with L-85 reactor operations. Background levels at Building 4453 were measured at 11.9 µR/hr. The building was reported to have a similar construction history as Building 4093, but had no history of non-sealed source radioactive material use.[447,448]

Former Use(s): Building 4453 was constructed between August 1957 and August 1959, and appears to have served as the fuel handling building for the L-85 reactor, Building 4093.[449] The fuel for the L-85 reactor consisted of uranyl sulfate. Ownership of Building 4093 was transferred from AEC to Rockwell in 1972, and the NRC licensed the facility on January 5, 1972 under license R-118 Docket No. 50-375. The documents do not provide information to indicate Building 4453 was included in the license. It should be noted; however, that the license allowed the storage of 200 grams of U-235 within a metal safe in Building 4093. "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." Documents do not provide the location of these storage containers. It is possible these materials were stored in Building 4453.[450]

In 1984, the building is listed as a neutron radiography storage building.[451] Documents relating to the dismantling of Building 4453 could not be located; however, a February 1987 radiation survey for license termination noted that Building 4453 was being used as a storeroom. According to an April 1987 Site Consolidation Assessment, Building 4453 was going to be used to store tools and materials from Building 4064.[452,453] Building 4093 was released for

[446] Atomics International Document, AI-70-73, *Safety Analysis Report for L-85 Nuclear Examination Reactor*, November 25, 1970.
[447] Rocketdyne Report N001SSR140087, *Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility*, March 6, 1986.
[448] Garcia, E.M, NRC Rockwell International Research Reactor L-85 Inspection, December 2, 1986.
[449] Rocketdyne Report N001SSR140087, "Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility," March 6, 1986.
[450] Skoholt, Donald, *North American Rockwell Corporatio, Docket No. 50-375, Facility License No R-118*, January 5, 1972.
[451] Olson, P, et. al, GEN-ZR-0002, *CERCLA Program Phase II – Site Characterization*, May 29, 1987.
[452] Energy Technology Engineering Center, *Site Consolidation Assessment*, April 16, 1987.
[453] It is important to note that HGL did not locate any references to Building 4453 in the documents cited by the May 2005 HSA, particularly those relating to the NRC license assigned to the L-85 reactor.

unrestricted use by NRC and the NRC license terminated March 19, 1987. The research team assumes Building 4453 was also released at this time.[454,455]

Information from Interviewees: There have been no interviews with persons familiar with the operations at Building 4453 to date.

Radiological Incident Reports: There have been no incident reports associated with the operations in Building 4453 located to date.

Current Use: The building was demolished sometime between October 1988 and June 1995, although the exact date of demolition is unknown. The concrete foundation of the building remains present at the site today.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- In 1985, Rocketdyne conducted a final radiological survey, releasing the final report in March 1986. (The survey included buildings 4073, 4074, 4083, 4084, 4093, 4453 and 4453). Because non-sealed radioactive materials were not reported to have been used in Building 4453, the survey applied reduced sampling with a 1-square meter sample being measured from every other 9-square meter grid, rather than every 3-square meter grid.[456]

  Average contamination measurements were taken with an alpha (Ludlum Model 43-1 or equivalent) or beta (Ludlum, Model 44-9 or equivalent) probe. The survey included a reduced inspection plan after a 100% floor survey conducted before and after the floor tile was removed found no radioactive contamination. The maximum average alpha detected was 17.2 dpm/100 cm^2 (limit is 5,000 dpm/100 cm^2) and the maximum average beta detected was 1,987 dpm/100 cm^2 (limit is 5,000 dpm/100 cm^2). The results were reported in the report as a summary of survey results for Buildings 4083, 4074, and 4453. As a result, the same results apply to all three buildings; however, it is uncertain whether these results are a true reflection of the conditions at Building 4453.

  According to the report, the limits for the release for unconditional use of Building 4453 were taken from the U.S. Nuclear Regulatory Commission Regulatory Guide 1.86 and the U.S. Nuclear Regulatory Commission Dismantling Order, Docket No. 50-375. The report indicated that these criteria were in agreement with the guidance found in the January 1985 version of the American National Standards Institute/Health Physics Society Standard ANSI N13.12, and in the DECON-1 document issued by the State of California in 1977.

  The maximum average ambient exposure rate for three buildings including Building 4453 was originally found to be 23.1 μR/hr (limit is 18.9 μR/hr). It is important to note the

[454] Remley, M.E., Summary Report of Ambient Exposure Rate Measurements at the L-85 Research Reactor Facility After Repair of Concrete Floor, February 1987.
[455] 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.
[456] Rocketdyne, N001SSR140087, "Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility," March 6, 1986.

findings were the average of the three buildings. The report does not provide the findings of each building individually. The report summarized that the ambient exposure rates over the limit were attributed to the nearby RMHF and were reported to not represent residual contamination. Additionally, the survey found that measured radiation levels were below acceptable limits, making the site acceptable for unrestricted use.

- A December 2, 1986, Nuclear Regulatory Commission inspection report states that Building 4453 was used by Rocketdyne to determine background levels for comparison with surveys being conducted at Building 4093. According to the report, the background levels measured by Rocketdyne at Building 4453 were 11.9 µR/hr.[457]

Radiological Use Authorizations: None.

Former Radiological Burial or Disposal Locations: None.

Aerial Photographs: There are no disturbances surrounding Building 4453 between August 1959 when the building first appears and October 1988 when the building is last visible in aerial photographs. Aerial photographs after 1988 show a concrete foundation to still be present at the Building 4453 location.[458]

Radionuclides of Concern: Building 4453 was located outside the restricted area surrounding the L-85 reactor and was reported to have had no history of non-sealed source radioactive materials use.[459] However, documents indicate the building served as the fuel handing facility for Building 4093. Accordingly, the contaminants of concern are Co-60, Cs-137, Eu-152, Eu-154, Sr-90, U-238 and U-235. All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.[460]

Drainage Pathways: the research team has not located any drainage pathways in the area at or surrounding Building 4453.

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4453 area is Class 1.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.2 provide a convenient reference for the following recommendations.

Because the building is stated to have served as a fuel handling facility for Building 4093, there is a possibility of there being elevated radionuclide concentrations in soil. Therefore, additional characterization is recommended for the Building 4453 area. This includes the following Building 4453 areas:

[457] Garcia, E.M., Nuclear Regulatory Commission Inspection, Rockwell International Research Reactor L-85, March 13, 1987.
[458] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[459] Murphy, G.L., Confirmatory Radiological Survey of the L-85 Reactor Facility, Final Report, December 1986.
[460] Rocketdyne Report N001SSR140087, "Radiation Survey for Release for Unrestricted Use – L-85 Reactor Facility," March 6, 1986.

- The former Building 4453 footprint. The building was demolished sometime between October 1988 and June 1995. The concrete foundation of the building remains present at the site today. Because the exact nature of the operations of the building as a fuel handling facility is unknown, it is possible residual contamination above background values may exist at and near the Building 4453 footprint.

2.2.7 Site 4633 Area

Note: Documents relating to the construction and operation of Site 4633 are limited.

Site Description: The Site 4633 area was located northeast of Building 4083/4103 and included Site 4633 and the surrounding area. The building was reported to have been constructed prior to 1962. Plate 1 presents a summary of all identified features for this site.

Building Features: No information was located.

Former Use(s): According to a June 1978 plot plan of the SSFL, Site 4633 served as the reactor cooling water pad. The research team has been unable to locate any information regarding the operations associated with Site 4633. Site 4633 was demolished in the late 1980s.[461]

Information from Interviewees: There have been no interviews with persons familiar with Site 4633 operations to date.

Radiological Incident Reports: There have been no incident reports associated with the operations at Site 4633 identified to date.

Current Use: Site 4633 was demolished in the late 1980s. Based on available information, the dimensions of the excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): Radiological surveys specific to Site 4633 have not been conducted; however, studies have been conducted at Building 4083/4103. The results of those surveys are presented in Section 2.2.3, above.

Radiological Use Authorizations: None.

Former Radiological Burial or Disposal Locations: None.

Aerial Photographs: Aerial photographs do not show enough detail to see the structure referred to as Site 4633. The only notable features near Site 4633 include a water pipeline that crosses the site from 12th Street to Building 4003.[462]

Radionuclides of Concern: There have been no radionuclides of concern identified at the Site 4633 area.

[461] 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.
[462] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

Drainage Pathways: The research team did not locate any information regarding the drainage pathways at Site 4633.

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Site 4633 area is Class 1 because there is so little information known about Site 4633.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.2 provide a convenient reference for the following recommendations.

Because there is such limited information on the use and operations of Site 4633, as well as the site's proximity to Building 4093, there is a possibility of elevated radionuclide concentrations in soil. Therefore, additional characterization is recommended for the Site 4633 area. This includes the following Site 4633 areas:

- The Site 4633 footprint. Because the exact nature of the operations of Site 4633 is unknown, it is possible residual contamination above background values may exist at and near the Site 4633 footprint.

2.2.8 Building 4643

Note: Limited documents relating to the construction and operation of Building 4643 have been located.

Site Description: The Building 4643 area comprises Building 4643 and the surrounding area. Other buildings in the vicinity were part of the KEWB reactor facility and included Buildings 4073 and 4123, discussed above, and Building 4793, discussed below. No as-built drawings were located for Building 4643. Figures 2.2.8a through 2.2.8d provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: 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.[463,464] Other materials within the building included filters, filter bank housing, power lines, fire detection equipment, gas lines, vacuum pump, electrical panels, and blower and drive motor.[465]

Former Use(s): Constructed in the early 1960s, Building 4643 was an exhaust building that provided ventilation for the KEWB reactor building. The building was demolished in 1975. During demolition a contamination survey of Building 4643 and the associated equipment indicated that the floor of the exhaust building was contaminated with removable beta contamination levels of up to 600 dpm/100 cm^2. The exhaust blower and filter plenum were also

[463] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[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.
[465] Atomics International, FDP-704-990-002, *Dismantling Plan for KEWB Facility (Bldgs 073,123 and 793)*, October 17, 1974.

contaminated and were removed and sent to the RMHF for disposal. After the floor was decontaminated by wiping with a caustic solvent, the building was resurveyed and found to be within the "as low as practicable" limits set forth in 1975. The building was released to the salvage contractor who demolished and removed the remaining structure, including the 60-foot exhaust stack, as well as the tanks and their associated fill and drain lines. The D&D report does not provide information to indicate how the structure and exhaust stack were disposed or if they were included in the material that was used as backfill material during the regarding of the KEWB facility. It also does not provide information to indicate the dimensions of the excavation made during building demolition.[466] ERDA released the land on which Building 4643 was located for unrestricted use on March 3, 1976.[467]

Information from Interviewees: Interviewee 5 had extensive knowledge on the operations of the KEWB facility. Interviewee 5 served as the responsible engineer for the KEWB and was one of three operators that ran the reactor. The following are excerpts from that interview:

> There were radioactive gases and liquids associated with KEWB. The KEWB did generate fission gases. The fission gases were held in an underground storage tank and then vented up a stack after a decay period. The only contamination that might still remain from that would be in the underground storage tank. I don't know what the status of the underground storage tank is after D&D. I don't know if the tank was dug out during the D&D process or not. We had fission gases that were generated and sent to the underground tank. Then we had argon-41 that was generated in the reactor vault, but this was not held in the underground tank, it was just vented up the stack. We would have to ventilate the room anytime we had to do work in the reactor room because of the radioactive argon gas. The fission gases were held in the underground tank and decayed for a while and then slowly bled out the stack.

Radiological Incident Reports: There have been no incident reports resulting from operations in Building 4643 identified to date.

Current Use: Building 4643 was demolished in 1975 and released for unrestricted use in March 1976.[468] Aerial photographs do not show any activities in this area.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations near this building is as follows:

- In July 1975, Rocketdyne performed surface scans of the KEWB site to validate that no radiological contamination remained. The survey found no levels of beta-gamma surface contamination above the measured background in 1975 (0.15 – 0.25 mrem/hr). The survey concluded that there was no radiation above 1975 background levels observed away from the site.[469]

- In 1976, Rocketdyne performed a final radiological survey of the KEWB building and support buildings, including Building 4643, during decontamination and disposition of the facility. A contamination survey of Building 4643, and the associated equipment

[466] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[467] Stamp, Stanley, Letter Re: "Decontamination and Disposition of ERDA Facilities," March 3, 1976.
[468] Stamp, Stanley, Letter Re: "Decontamination and Disposition of ERDA Facilities," March 3, 1976.
[469] Owen, R.K., Letter Re: "Radiation Survey – T073 (KEWB) Site," July 17, 1975.

indicated that the floor of the exhaust building was contaminated with removable contamination levels of up to 600 dpm/100 cm2 beta. The exhaust blower and filter plenum were also contaminated. During disposition, the exhaust blower and filter plenum were removed and sent to the RMHF for disposal. Rocketdyne personnel decontaminated the floor by wiping it with a caustic solvent and then resurveyed the building. The smear samples indicated contamination of less than 30 dpm/100 cm2 beta and less than 5 dpm/100 cm2 alpha. The building was completely demolished, including the removal of all concrete footings and pads. The report included a final survey of the entire KEWB area following grading activities. The survey found that all remaining surfaces were decontaminated to levels as low as reasonably achievable; in all cases below the 1976 levels for future unrestricted use (removable contamination of 20 dpm/100 cm^2 α or 100 dpm/100 cm^2 β). The survey concluded that the site was free of radioactivity except for normal background.[470]

- In May 1983, Argonne National Laboratories performed a post remediation radiological survey to verify that the KEWB site was free of radioactivity except for normal background. The survey performed a surface scan to determine the ambient gamma exposure rate and low-level radiation level. Soil samples were collected and analyzed for gamma radiation and uranium. The soil samples were taken at four locations around the perimeter of the site. Additionally, nine bore holes were drilled to depths of up to twelve feet, and sampled in sequential one-foot increments. The report did not include any figures to show the locations of the soil samples or bore holes. The report also did not include any analytical data or sampling results.

  The survey found no measurements above background in May 1983. According to Argonne National Laboratories, background was reported to be relatively high (40 µR/h and 8,000 cts/min) due to the shine from nearby Buildings 4021 and 4022. The report stated that the results of the analyses of soil samples revealed no radionuclide concentration above background levels. The survey concluded that the site could be released for unrestricted use.[471]

- On August 1988, Rocketdyne performed a surface scan of the terrain between the KEWB facilities and the RMHF measuring ambient gamma exposure rates to ensure that no contamination existed as a result of radioactive materials movement. The mean ambient gamma radiation detected was 17.4 ± 0.96 µR/hr, with background being 17.0 µR/hr. The acceptable limit, according to the report, was determined to be 5.0 µR/hr above background, meaning the survey results found no contamination above 1988 background levels.[472] The findings are inconsistent with the findings of the Argonne National Laboratories report that determined background levels to be 40 µR/hr. The August 1988

[470] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[471] 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.
[472] ETEC, GEN-ZR-0009, "Radiological Survey of the T513 Parking Lot; Old R/A Laundry Area; Plot 333; and Areas Between the SRE to RMHF, and KEWB to RMHF," August 26, 1988.

report did not provide any comparison of findings with previous reports to provide any reasons for the discrepancy.[473]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: There have been no radiological burial or disposal locations identified during the course of Building 4643 operations; however, it is important to note that asphalt and concrete from D&D activities were used as backfill at the site in 1975. While the concrete was decontaminated to levels that were "as low as practicable," it is uncertain whether these levels are in compliance with the requirements of SB-990.

Aerial Photographs: It is difficult to discern any features related to Building 4643 in aerial photographs.[474]

Radionuclides of Concern: Reactor fuel for the KEWB reactor was U-235 dissolved as uranyl sulfate in solution. As a result, the radionuclides of concern include Co-60, Cs-137, Eu-152, Eu-154, Sr-90, U-238 and U-235.[475,476] All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Drainage at Building 4643 is south-southwest toward a drainage ditch located adjacent to the former dirt road leading to the site. A 2-inch drain line also extends from this area to areas south-southwest.

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4643 area is Class 1 as a result of the use of the building as an exhaust stack for radioactive gases, known contamination, and proximity to Building 4073.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.2 provide a convenient reference for the following recommendations.

Due to the potential of radioactive material migration via surface water flow or airborne release from Buildings 4073 and 4643, there is a possibility of elevated radionuclide concentrations in soil. Therefore, additional characterization is recommended for the Building 4643 area. This includes the following Building 4643 areas:

It is recommended that sampling at the Building 4643 area be included in the Building 4073 sampling plan.

- The former Building 4643 footprint. During demolition, a contamination survey of Building 4643 and the associated equipment indicated that the floor of the exhaust

[473] 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.
[474] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[475] It is important to note that Ar-41 is not included in the listing of radionuclides of concern as a result of its short half-life of 109 minutes.
[476] Rocketdyne Report, N001ER000017, "Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective," September 1991.

building was contaminated with removable beta contamination levels of up to 600 dpm/100 cm^2. The exhaust blower and filter plenum were also contaminated and were removed and sent to the RMHF for disposal. During the course of building demolition, it is possible residual contamination above background values may exist at the former building location.

- The gas line from the 300-gallon storage tank to the former building. 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.[477,478] The removal of the pipe or the passage of radioactive gasses through the pipe may have caused possible residual contamination above background values along the gas line.

- As outlined in the sampling recommendations for Building 4073, the ditch adjacent to the former dirt road should be sampled. The ditch leads to 12th Street where the flow of drainage proceeds southeast along 12th Street to G Street and continues southwest to 17th Street.[479] If radioactive materials were released the ground surface near Building 4073, residual contamination above background values may exist in the materials surrounding the ditch.

2.2.9 Building 4793

Note: Limited documents relating to the construction and operation of Building 4793 have been located.

Site Description: The Building 4793 area is located within the KEWB facility area, east of Building 4073, and includes Building 4793 and the surrounding area. Building 4793 was a small above-ground mechanical building located east of the KEWB reactor building.[480] Figures 2.2.9a through 2.2.9d provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: D&D documents describe the building as a sheet-steel electrical control building. The building contained the electrical panels, air conditioner, and heater. A pit was located in the floor of this building where most of the electrical conduits to the reactor room terminate.[481482]

[477] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[478] 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.
[479] Atomics International, Drawing 303-00C-C2, "Misc. Paving, Patching & Drainage Improvements – KEWB," Date illegible, circa 1969. HDMSE00457545.
[480] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[481] 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.
[482] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.

Former Use(s): Building 4793 housed the heating and air conditioning systems for the KEWB reactor building and was constructed in the early 1950s. The building was demolished in 1975. During D&D operations, the building was surveyed and found to be free of contamination. The underground electrical wiring to and from the building was removed by the salvage contractor. The building was unbolted from the foundation and removed from the site and sent to the salvage yard. The concrete pad was demolished and removed.[483] The land on which Building 4793 was located was released for unrestricted use March 3, 1976, by the ERDA.[484]

Information from Interviewees: None to date.

Radiological Incident Reports: There have been no incident reports relating to the operations of Building 4793 identified to date.

Current Use: Building 4793 was demolished in 1975 and the building's footprint has been released for unrestricted use since 1976.[485] Based on available information, the dimensions of the excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations in the vicinity of this building is as follows:

- In 1975, Rocketdyne performed a final radiological survey of the KEWB building and support buildings, including Building 4793, during D&D of the facility. Rocketdyne surveyed Building 4793 and found the building to be free of contamination. Following the survey, the salvage contractors removed the underground electrical wiring to and from the building. Rocketdyne maintenance personnel removed the building from the site and sent it to the "salvage yard." The report indicates the concrete pad was demolished and removed but does not indicate who conducted the removal. The survey of the area after demolition found that all remaining surfaces were decontaminated to levels as low as reasonably achievable; in all cases below the levels for future unrestricted use (removable contamination of 20 dpm/100 cm^2 α or 100 dpm/100 cm^2 β). The survey concluded that the entire KEWB site was free of radioactivity except for normal background.[486]

- In July 1975, Rocketdyne performed a surface scan of the KEWB site, including Building 4793, following demolition to confirm that no radiological contamination remained.[487] The survey found no levels of beta-gamma surface contamination above the measured background (0.15 – 0.25 mrad/hr). According to the report, survey results were below 1975 background limits and were, as a result, below acceptable limits.

- In May 1983, Argonne National Laboratories performed a post remediation radiological survey to verify that the KEWB site, including Building 4793, was free of radioactivity

[483] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[484] Stamp, Stanley, Letter Re: "Decontamination and Disposition of ERDA Facilities," March 3, 1976.
[485] Stamp, Stanley, Letter Re: "Decontamination and Disposition of ERDA Facilities," March 3, 1976.
[486] Rockwell International, AI-ERDA-13159, "KEWB Facilities Decontamination and Disposition Final Report," February 25, 1976.
[487] Letter from R.K. Owen (Rockwell International) to R.J. Tuttle, "Radiation Survey T073 (KEWB) Site," July 17, 1975.

except for normal background. The survey performed a surface scan to determine the ambient gamma exposure rate and low-level radiation levels. Soil samples were collected and analyzed for gamma radiation and uranium. The soil samples were taken at four locations around the perimeter of the site. Additionally, nine bore holes were drilled to depths of up to twelve feet, and sampled in sequential one-foot increments. The report did not include any figures to show the locations of the soil samples or bore holes. The report also did not include any analytical data or sampling results.

The survey found no measurements above background. According to Argonne National Laboratories, background was reportedly relatively high (40 μR/hr and 8,000 cts/min) due to the "shine" from nearby Buildings 4021 and 4022. The report stated that the results of the analyses of soil samples revealed no radionuclide concentration above background levels. The survey concluded that the site could be released for unrestricted use.[488]

- On August 1988, Rocketdyne performed a surface scan of the terrain between the KEWB facilities and the RMHF measuring ambient gamma exposure rates to ensure that no contamination existed as a result of radioactive materials movement. The mean ambient gamma radiation detected was 17.4 ± 0.96 μR/hr, with background being 17.0 μR/hr. The acceptable limit, according to the report, was determined to be 5.0 μR/hr above background, meaning the survey results found no contamination above 1988 background levels.[489] The findings are in contract with the Argonne National Laboratories report that determined background levels to be 40 μR/hr.[490]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: There have been no radiological burial or disposal locations identified during the course of Building 4793 operations; however, it is important to note that asphalt and concrete from D&D activities of this building and Building 4073 were used as backfill at the site in 1975. While the concrete was decontaminated to levels that were "as low as practicable," it is uncertain whether these levels are in compliance with the requirements of SB-990.

Aerial Photographs: Aerial photographs do not show any disturbances near Building 4793, with the exception of a water pipeline that crosses near the site from 12th Street to Building 4003. The presence of Building 4793 is difficult to discern in the aerial photographs, as a result, the research team was unable to confirm the time of construction or demolition.[491]

Radionuclides of Concern: There have been no indications of use of radionuclides in Building 4793; however, because the building is associated with the operations of the KEWB reactor, the

[488] 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.
[489] ETEC, GEN-ZR-0009, "Radiological Survey of the T513 Parking Lot; Old R/A Laundry Area; Plot 333; and Areas Between the SRE to RMHF, and KEWB to RMHF," August 26, 1988.
[490] 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.
[491] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

radionuclides of possible concern include Co-60, Cs-137, Eu-152, Eu-154, Sr-90, U-238 and U-235.[492] All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Drainage at the Building 4793 area appears to be south, southwest.[493]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4793 area is Class 1 because of the building's proximity to Building 4073.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.2 provide a convenient reference for the following recommendations.

Due to the potential of radioactive material migration via surface water flow or airborne release from Buildings 4073 and 4643, additional characterization is recommended for the Building 4793 area. This includes the following Building 4606 areas:

It is recommended that sampling at the Building 4793 area be included in the Building 4073 sampling plan.

- The former Building 4793 footprint. Because the demolition of Building 4793 occurred concurrently with Building 4073 demolition activities and rubble from both structures was used as backfill material, it is possible residual contamination above background values may exist at the former Building 4793 location.

- As outlined in the sampling recommendations for Building 4073, the ditch adjacent to the former dirt road should be sampled. The ditch leads to 12th Street where the flow of drainage proceeds southeast along 12th Street to G Street and continues southwest to 17th Street.[494] If radioactive materials were released the ground surface near Building 4073, residual contamination above background values may exist in the materials surrounding the ditch.

2.3 GROUP 3

The Group 3 index map is presented in Figure 2.3. Following Figure 2.3, the site photograph and layout drawings for each building area within HSA-5A Group 3 are presented. HSA-5A Group 3 includes three building areas including Building 4030/4035 and Building 4641.

2.3.1 Building 4030/4035 Area

Site Description: The Building 4030/4035 area includes Building 4030, Building 4035, and the surrounding area. Building 4030/4035 was in the north-eastern section of ETEC on 10th Street, off the west side of G Street and had a total enclosed area of 2,311 square feet. Also on 10th Street, Building 4641 shared a fenced area with Building 4030 that was used as a palletized

[492] Rocketdyne Report, N001ER000017, *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, September 1991.
[493] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.
[494] Atomics International, Drawing 303-00C-C2, "Misc. Paving, Patching & Drainage Improvements – KEWB," Date illegible, circa 1969. HDMSE00457545.

material holding area in the early 1960s and may have held drums containing mixed fission products.[495,496] Drawings indicate the building had an associated leach field that was likely used until 1961 to 1962, when the building was connected to the newly-built Area III site-wide sewage system.[497] Figures 2.3.1a through 2.3.1d provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4030 was constructed in 1958 for research with a small accelerator neutron source. The building included two connected sections, each with steel framing, siding and roof. The western portion of Building 4030 was constructed at a right angle to the front office section. The front section of Building 4030 was known as Building 4035 before the rear section was added, and the two buildings were combined to form Building 4030.[498] The rear section of Building 4030 was configured to house a Van de Graaf accelerator that provided an adjustable energy proton beam to bombard a tritium target to produce neutrons. A Van de Graaf accelerator was also located in Building 4009 in Subarea HSA-8. An outside concrete wall was constructed to the north and east sides of the rear section of the building to provide shielding for the proton beams.[499] The building included restrooms so that the facility provided a complete self-contained accelerator test installation.[500] The building had an associated leach field that was likely used until 1961 to 1962, when the building was connected to the newly-built Area III site-wide sewage system.[501] Additionally, the building is serviced by electrical substation 4064.[502]
A fenced-in asphalt area between Buildings 4030 and 4641 was used as a palletized material holding area. According to a 1988 survey, some drums containing mixed fission products may have been stored in this area.[503]

Former Use(s): During the course of its operation, Building 4030 has been referred to as the AE-6 counting room and workshop, the AE-6 office annex (former Building 4035), the particle accelerator facility, the site purchasing office, and traffic and warehousing. Building 4030 was constructed in 1958 for research with a small accelerator neutron source. 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 continuously adjustable energies from a few hundred KeV up to a maximum of

[495] ETEC Document, GEN-ZR-0007, "Radiological Survey of Shipping /Receiving and Old Accelerator Area-Buildings T641 and T030," August 19, 1988.
[496] Rocketdyne Report, 030-AR-0002, "Decontamination and Decommissioning (D&D) of Building T030," November 13, 1997.
[497] The May 2005 HSA lists the following document as the source document for the information regarding the leachefield; however, HGL was unable to locate this information within this document: 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.
[498] Rocketdyne Report, 030-AR-0002, "Decontamination and Decommissioning (D&D) of Building T030," November 13, 1997.
[499] ETEC Document, GEN-ZR-0007, "Radiological Survey of Shipping /Receiving and Old Accelerator Area-Buildings T641 and T030," August 19, 1988.
[500] Rocketdyne Report, 030-AR-0002, "Decontamination and Decommissioning (D&D) of Building T030," November 13, 1997.
[501] Atomics International, Drawing 303-GEN-C17, Central Sewage System, Plan & Topography, August 27, 1959. Not an "As-built" drawing.
[502] Energy Technology Engineering Center, *Site Consolidation Assessment*, April 16, 1987.
[503] Rocketdyne Report, 030-AR-0002, "Decontamination and Decommissioning (D&D) of Building T030," November 13, 1997.

about 1 MeV. The particle beam was well-focused with a diameter of a few millimeters. Neutrons were generated using a tritium target via the H-3(p,n)He-3 reaction. Five-gallon cans of borated water were used for neutron shielding around the accelerator to thermalize and capture neutrons.[504,505] As indicated above, the reactor operated through 1964, at which time the facility was reportedly decommissioned, although documents relating to this decommissioning could not be located.

Following its use, the Van de Graaf accelerator was mothballed and remained in the building until 1966. A 1966 smear survey of the accelerator detected significant tritium contamination. The results of this survey are provided in the summary of previous radiological investigations, below. According to the 1997 decontamination and decommissioning report for Building 4030, Atomics International resurveyed the building following the removal of the accelerator and no residual contamination was found. The report does not indicate how the building was resurveyed or provide the survey results.[506] It is important to note that disposition of the accelerator could not be determined.

In 1965, Building 4030 was converted to an office. Beginning in 1972, the building was used as a purchasing office for the site and for traffic and warehousing.[507,508,509] According to a 1988 Use Agreement, DOE provided approval to the Rockwell Rocketdyne Division's request to relocate the SSFL shipping and receiving function to government-owned Buildings 4641 and 4030. The buildings, at the time, were under the cognizance of the DOE. The use agreement appears to have been in effect from April 1, 1988, through September 30, 1988.[510,511] The building was utilized as an office area until 1995.

Information from Interviewees: Interviewee 196 worked at the SSFL from 1959 to 1981 and again from 1991 to 1995 and stated:

> The only tritium I know about at the site was a particle source for an accelerator was in building 4035 or perhaps 4030. I've talked to the guy who was in charge of that accelerator, DGH. As I recall he didn't know what happened to the source. It was a small source.

Radiological Incident Reports: There are no incident reports associated with Building 4030. However, on June 20, 1989, a box of radioactive materials was removed from "T641/T030." The material, 13 mCi of Be-7, had been shipped from the DeSoto Facility in a Type A box. An

[504] ETEC Document, GEN-ZR-0007, "Radiological Survey of Shipping /Receiving and Old Accelerator Area-Buildings T641 and T030," August 19, 1988.
[505] Rocketdyne Report, 030-AR-0002, "Decontamination and Decommissioning (D&D) of Building T030," November 13, 1997.
[506] Rocketdyne Report, 030-AR-0002, "Decontamination and Decommissioning (D&D) of Building T030," November 13, 1997.
[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.
[510] Schelin, Earl, Letter Re: Use Agreement for Relocation of Shipping & Receiving to Buildings 641 and 030, March 21, 1988.
[511] Additional information regarding this use agreement could not be located.

external survey of the surface for contamination and external radiation found no contamination (A0581).[512]

Current Use: DOE released the facility for unrestricted use on December 22, 1997.[513] DHS concurred with the release of the facility for unrestricted use on January 15, 1999.[514] According to the 2005 HSA, Building 4030 was demolished in 1999 and the site was paved.[515] Based on available information, the dimensions of the excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- On March 29, 1966, personnel conducted a tritium smear survey on Building 4030 and associated equipment. 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 an 1/8-inch diameter hole at its center. As a result, the tritium beta particles from the sample area outside the 1/8-inch diameter 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 results of five sample locations with the most severe estimated contamination.

1966 Building 4030 Tritium Contamination Levels

Location	Activity (dpm/100 cm^2)
Plate below target holder	~1 x 10^5
Tritium target storage can	~1 x 10^5
Lower cooling hose	~1 x 10^5
Target holder (sides and front)	~3.6 x 10^6
Target holder (rear)	~3.6 x 10^6

The report recommended that the areas of severe contamination be decontaminated to an "acceptable" level but did not define the "acceptable" level.[516]

- In 1988, Rocketdyne performed a survey to clarify and identify areas at SSFL requiring further radiological inspection or remediation. The survey treated the building, Building 4641, and the surrounding area as a single sample lot for characterization and interpretation. As a result, the results presented here include data from Building 4641, discussed below. For the purposes of the survey, ETEC personnel superimposed 6-meter square grids over the terrain and building areas. One ambient gamma exposure rate

[512] Rowles, Jim, Internal Letter Re: Radiation Safety Incident Report, SSFL T641, June 20, 1989.
[513] Joma, Hannibal, Letter Re: Release of Facilities for Unrestricted Non-Radiologic Use, December 22, 1997.
[514] Wong, Gerald, DHS/RHB, Untitled letter, January 15, 1999.
[515] 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.
[516] Mooers, A.R., Atomics International Internal Letter Re: Tritium Smear Survey, Building 030 Van de Graaff Accelerator, March 29, 1966.

measurement was made 1 meter from the surface in each 36-square meter area, resulting in approximately 114 measurements being acquired. In addition to the ambient gamma exposure rate measurements, the survey also included beta surveys of the accelerator room and outside paved area (palletized-container storage area). The survey also included surface soil sampling near the west and north sides of Building 4030. Ten samples were collected at random and were analyzed for tritium by U.S. Testing Inc.

The survey indicated that the large concrete block wall built as a shield outside the north wall of Building 4030 was not activated during building operations. The only suspect radionuclide was tritium, which was used as the target for producing neutrons. Radiological contamination quantities were compared against unrestricted-use acceptable contamination prescribed by DOE 5400.1, below.[517]

Building 4030 1988 Maximum Acceptable Contamination Limits

Criteria	Alpha (dpm/100 cm^2)	Beta (dpm/100 cm^2)
Total Surface, averaged over 1 m^2	5,000	5,000
Maximum Surface, in 1 m^2	15,000	15,000
Removable Surface, over 100 cm^2	1,000	1,000
Ambient Gamma Exposure Rate	5 µR/hr over background	
Soil Activity Concentration	21 pCi/g 31 pCi/g	100 pCi/g
Water Activity Concentration	$1x10^{-4}$ µCi/mL	$1x10^{-5}$ µCi/mL

The average ambient gamma radiation measured for the entire data set of 114 measurements was 12.7 µR/hr with the limit being 5 µR/hr above background. Background was determined to be between 14 and 15.6 µR/hr based on 1988 measurements of the areas surrounding the "Incinerator Road" and the Building 4309 area. There was no detectable activity of beta radiation. The average tritium activity concentration in soil was 5.31 pCi/l with the maximum acceptable contamination being 366 pCi/l, meaning the survey results were below the 1988 acceptable limits.

It is important to note that according to the report, Rocketdyne experienced difficulty in assessing the radiological condition of "a clean facility based on an acceptance requirement relative to 'background'". The report indicated a large variabiligy of gamma exposure rated depending on whether measurement were taken indoors, outdoors, or near a large sandstone outcropping. Accounting for the variables and deviations, and subtracting a value that represents "natural" background gamma radiation at SSFL, Rocketdyne determined the area to be clean of any residual radioactive contamination.[518]

[517] DOE 5400.1 is a November 9, 1988, order from the U.S. Department of Energy pertaining to the general environmental protection program. The purpose of the order is to "establish environmental protection program requirements, authorities, and responsibilities for [DOE] operations for assuring compliance with applicable Federal, State, and local environmental protection laws and regulations, Executive orders, and internal Department policies. The Order more specifically defines environmental protection requirements that are generally established in DOE 5480.1B."

[518] ETEC Document, GEN-ZR-0007, "Radiological Survey of Shipping /Receiving and Old Accelerator Area-Buildings T641 and T030," August 19, 1988.

- ORISE conducted an independent verification survey for Building 4030/4035 in 1995. Surface scans for alpha, beta and gamma activity and single-point direct measurements for total alpha and total beta activity were performed on floors, walls, equipment and outside soil. These levels were compared to the guidelines specified in DOE 5400.1 as presented in the table above. Total alpha surface activity was found to be less than 55 dpm/100 cm^2, while total beta surface activity was found to be less than 1,400 dpm/100 cm^2. One sample of total tritium activity exceeded the average guideline for beta-gamma emitters (6,600 dpm/100 cm^2), and ORISE recommended additional sampling be performed in this area.[519]

- In 1996, Rocketdyne performed a Final Comprehensive Radiological Survey designed to measure total or removable surface activity and provide additional sampling for tritium activity in the accelerator area. Walls, floors and ceilings were surveyed for total and removable alpha and beta activity and maximum alpha and beta activity. Floors were surveyed for ambient gamma readings in μR/hr at 1 meter. The total alpha and beta limits were both 5,000 dpm/100 cm^2. The removable alpha and beta limits were both 1,000 dpm/100 cm^2. The removable tritium limit was 10,000 dpm/100 cm^2, and the ambient gamma limit was less than 5.0 μR/hr at 1 meter from surface. All survey results were below the 1996 acceptable limits.[520]

- DHS performed verification sampling in 1996 and 1998 to support concurrence of release for unrestricted use. According to a March 1996 letter, the release of Building 4030/4035 by DHS was put on hold as a result of DOE's recommendation that Rocketdyne resurvey the building.[521]

- In November 1997, Rocketdyne reported the decontamination and decommissioning activities at Buildings 4030 and 4641 in a single report. The report provides a summary of previous survey and decommissioning activities. According to the report, the Van de Graaf Accelerator was removed from Building 4030 in 1966. In 1996, Rocketdyne removed approximately 2,311 square feet of asbestos floor tile that was disposed of as non-radioactive hazardous waste. The document does not provide information regarding the final removal of Building 4030.[522]

- In March 2007, Cabrera Services completed the results of a final status survey on post-HSA sites, including Building 4030/4035. The purpose of the survey was to determine final status for areas where radionuclide concentrations were found to be below their respective derived concentration guideline level. The scope of the survey included surface soil to a depth of 0.5 feet below ground surface. Additionally, two subsurface soil samples were collected to support the assumption that contamination was restricted to the first 0.5 feet below ground surface. None of the samples reported radionuclide concentrations above their respective 2007 DCGLs, and, as a result, Cabrera

[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.
[520] Rocketdyne Report, 030-AR-0001, "Final Radiological Survey Report for Building T030," January 22, 1997.
[521] Montes, Michael, Letter Re: Buildings 030, 019, and 654, March 29, 1996.
[522] Rocketdyne Report, 030-AR-0002, "Decontamination and Decommissioning (D&D) of Building T030," November 13, 1997.

recommended Building 4030 for unrestricted release. The DCGLs were derived, radionuclide-specific activity concentrations within a survey unit corresponding to the release criterion and are summarized in the table below.[523]

DCGLs for Radionuclides of Concern

Constituent	Residential Soil Concentration (pCi/g)	
	Boeing DCGL [1]	EPA PRG 10-4 Risk Level [2]
Americium-241	**5.44** [3]	187
Cobalt-60	**1.94**	4
Cesium-134	**3.33**	16
Cesium-137	9.2	**6**
Europium-152	4.5	**4**
Europium-154	**4.1**	5
Tritium	31,900	**228**
Manganese-54	**6.1**	69
Plutonium-238	**37.2**	297
Plutonium-239	**33.9**	259
Plutonium-240	**33.9**	-
Plutonium-241	**230**	40,600
Strontium-90	36	**23**
Thorium-228	**5**	15
Thorium-232	**5**	**5**
Uranium-234	**30**	401
Uranium-235	30	**20**
Uranium-238	**35**	74

[1] Boeing, Approved Sitewide Release Criteria for Remediation of Radiological Facilities at the SSFL, 1998

[2] Source: Based on EPA preliminary remediation guides (PRGs) for residential soil at a 10-4 risk level. OSWER 9355.01-83A. "Distribution of OSWER Radionuclide Preliminary Remediation Goals (PRGs) Superfund Electronic Calculator." February 7, 2002. http://epa-prgs.ornl.gov/radionuclides. Data retrieved October 26, 2006.

[3] More restrictive standard for each constituent is bolded and shaded.

Radiological Use Authorizations: The research team has not located any use authorizations for the use of radiological materials at the building.[524]

Former Radiological Burial or Disposal Locations: None found.

Aerial Photographs: In 1957, the future location of Building 4030 is being developed. There is evidence of fill being placed in the surrounding area. By 1959, the building is visible and in 1962 the building has been expanded to include the Building 4035 portion of the building. A parking lot is present south of the building in 1959 and 1962 where Building 4641 will eventually be constructed. In 2005 the building is no longer present. The aerial photograph

[523] Cabrera Services, Inc., *Final Status Survey Report: Final Status Survey Post Historical Site Assessment Sites, Block 1*, March 2007.

[524] 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.

interpretation indicated that outdoor storage and possible stains were visible in 2002 and ground scarring and dark-toned material were visible in 2003.[525]

Radionuclides of Concern: Regulated radiological materials were managed at Building 4030.[526] The van de Graaf accelerator produced neutrons by the $H^3(p,n)He^3$ 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.[527] All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: As indicated above, the building had an associated leach field that was likely used until 1961 to 1962, when the building was connected to the newly-built Area III site-wide sewage system.[528] The associated leach field was not located during decontamination and demolition. During the October 2003 RCRA Facility Investigation Report on Area IV leach field sites, the Building 4030 leach field is identified as comprising approximately 90 total linear feet, receiving flow from a 1,000-gallon septic tank. On a facility map, the leach field was located approximately 300 feet southwest of Building 4030; however, the existence of the leach field could not be confirmed during the RFI.[529] In 1995, disturbed ground is visible south-southwest of Building 4641 along 11th Street at the presumed location of the leach field. The disturbed ground is vegetated by 2005.

Otherwise drainage at the site is to the south on the west side of the building and to the northeast on the east side of the building.[530]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4030 area is Class 1 based on previous site activities.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.2 provide a convenient reference for the following recommendations.
Due to the possible storage of drums containing mixed fission products, tritium contamination, and the building's operations, additional characterization is recommended for the Building 4030/4035 area. This includes the following Building 4030/4035 areas:

- Outdoor storage and possible stains were visible in 2002 aerial photographs and ground scarring and dark-toned material were visible in 2003. It is recommended these locations

[525] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[526] 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.
[527] ETEC Document, GEN-ZR-0007, "Radiological Survey of Shipping /Receiving and Old Accelerator Area-Buildings T641 and T030," August 19, 1988.
[528] The May 2005 HSA lists the following document as the source document for the information regarding the leachefield; however, HGL was unable to locate this information within this document: 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.
[529] MWH, *DOE Leach Fields (Area IV AOC) RCRA Facility Investigation Report, Santa Susana Field Laboratory, Ventura County, California*, October 2003.
[530] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.

be sampled due to the unknown nature of the storage activities. Residual contamination bay be above background values in this area as a result of storage activities.

- The possible leach field for Building 4030 should be further researched and evaluated for possible sampling. To date, historical documents for Building 4030 do not provide information on the leach field location. The possible location of the leach field should be investigated further through geophysical techniques and targeted sampling strategy.

- The drainage area on the east and west sides of the building should be evaluated. If radiological materials were released into the environment, residual contamination may be above background values in the area.

- The location of the former concrete shield wall on the north side of the building should be evaluated by sampling to ensure that no radioactivity from operations remain at the former shield wall.

- The sanitary sewer lines located along the western side of the Building 4030. If radioactive materials were released into the sanitary sewer system, residual contamination may exist in the materials surrounding the sewer lines.

- The Building 4030/4035 footprint, specifically the former location of the accelerator should be evaluated as a result of the elevated levels of tritium contamination in relation to the operation of the accelerator. Based on the operations in this area of the building, residual contamination above background values may be present in this area.

2.3.2 Building 4046 Area

Note: To date, the research team has been unable to locate documents relating to the construction and operation of Building 4046.

Site Description: The Building 4046 area includes Building 4046 and the surrounding area, excluding Buildings 4030/4035 and 4641. Building 4046 was located west of Building 4030/4035 (discussed above) and northwest of Building 4641 (discussed below). A sidewalk joined Building 4046 to Building 4453, a fuel handling facility. [531] Figures 2.3.2a provides a current photograph of the former Building 4046 location. Plate 1 presents a summary of all identified features for this site.

Building Features: No information was located.

Former Use(s): Building 4046 was constructed in approximately 1977 and, reportedly, did not handle radiological materials.[532] The building is identified in industrial planning maps as a material office annex owned by Rockwell International; however, additional information regarding the building operations could not be located. [533]

[531] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[532] 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.
[533] SSFL Area IV, ETEC Industrial Planning Maps, 1962-1992.

Information from Interviewees: None to date.

Radiological Incident Reports: There have been no incidents identified associated with operations at Building 4046.

Current Use: Building 4046 appears to have been demolished prior to 1980.[534] Based on available information, the dimensions of the excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): There have been no radiological surveys specific to Building 4046 conducted to date; however, radiological investigations have occurred at and surrounding Buildings 4030/4035 and 4641.

Radiological Use Authorizations: None.

Former Radiological Burial or Disposal Locations: None found.

Aerial Photographs: The area that includes and surrounds Building 4046 is vegetated in most of the aerial photographs. The building appears in the 1978 aerial photographs and by 1980 has been removed and the area is partially re-vegetated.[535]

Radionuclides of Concern: None found.

Drainage Pathways: No drainage pathways associated with Building 4046 have been located, although, generally, as identified in 1964, the drainage in the vicinity of the future building show the drainage to flow south, southeast.[536]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4046 area is Class 2 because of the unknown nature of the building's use and operation, as well as the building's proximity to Building 4030/4035 and Building 4641.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.3 provide a convenient reference for the following recommendations.

Due to the limited information available regarding the construction, operation, and demolition of Building 4046, additional characterization is recommended for the Building 4046 area. This includes the footprint of Building 4046, as well as the areas south-southeast of the building to coincide with the approximate drainage from Building 4030/4035 prior to Building 4046 being constructed.

2.3.3 Building 4641Area

Site Description: The Building 4641 area is located south of Building 4030/4035 and comprises Building 4641 and the surrounding area. Building 4641 was constructed in 1964 as a shipping and receiving facility. A fenced area between Buildings 4030/4035 and 4641 was used as a

[534] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[535] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[536] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.

palletized material holding area. South and west of the building are outcroppings of Chatsworth sandstone formation.[537] Building 4030/4035 located north of Building 4641 originally served as the AE-6 counting room and workshop, and was discussed previously. Building 4046 was located at the northwest corner of Building 4641 for a short period of time in the late 1970s and is discussed above, also. No as-built drawings depicting the building floor plan were located for Building 4641. Figures 2.3.3a through 2.3.3d provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4641 was located south of Building 4030. The building had 7,680 square feet of storage space, 240 square feet of office space, and a loading dock for shipping and receiving.[538]

Former Use(s): Building 4641 was constructed in 1964 to be used for shipping and receiving. Building 4641 served as a transfer point for all SSFL incoming and outgoing shipments. Through 1985, this included radioactive materials. Non-radioactive materials were stored in the warehouse. Radioactive and nuclear shipments reportedly were only handled on the outdoor dock; they were never stored in the warehouse. Additionally, 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. All radioactive materials being shipped or received were always completely containerized and packaged. Containers were not opened in the area of Building 4641. The building had a radiation detector alarm system in the dock, and the alarm system was never triggered.[539]

In 1985, Building 4641 was designated as an on-site, internal moving and transport facility, and radioactive materials handling at the building ceased.[540] According to a 1988 Use Agreement, DOE provided approval to Rockwell's Rocketdyne Division to relocate the SSFL shipping and receiving function to government-owned Buildings 4641 and 4030. The buildings, at the time, were under the cognizance of the DOE. The use agreement appears to have been in effect from April 1, 1988, through September 30, 1988.[541,542] Building 4641 was demolished in 2004.[543]

Information from Interviewees: None to date.

Radiological Incident Reports: There has been one incident associated with Building 4641 that could have resulted in a release to the environment. The following table provides information

[537] 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, November 1995.
[538] 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, November 1995.
[539] ETEC Document, GEN-ZR-0007, "Radiological Survey of Shipping/Receiving and Old Accelerator Area-Buildings T641 and T030," August 19, 1988.
[540] ETEC Document, GEN-ZR-0007, "Radiological Survey of Shipping/Receiving and Old Accelerator Area-Buildings T641 and T030," August 19, 1988.
[541] Schelin, Earl, Letter Re: Use Agreement for Relocation of Shipping & Receiving to Buildings 641 and 030, March 21, 1988.
[542] Additional information regarding this use agreement could not be located.
[543] 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.

presented in an incidents database provided by Boeing. Summaries of the incident reports are provided following the table, when available.

Building 4641 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0581	6/20/1989	Building 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 releases to the environment as a result of this incident (A0581).[544]

Current Use: Building 4641 was demolished in 2004.[545] According to December 18, 2003, letter from Boeing to the Ventura County Air Pollution Control District, the superstructure, concrete foundation, utilities, and asphalt surrounding the building were removed in accordance with the Ventura County Building Codes. Following demolition, the area was graded for proper drainage and returned to "green field conditions". The letter does not define "green field conditions."[546] Based on available information, the dimensions of the excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- In 1988, Rocketdyne performed a survey to clarify and identify areas at SSFL requiring further radiological inspection or remediation. The survey treated the building, Building 4030, and the surrounding area as a single sample lot for characterization and interpretation. As a result, the results presented here include data from Building 4030, discussed above. For the purposes of the survey, ETEC personnel superimposed 6-meter square grids over the terrain and building areas. One ambient gamma exposure rate measurement was made 1 meter from the surface in each 36-square meter area, resulting in approximately 114 measurements being acquired. In addition to the ambient gamma exposure rate measurements, the survey also included beta surveys of the accelerator room and outside paved area (palletized-container storage area). The survey also included surface soil sampling near the west and north sides of Building 4030, but did not include any soil samples near or around Building 4641.

  Radiological contamination quantities were compared against unrestricted-use acceptable contamination prescribed by DOE 5400.1, below.[547]

[544] Rowles, Jim, Internal Letter Re: Radiation Safety Incident Report, SSFL T641, June 20, 1989.
[545] Pomatto, G., Letter Re: Contract DE-AC03-99SF21530 GFY04 Performance Incentive Fee Achievements, November 17, 2004.
[546] Ludwig, Barbara, Letter Re: Demolish Buildings 4487& 4641, December 18, 2003.
[547] DOE 5400.1 is a November 9, 1988, order from the U.S. Department of Energy pertaining to the general environmental protection program. The purpose of the order is to "establish environmental protection program requirements, authorities, and responsibilities for [DOE] operations for assuring compliance with applicable Federal, State, and local environmental protection laws and regulations, Executive orders, and internal Department policies.

Building 4641 1988 Maximum Acceptable Contamination Limits

Criteria	Alpha (dpm/100 cm^2)	Beta (dpm/100 cm^2)
Total Surface, averaged over 1 m^2	5,000	5,000
Maximum Surface, in 1 m^2	15,000	15,000
Removable Surface, over 100 cm^2	1,000	1,000
Ambient Gamma Exposure Rate	5 µR/hr over background	
Soil Activity Concentration	21 pCi/g 31 pCi/g	100 pCi/g
Water Activity Concentration	$1x10^{-4}$ µCi/mL	$1x10^{-5}$ µCi/mL

The average ambient gamma radiation measured for the entire data set of 114 measurements was 12.7 µR/hr with the limit being 5 µR/hr above background. Background was determined to be between 14 and 15.6 µR/hr based on 1988 measurements of the areas surrounding the "Incinerator Road" and the Building 4309 area. There was no detectable activity of beta radiation.

It is important to note that according to the report, Rocketdyne experienced difficulty in assessing the radiological condition of "a clean facility based on an acceptance requirement relative to 'background'". The report indicated a large variabiligy of gamma exposure rated depending on whether measurement were taken indoors, outdoors, or near a large sandstone outcropping. Accounting for the variables and deviations, and subtracting a value that represents "natural" background gamma radiation at SSFL, Rocketdyne determined the area to be clean of any residual radioactive contamination.[548]

- In 1995, ORISE performed an independent verification survey for Building 4641. Surface scans for alpha, beta and gamma activity and single-point direct measurements for total alpha and total beta activities were performed on the loading dock. In addition, 25 single-point direct measurements for total alpha and total beta activity were preformed on floors, walls, equipment, and pavement.

  Surface activity levels were less than 100 dpm/100 cm^2 for total alpha and less than 1,400 dpm/100 cm^2 for total beta on the loading dock. These levels were compared to the guidelines specified in DOE 5400.1 presented in the table above and were considered radiologically clean. Exposure rate measurements were performed at 1 meter above the surface of the loading dock using a proportional ionization counter and ranged from 10 to 12 µR/hr. The background exposure rate was 8 µR/hr. The report summarizing the verification survey results showed that surface activity levels, exposure rates, and/or radionuclide concentration levels in soil were less than the above guidelines for release to unrestricted use.[549]

The Order more specifically defines environmental protection requirements that are generally established in DOE 5480.1B."

[548] ETEC Document, GEN-ZR-0007, "Radiological Survey of Shipping /Receiving and Old Accelerator Area-Buildings T641 and T030," August 19, 1988.

[549] 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, November 1995.

Radiological Use Authorizations: The research team did not locate any use authorizations associated with the operations in Building 4641.

Former Radiological Burial or Disposal Locations: No former radiological burial or disposal locations have been identified at or around Building 4641.

Aerial Photographs: In 1957, the Building 4641 area appears to be a fill area and by 1959 the area is a parking area. The parking area remains until sometime between 1962 and 1965 when Building 4641 is constructed. Outside storage begins to appear directly north of Building 4641 in 1967. Between 1972 and 1978, the building was expanded on the south side. A possible stain is visible in August 1986 on the north side of the building. In 1995, disturbed ground is visible south-southwest of the building along 11th Street at the approximate location of the Building 4030/4035 leach field. By 2005 the building has been removed and ground scarring is visible at the former building location. The disturbed ground visible in 1995 is vegetated by 2005.[550]

Radionuclides of Concern: As a result of the limited information regarding the types of radioactive and nuclear shipments handled on the outdoor dock, the research team has been unable to identify a list of radionuclides of concern specific to this building. As a result, it is recommended the building be evaluated for all radionuclides included in the August 2009 Final Field Sampling Plan. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: According to the May 2005 HSA, the Building 4030/4035 leach field was located in the vicinity of Building 4641 from approximately 1961 to 1962. However, attempts to locate the leach field have been unsuccessful. Drainage surrounding Building 4641 is to the south.

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4641 area is Class 2 based on previous site activities on the outdoor dock and the storage activities surrounding the building.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.3 provide a convenient reference for the following recommendations.

Due to the use of the building as a shipping and receiving building, including radioactive material, additional characterization is recommended for the Building 4641 area. This includes the following Building 4641 areas:

- Outdoor storage directly north of Building 4641 and possible stains were visible in 1967 and 1986 aerial photographs. It is recommended these locations be sampled due to the unknown nature of the storage activities and the possibility that radioactive materials may have been stored in this location, resulting in the possibility that radionuclide concentrations in the soil will exceed background values .

- The former location of the outdoor dock should be evaluated as this is reported to have been the area of the building where radioactive materials were received.

[550] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

2.4 GROUP 4

The Group 4 index map is presented in Figure 2.4. Following Figure 2.4, the site photograph and layout drawings for each building area within HSA-5A Group 4 are presented. HSA-5A Group 4 includes seven building areas including Building 4005 and Building 4042.

2.4.1 Building 4005 Area

Site Description: The Building 4005 area comprises Building 4005, substation Building 4705, two holding tanks and drain lines, and the land surrounding these two buildings located south of B Street and northeast of 17th Street. These buildings were located outside the boundaries of the U.S. Government-optioned land at the SSFL Site.[551] Building 4005 was constructed in 1958 for non-nuclear testing of thermodynamic characteristics of proposed coolants for the Organic Moderated Reactor Experiment and Piqua reactors.[552] Figures 2.4.1a through 2.4.1e provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4005 was a tilt-up concrete structure with Butler aluminum siding and several windows. The structure was 80 feet long (running northwest to southeast) and 60 feet wide.[553] The building also included "a number of concrete pads" on the east end of the building that held equipment used in the Molten Salt Oxidation Project and filter plenums from the fuel fabrication project.[554] An underground storage tank installed in 1961 was located immediately southwest of Building 4005 for the storage of fuel oil to operate power generators during natural gas curtailment. The tank was excavated and removed on August 31, 1987.[555]

Building 4005 was divided into several portions, including a small administration area, change rooms, chemistry laboratories, storage rooms and a large high-bay area. Several concrete pads sat east of the building and held various equipments from the Molten Salt Oxidation project and the radioactive filter plenums. Building 4005 was connected to two underground radioactive liquid holding tanks by drain lines. The tanks were located approximately 60 feet northeast of the building. The drain lines extended from various laboratories and work areas within Building 4005 and were made of cast iron. The pipe joints and fittings were connected and sealed with oakum and lead. Portions of the exterior drain lines were located under two major equipment installations that included a large tank and support structure and a free-standing bag-house structure.[556,557]

Former Use(s): Building 4005, a "company-owned" facility used for Government programs, was constructed in 1958 for non-nuclear testing of thermodynamic characteristics of proposed

[551] Rutherford, P.D., *Exemption from Decommissioning Docket Process, Rocketdyne Building T005,* July 24, 1996
[552] Rockwell International, *Decontamination and Decommissioning (D&D) of the Uranium Carbide Fuel Facility – Building T005,* 005-AN-002, September 28, 1993.
[553] Rocketdyne, *Final Radiological Survey of Building 005*, 005-ZR-0001, September 21, 1993.
[554] ORISE, *Verification Survey of Buildings 005, 023, and 064, Santa Susana Field Laboratory, Rockwell International, Ventura County, California*, 94/K-14, October 1994.
[555] Groundwater Resources Consultants, Inc., *Preliminary Site Assessment Work Plan, Tank 1, Building 005*, September 25, 1990. p. 2
[556] Rocketdyne, *Final Radiological Survey of Building 005*, 005-ZR-0001, September 21, 1993.
[557] Rockwell International, *Decontamination and Decommissioning (D&D) of the Uranium Carbide Fuel Facility – Building T005,* 005-AN-002, September 28, 1993. p. 23

coolants for the Organic Moderated Reactor Experiment and Piqua reactors. During the middle 1960s, 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 Atomic Energy Commission (AEC) Heavy-Water Organic-Cooled Reactor.[558,559] 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. In the pilot plant, uranium oxide was reacted with graphite to convert it to uranium carbide. The uranium carbide was cast into pellets, machined, and assembled into cladding tubes to make fuel assemblies. During this time approximately 700 UCx cylinders, 0.25 inches in diameter and 3 inches lone were fabricated. Highly enriched uranium (93.1 % by weight) metal was homogenized with 4.9 % by weight enriched uranium by induction melting and casting to produce 12.7 % by weight enriched uranium slugs. The uranium slugs were then synthesized by reacting uranium metal with graphite in an arc furnace. The cast slugs were then machined into cylinders. The facility operated for a period of nine months during 1966 and1967, first using depleted uranium, and later enriched uranium and was a radiological controlled access area. In 1967, equipment was removed and surfaces decontaminated to permit non-radiological use of the building.[560,561,562]

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).[563] The molten salt test facility, according to a 1992 environmental monitoring program plan, was a general purpose molten salt combustion pilot plant constructed in 1973 in Building 4005 to permit investigation of new processes using engineering scale equipment. Tests were completed at the facility in July 1986. During the facility's use, approximately 25 test campaigns were conducted for a total of approximately 1,000 hours of operation. Testing was completed under contract to the DOE, the EPA, and the Department of the Navy, in addition to Rockwell-funded independent research and development projects.[564]

According to the 1992 environmental monitoring program plan, the molten salt gasification plant (or 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. "Make-up salt," together with coal, was continuously fed to a refractory lined combustion vessel, and a small streat of the molten salt bed was continuously removed and water quenched to control the concentration of absorbed sulfur

[558] It is important to note that the 1988 "Executive Summary of the DOE SSFL Site Radiological Survey" by Rocketdyne indicates the uranium carbide fuel fabrication facility operated in Building 4005 from the late 1950s to 1969. Historical documents of the building's use during this time period could not be located to verify the dates of operation.
[559] Rockwell International, *Environment, Safety, and Health Long Range Plan II*, N001PMP000008, September 13, 1988.
[560] Rockwell International, *Decontamination and Decommissioning of the Uranium Carbide Fuel Facility – Building T005*, 005-AN-002, September 28, 1993.
[561] Rocketdyne, *Final Radiological Survey of Building 005*, 005-ZR-0001, September 21, 1993.
[562] Rockwell International, *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, N001ER000017, December 20, 1989. p. 19
[563] Rockwell International, *Decontamination and Decommissioning of the Uranium Carbide Fuel Facility – Building T005*, 005-AN-002, September 28, 1993.
[564] Rockwell International, *Environmental Monitoring Program Plan, Santa Susana Field Laboratory, Area IV*, ER-AN-0006, September 30, 1992.

and ash. The product gas was ducted out of the vessel to an aqueous particulate scrubber/cooler and then burned in a waste gas incinerator.

The quenched salt, which contained sulfur and ash from the coal, formed a "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 1992 plan, these operations were first started in November 1978 and operated for a total of nine test runs until 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. Following testing, the aqueous plant equipment was flushed with clean water to remove "green liquor" and salt residues. All bulk quantities of sodium carbonate and coal were disposed of off-site; however, the document does not indicate where. In 1991, an unidentified commercial demolition company completed disposal of all plant equipment and foundations and returned the site to its "original" condition.[565] This occupied a few offices, while the remaining offices served as storage and tool cribs.[566]

In addition to the above, in 1982, Building 4005 also contained a low NOx-SOx burner at the north edge of the building to determine the possibility of burning high-sulfur coal with reduced emissions of NOx and sulfur dioxide. Rockwell operated the unit intermittently until 1988 with a total of 48 test runs completed between 1982 and 1988. According to the 1992 environmental monitoring program plan, the "site" had been partially remediated by removing bulk quantities of coal and fly ash.[567]

According to a 1988 long range plan, Building 4005 had been "partly decontaminated" to permit restricted use. The plan stated that additional decontamination was required for unrestricted use. This decontamination included the removal of the contaminated exhaust system and liquid radioactive waste tank.[568] In 1993, according to project progress reports, Rockwell International completed the removal of the Building 4005 filter plenum and exhaust ducting. The material was size-reduced for packaging and shipment.[569]

Information from Interviewees: A number of interviewees were knowledgeable about operations at Building 4005. Interviewee 254 worked in Building 4005 doing heat transfer studies with loops. The following provides excerpts from the Interviewee 254 interview:

> I first handled radioactive material in about 1965 when I worked in Building 5. We had been doing heat transfer studies with loops using non-radioactive materials. Then we received radiologically-contaminated organic material for use in our loops in Building 5. That was my first encounter with radioactive materials…

[565] Rockwell International, *Environmental Monitoring Program Plan, Santa Susana Field Laboratory, Area IV*, ER-AN-0006, September 30, 1992.
[566] ETEC, *Radiological Survey of Building T005*, GEN-ZR-0003, November 16, 1987. p. 9
[567] Rockwell International, *Environmental Monitoring Program Plan, Santa Susana Field Laboratory, Area IV*, ER-AN-0006, September 30, 1992.
[568] Rockwell International, *Environment, Safety, and Health Long Range Plan II*, N001PMP000008, September 13, 1988.
[569] Gaylord, G., Energy Technology Engineering Center Project Progress Report, Accounting Period For First Quarter FY93, January 26, 1993.

> …When I first started working with radiological material in Building 5 we had safety procedures to follow… You had to clean the area when you were done and put radioactive waste in RA (radioactive) disposal containers…
>
> …The level of radiation was so low in Building 5 that time limits for exposure were not in place yet. Most of the contamination in Building 5 was alpha contamination so it wouldn't penetrate very far.

Interviewee 255 worked for Atomics International from 1967 to 1985 as an atomic reactor inspector and certified x-ray technician. According to Interviewee 255:

> I worked in Building 4005 and we made fuel rods for a reactor. That building has been cleaned up and used for other purposes since then. I don't think there were any problems in Building 4005. We didn't manufacture a lot of fuel up there…
>
> … When we were manufacturing fuel in Building 4005, there were two or three times we had to evacuate the building because some of the monitor alarms went off…
>
> … As far as specific radionuclide sources, we built uranium fuel rods in Building 4005 for an offsite reactor. The building was cleaned up completely and used for other tests afterward, but I wasn't involved then because I had moved to ETEC/LMEC.

Later, when the focus of Building 4005 operations shifted to coal gasification, Interviewee 78 provided the following information:

> Building 5 had a coal gasification system that we ran around the clock. Coal was converted to a low butane gas by putting the coal in a vessel of molten salt. One day the molten salt vessel blew up. The vessel was under pressure and a 36-inch blind flange malfunctioned. Molten salt was spewing all over the place and going into the drainage system… after the explosion following the flange blow out, nasty crap was coming out of there and running into the street in front of the building. We were putting sand bags out to keep it on the street. The stuff eventually froze up again. We got it shut down.

Interviewee 277 appears to describe a similar incident in his description of the operations at Building 4005 and the PDU as follows:

> At Building 5 there was the Molten Salt Test Facility (MSTF), I think but I'm not sure, and the Process Demonstration Unit (PDU). I worked at both. The PDU was built and we had 20-25 mechanics there who were getting the unit ready to function. The unit was built by an outside contractor and we did testing and checked everything out. I worked with Kentucky coal and Pennsylvania coal and worked with coke which was a more refined coal – it was very fine and air bubbles would come out of it like a volcano. The vessels ran at 1900 degrees and were lined with ceramic bricks at the bottom and the coal bed was like lava. When cooled there was a by-product we called "green liquor" that would eat the leather off of your boots. If you got it on your hands it would start to burn and you would have to wash it off.
>
> There was a spill of the green liquor that when down the 17th Street drainage. I was working off site back east deconning at the Frankfurt Arsenal when I was asked to come back to help with the green liquor spill. The cause of the spill was that the pumps weren't working and the stuff overflowed into Silvernale pond. It turns out that one of the

> technicians was smoking cigars with plastic tips and throwing the butts into the area that was being pumped out and these plastic cigar tips jammed up in the pumps.

Interviewee 411 began working at the SSFL property in 1985 and indicated the use of Building 4005 as possible storage of radioactive materials, as indicated below; however, information stating such storage activities in Building 4005 could not be located in available historical documents.

> I was responsible for overseeing shipment of radiological materials off the mountain. I didn't actually have anything to do with how radiological materials were handled, we just managed the paperwork for the shipments. We had to check their radiological readings before we put them on a truck for transport. We made sure they met the requirements for acceptable levels of radiation. I made the arrangements for all the shipments and thus I knew where everything that was shipped was going. All radioactive materials that were shipped were shipped off-site; nothing stayed at the SSFL. There were some materials that we stored temporarily until there was a sufficient quantity to ship - I think the building we used for that was Building 5 - where we stored things until we had enough to ship. I really can't remember. Everything was stored inside a building.

Radiological Incident Reports: There have been several incidents associated with Building 4005 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 the incident reports are provided following the table, when available.

Building 4005 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0494	12/17/1959	Low bay	Not applicable	Employee did not wear prescribed protective clothing in a controlled area.
A0473	6/3/1960	High bay	S-35	HBR and kerosene caught fire.
A0430	8/15/1960	HBR Low Bay	Not applicable	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	7/8/1967	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 January 5, 1967, with the subject "Radiation Safety Unit Weekly Highlights for 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 (A0494).[570]

- 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 0.9 mR/hr. The nature and quantity of the material could not be deciphered from the scanned document (? Gallons of 30% high boiler residue containing mainly S-35 and C-14?) (A0473).[571]

- 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 gloved, and caused a second degree burn. The incident report stated that no contamination was detected on the skin (A0430).[572]

- 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 fire. Samples of the residue removed from the tanks following the fire were submitted for analysis; however, the results of this analysis was not provided in the documentation relating to this incident (A0606).[573]

- 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)[574]

- 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

[570] Atomics International, Notice of [Illegible] Infraction, A0494, December 18, 1959.
[571] Warren, J.W., *A0473, Building 4005 North High Bay*, July 1, 1960.
[572] Warren, J.W., A0430, Radiological Safety Incident Report, Bldg 005 Low Bay, August 15, 1960.
[573]. Unknown, Internal Letter Regarding "Radiation Safety Unit Weekly Newsletter for Period Ending February 4, 1967," February 9, 1967.
[574] Unknown, Internal Letter Regarding "Radiation Safety Unit Weekly Newsletter for Period Ending February 13, 1967," February 23, 1967.

facility vacuum system. The inspection determined that no release to the atmosphere resulted (A0649).[575]

- 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 cm2 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).[576]

Current Use: The research team did not locate specific information regarding the demolition of Building 4005. However, according to the 1997 annual site environmental report, Building 4005 was demolished in 1997.[577] Based on available information, the dimensions of the excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- As indicated above, following the fuel fabrication program in 1967, the building was decontaminated to permit non-radiological use of Building 4005. According to Report 005-AN-0002, all associated project equipment was removed from the building. The wall between rooms 105 and 112 was removed to allow use of the high bay for storage and "other appropriate activities." The floor tile, wall baseboards and coving were removed from Rooms 105, 112, 116, 111, 111A, 115, and 108, and radioactive material exhaust outlets were cut and capped. Additionally, "some" of the radioactive liquid drain lines were removed. Surveys conducted on the underlying floor and exhaust ducts ensured no contamination remained, and ensured no loose contamination spread to surrounding areas. During the late 1970s, both underground radioactive liquid holdup tanks were removed and disposed as low-level radioactive waste. The excavated areas were backfilled and resurfaced with asphalt paving. The radioactive liquid drain lines from the building to the holdup tanks were capped and left in place.[578]

- Additional decontamination activities occurred in 1987 at Building 4005 and included the decontamination of Rooms 108 and 106, decontamination of the walls and floors of Rooms 115, 107, 111, 110, 116, 110A, and the hallways, removal of four radioactive-contaminated exhaust ventilation drops, and removal of radioactive drain lines in the floors of Rooms 107, 111, 110, 108, 116, 115, 110A, and hallways. Decontamination

[575] Alexander, R.E., Internal Letter Regarding "Radiation Safety Unit Weekly Newsletter for Period Ending July 8, 1967," July 13, 1967.
[576] Wallace, J.H., Radiological Safety Report A0215, August 12, 1991.
[577] Rocketdyne Division, *Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1997*, A4CM-ZR-0012, November 1998. p.44
[578] Rockwell International, *Decontamination and Decommissioning (D&D) of the Uranium Carbide Fuel Facility – Building T005*, 005-AN-002, September 28, 1993.

efforts were to also include the removal of the radioactive exhaust ducting, radioactive filter plenums, and the underground radioactive liquid drain lines located outside the building; however, these tasks were not completed at the time. The decontaminated areas were surveyed and the results of this survey are presented below.[579]

- In 1987, Rocketdyne performed a characterization survey to confirm that residual contamination remained in ventilation systems and drain lines. The survey showed that several areas were contaminated at levels above 1987 DOE release limits: room 113, room 110E, four remaining radioactive exhaust ducts and both radioactive exhaust filter plenums. The maximum beta level detected in the rooms was 107,954 dpm/100 cm^2 (acceptable limit 1,000 dpm/100 cm^2), while the maximum alpha level detected was 2,467 dpm/100 cm^2 (acceptable limit 1,000 dpm/100 cm^2). The maximum beta level in the exhaust ducts measured 6,302 dpm/100 cm^2. Additionally, a radiation survey of the outside concrete equipment pads and the gutter leading from Building 4005 to south of G Street were also surveyed and were found to be "free of radioactive material contamination."[580]

- Prior to decontamination and decommissioning activities, Rocketdyne performed surveillance and maintenance activities at Building 4005. In April 1991, during surveillance, it was determined that Building 4005 required a number of repairs to maintain exhaust ducting containment. According to the April 1991 progress report, the doors and other openings into the large and the small filter plenums were sealed with a silicon caulking sealant. Original makeup air penetrations into the deactivated exhaust system were sealed off using sheet metal coverings, and the roof of the large filter plenum was cleaned of accumulated debris. The progress report did not provide any information regarding survey results at Building 4005.[581]

  As documented in an August 1991 project progress report, during routine inspection of the Building 4005 contaminated ventilation system in August 1991, personnel noticed a substance leaking from what appeared to be a "pinhole in a section of ducting." the substance was surveyed and found to be radioactively contaminated. The material was cleaned up, the leak sealed, and an occurrence report was issued.[582] The progress report does not provide any details to indicate the volume of material removed, the activity of the material, or the disposal of the material.

- In 1993, Rocketdyne conducted additional decontamination activities to release the building and surrounding grounds for unrestricted use. This included the removal and disposal of radioactive-contaminated exhaust ducting, radioactive exhaust filter plenums and previously left in place underground radioactive liquid waste drain lines at the northeast corner of the building. Surveys were conducted and documented to ensure "all detectable [radioactive] materials contamination above background levels were removed

[579] Rockwell International, *Decontamination and Decommissioning (D&D) of the Uranium Carbide Fuel Facility – Building T005*, 005-AN-002, September 28, 1993. p. 8
[580] ETEC, *Radiological Survey of Building T005*, GEN-ZR-0003, November 16, 1987.
[581] Gaylord, G., Energy Technology Engineering Center, Project Progress Report, Accounting Period for April 1991, April 1991.
[582] Gaylord, G., Energy Technology Engineering Center, Project Progress Report, Accounting Period for August 1991, August 1991.

from the facility site." The report did not provide the background levels used; however, they were likely the same as those presented in the table below. The radioactive-contaminated waste generated during removal was packaged and disposed of as low level radioactive waste at the Hanford Disposal Site in Hanford, Washington. A summary of the exterior radioactive drain line removal project is provided below: [583]

- According to Report 005-AN-0002, the remaining exterior underground radioactive liquid waste drain lines were located off the northwest corner of Building 4005. Extending approximately 60 feet from various laboratories and work areas within Building 4005 to the two previously removed holding tanks, the drain lines comprised three 2-inch, one 3-inch, and two 4-inch diameter lines. The drain lines were approximately 40 feet in length. As indicated above, two major equipment installations were located above the drain lines. The bag house structure was lifted and relocated and the tank and support structure were left in place.

  Personnel removed the surface concrete and asphalt paving above the drains lines with saws, jack hammers, bob cat ram, and backhoe. Removed concrete, asphalt paving and soil were surveyed for radioactivity and hazardous materials and were found to be free of "hazardous materials." The report does not specify if the removed material was also found to be free of radioactivity. The drain line pipe sections were removed from the excavations and placed in a Radioactive Material Management Area (RMMA) where the pipe joints were separated and the lead seals were removed.[584] Approximately 80 pounds of lead seals were found to be free of radioactivity and were packaged and processed from the RMMA. The drain pipe was reduced in size by an unknown method, surveyed and packaged for disposal as low level radioactive waste. According to the report, "a few sections of drain pipe were embedded in concrete support foundations. In these instances, the drain pipe interiors were surveyed, found to be free of [radioactivity] or hazardous materials contamination and the pipe left embedded in the concrete."

  In addition to the above, soil samples were taken from the bottom areas of the excavations for testing. The area adjacent to the wall of the "underground pit that contained the two holdup tanks previously removed" was also excavated deeper to expose soil near the base of the pit. Samples taken here were analyzed to confirm no contamination resulting from the removal of the tanks. Analysis found no radioactivity or hazardous materials contamination. The excavations were then backfilled and paved with concrete.[585]

- Report 005-ZR-0001 reported the calculated radioactive waste shipped from the building's final D&D procedures to be Th-231 (0.053 mCi), U-235 (0.035 mCi), Th-234 (0.108 mCi), Pa-234m (0.108 mCi), U-234 (0.923 mCi), and U-238 (0.108 mCi). This

[583] Rockwell International, *Decontamination and Decommissioning (D&D) of the Uranium Carbide Fuel Facility – Building T005*, 005-AN-002, September 28, 1993. p. 9
[584] The report did not provide the location of the radioactive material management area used for these removed materials.
[585] Rockwell International, *Decontamination and Decommissioning (D&D) of the Uranium Carbide Fuel Facility – Building T005*, 005-AN-002, September 28, 1993. p. 23-24

waste included interior and exterior radioactive ducting, two radioactive filter plenums, and the remaining exterior radioactive drain lines.[586]

- Rocketdyne performed a final survey in September 1993 to demonstrate regulatory compliance for releasing the Buildings 4005, 4009, and its adjacent yards without radiological restrictions. The survey divided the interior and exterior into eight areas or sample lots. Each sample lot was surveyed for total alpha and beta, removable alpha and beta, and ambient gamma exposure. The survey found that Building 4005 and adjacent yards were acceptably free of contamination in 1993 and recommended that the facility be released for unrestricted use. The following table presents the contamination limit criteria for Building 4005 in 1993.[587,588]

Building 4005 1993 Contamination Limit Criteria

Parameter	Limit			
Allowable Total	**Radionuclides**	**Average**	**Maximum**	**Removable**
Residual Surface Contamination for Alpha and Beta (dpm/100 cm^2)	U, U-235, U-238, and associated decay product, alpha emitters	≤5,000	≤15,000	≤1,000
Surface Contamination for Gamma Exposure Rate	≤5 UR/hr above background at 1 meter interior and exterior			
Soil Contamination Limits for Uranium	U-234 <23.17 pCi/g U-235 <5.54 pCi/g U-238 < 24.55 pCi/g			
Soil Contamination Limits for Thorium	Th-234 <23.17 pCi/g			

Source: Rocketdyne, *Final Radiological Survey of Building 005*, 005-ZR-0001, September 21, 1993.

- ORISE performed a verification survey in 1994. The ORISE survey included document reviews, visual inspection, and independent measurement and sampling of the interior of the building, as well as exterior areas. Surface activity levels in Building 4005 were compared to the residual uranium radioactive material guidelines specified in DOE Order 5400.5 and were found to meet the DOE 1994 requirements for release to unrestricted use.[589] In October 1994, the radioactive material and management area designation was removed by DOE from Building 4005.[590]

- The California Department of Health Services (DHS) Radiologic Health Branch released Building 4005 for unrestricted use on March 22, 1995.[591]

- The 2001 site environmental report indicates five septic tanks and leach fields, located at Buildings 4005, 4011, 4100, 4373, and 4535, were excavated. The report indicates that

[586] Rocketdyne, *Final Radiological Survey of Building 005*, 005-ZR-0001, September 21, 1993. p.16
[587] Rocketdyne, *Final Radiological Survey of Building 005*, 005-ZR-0001, September 21, 1993.
[588] Rocketdyne, *Building 005 Final Survey Procedure*, 005-SP-0001, December 9, 1992.
[589] ORISE, *Verification Survey of Buildings 005, 023, and 064, Santa Susana Field Laboratory, Rockwell International, Ventura County, California*, 94/K-14, October 1994.
[590] Rocketdyne Division, *Annual Site Environmental Report, Santa Susana Field Laboratory and De Soto Sites 1994*, RI/RD95-153, September 1995.
[591] Rocketdyne Division, *Annual Site Environmental Report, Santa Susana Field Laboratory and De Soto Sites 1995*, RI/RD96-140, July 1996. p. 10

soil samples taken at Building 4005 at various stages of the excavation found Eu-152 at maximum concentrations of 2.84 pCi/g; however, it was determined that concentrations were below the site-wide release limit of 4.5 pCi/g for Eu-152.[592]

Radiological Use Authorizations: On April 8, 1976, a Rockwell International internal letter granted approval for the use of radioactive materials under Authorization No. 101 for the use of Mn-54 (with minor associated activation products) in Buildings 4005 and 4006 for the "decontamination of sodium components."[593] On April 8, 1977, Authorization No. 101A renewed Authorization No. 101 until April 8, 1978.[594] The research team did not find any additional information to indicate the authorization was renewed or cancelled after April 8, 1978. The research team has also not located any information regarding the actual use of Mn-54 within Building 4005.

To date, no use authorizations or licenses have been located for the use of U-234, U-235, or U-238 in Building 4005; however, an April 5, 1995, memorandum from the DHS/RHB indicated that Amendment No. 90 to License #0015-70, dated March 22, 1995, specifically released Building 4005.[595] According to 1996 correspondence from Rocketdyne to DOE, the building, while being used to develop fabrication techniques for enriched uranium carbide fuel, was operated by Atomics International as a license-exempt operation under the authority of the AEC Chicago Operations Office.[596]

Former Radiological Burial or Disposal Locations: As indicated above, Building 4005 was connected to two underground radioactive liquid holding tanks by drain lines. The tanks were located approximately 60 feet northeast of the building. The drain lines extended from various laboratories and work areas within Building 4005 and were made of cast iron. The pipe joints and fittings were connected and sealed with oakum and lead. Portions of the exterior drain lines were located under two major equipment installations that included a large tank and support structure and a free-standing bag-house structure.[597,598]

Aerial Photographs: The aerial photographs of the Building 4005 area show the area to be highly industrialized with outside storage and staining visible throughout the building's operation. The March 2010 Environmental Photographic Interpretation Center Draft Report identifies the area, including Building 4005, as solid waste management unit 7.10, the former coal gasification PDU (FCG PDU). The FCG PDU, located on the eastern side of 17th street appears to be a processing area (PA-3) that is active by 1959 and included the addition of buildings by 1965. By 2005, all structures have been removed from this location. The processing area (PA-3) is characterized by the presence of storage tanks, overhead pipelines, a smokestack, open storage areas, stains and ground scars. From 1978 to approximately 1990 a

[592] Boeing, *Site Environmental Report for Calendar Year 2001, DOE Operations at the Boeing Company Rocketdyne Propulsion & Power*, RD02-148, September 2002.
[593] Tuttle, R.J., *Authorization for Use of Radioactive Materials or Radiation Producing Devices, Authorization No. 101*, April 8, 1976.
[594] Tuttle, R.J., *Authorization for Use of Radioactive Materials or Radiation Producing Devices, Authorization No. 101*, April 8, 1976.
[595] Kapel, Ben R., Memorandum regarding Building 4005 and Amendment 90 to License 0015-70, April 5, 1995.
[596] Rutherford, P.D., Exemption from Decommissioning Docket Process, Rocketdyne Building T005, July 24, 1996
[597] Rocketdyne, *Final Radiological Survey of Building 005*, 005-ZR-0001, September 21, 1993.
[598] Rockwell International, *Decontamination and Decommissioning (D&D) of the Uranium Carbide Fuel Facility – Building T005*, 005-AN-002, September 28, 1993. p. 23

probable conveyor connected the processing area to a coal storage area to the south (see Parking Lot 4501). A drainage channel carried runoff from the processing area into impoundment IM-5, located south of the intersection of G and 17th Street in 1965 and 1967.[599]

Radionuclides of Concern: As the Uranium Carbide Fuel facility, Building 4005 was used to react uranium oxide with graphite to convert it to uranium carbide. The uranium carbide was cast into pellets, machined, and assembled into cladding tubes to make fuel assemblies. The facility operated for a period of nine months during 1966 and 1967, using depleted uranium and enriched uranium.[600,601,602] 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).[603,604] 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. All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Surface drainage is to the southwest of the facility. Building 4005 was surrounded by open-grated catch basins that directed drainage from the building south along 17th Street through an open outfall south of G Street and through a field to "R-2A Pond." A sump located within the building emptied into the same subsurface network of open-grated catch basins. During the 1992 Building 4005 D&D Operations Plan, it was discovered that six underground drain lines ran from the Northeast corner of Building 4005 to a below-grade radioactive holdup tank area. The two tanks "had been previously removed and the area was backfilled with soil."[605]

Also a sump is depicted in 1969 facility drawings just east of the southeast corner of the building.[606] The 1993 final radiological survey of Building 4005 identifies this sump as a cooling tower sump.[607] Additional information regarding this sump could not be located.

Radiological Contamination Potential: Class 1 because of prior history as use as uranium carbide fuel facility, known site contamination, reported incidents, and unknown building demolition operations.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.4 provide a convenient reference for the following recommendations.

[599] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[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
[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.
[605] Rocketdyne, *Final Radiological Survey of Building 005*, 005-ZR-0001, September 21, 1993.
[606] Atomics International, Santa Susana Facility Plot Plan, 303-GEN.-C40, May 1969.
[607] Rocketdyne, *Final Radiological Survey of Building 005*, 005-ZR-0001, September 21, 1993. p.14

Extensive soil sampling is recommended in the Building 4005 area. As discussed above, there were several radiological incidents at Building 4005 and documented evidence of radiological releases. Significant information is lacking regarding the excavation activities at Building 4005. In addition, previous characterization studies for the Building 4005 area were focused on delineating the extent of contamination to standards that were applicable at the time. Therefore, additional characterization is recommended for the Building 4005 area. This includes the following Building 4005 areas and appurtenances:

- Former radioactive gas holdup tank locations exterior and northeast of the Building 4005 footprint. The known radioactive waste holdup tank may have left residual contamination above background values in the area. Additionally, drain lines contained in concrete may still be present at site.[608,609]

- 17th Street drainage channel to G Street located west of former Building 4005 location. If radioactive materials were released from Building 4005 and drained into the drainage channel area, residual contamination above background values may exist to the west of the building.

- The storm drain and former location of the 8-inch surface trough surrounding former building location. If radioactive materials were released into the storm drain and surface trough, residual contamination above background values may exist in the materials surrounding the storm drains.

- Sewer lines located northwest and northeast of the Building 4005 footprint. If radioactive materials were released into the sewer system, residual contamination above background values may exist in the materials surrounding the sewer lines.

- Sump located just east of the southeast corner of the building. Identified as a cooling tower sump, historical information could not be located regarding the sump operations. As a result, it is possible residual contamination above background values may exist at the former sump location.

2.4.2 Building 4042 Area

Site Description: Located along B Street, south of 12th Street and west of G Street, the Building 4042 area includes Building 4042, substation Building 4742, and the surrounding area. Constructed in 1963, Building 4042 was a 4,269-square-foot structure with steel sides and a steel roof.[610,611] Building 4042 is located opposite Buildings 4023 and 4032 along 12th Street. Buildings 4023 and 4032 were discussed above. Figures 2.4.2a through 2.4.2c provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

[608] Rocketdyne, *Final Radiological Survey of Building 005*, 005-ZR-0001, September 21, 1993.
[609] Rockwell International, *Decontamination and Decommissioning (D&D) of the Uranium Carbide Fuel Facility – Building T005*, 005-AN-002, September 28, 1993. p. 23
[610] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[611] ETEC, *Site Consolidation Assessment*, April 16, 1987.

Building Features: Limited information regarding the building features of Building 4042 could be located. The building contained 4,117 square feet of laboratory space and had 38-foot ceilings. According to a 1988 plot plan of the building, the building included three trenches. Drainage from these trenches could not be determined.[612] Special features of the 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.[613]

Former Use(s): Constructed in 1963, Building 4042 is identified as a SNAP program thermal and structure test facility. It is identified as a non-nuclear test and 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. The facility was also used for sodium aerosol and related technology tests.[614] After support work for SNAP tests ceased, Building 4042 was used for testing liquid metal systems, also known as LMFBR Development Testing.[615]

On February 14, 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." The permission letter does not provide the amount of UO_2 used; however, the use authorization authorized 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.[616,617] Additional information regarding these operations could not be located.

A 1986 plan of long range D&D of facilities at the SSFL identifies hazardous waste as being present at the site, but no radiological waste.[618] A December 20, 1989 report titled "Nuclear Operations at Rockwell's Santa Susana Field Laboratory–A Factual Perspective" identifies Building 4042 as having contained a radioactive test loop.[619] The 1987 Site Consolidation Assessment indicated the building was used for cleaning of small sodium components in the LMFBR test program. Additionally, equipment from LiH shield test and development was being stored in the building. The possible future uses of the building were identified as the assembly and disassembly and cleaning of sodium components and subscale sodium pump for the DFBR program.[620]

Information from Interviewees: None to date.

[612] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[613] ETEC, *Site Consolidation Assessment*, April 16, 1987.
[614] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[615] 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.
[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.
[618] Tessier, M.J., Letter Re: Long Range D&D Plan for NE Contaminated Facilities, October 24, 1986.
[619] Rockwell International, N001ER000017, *Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective*, December 20, 1989.
[620] ETEC, *Site Consolidation Assessment*, April 16, 1987. p. 13.

Radiological Incident Reports: The research team has not identified any incident reports associated with radiological operations at Building 4042.[621]

Current Use: Building 4042 was demolished between 2002 and 2005.[622] The statement of work indicated that the building structures, including all equipment and fixtures, should be demolished or dismantled and removed from the SSFL. The concrete slab foundations were to be removed, as well as the asphalt aprons surrounding the building. The sewer system for bathrooms was to be removed to "logical points of disconnect."[623] Based on available information, the dimensions of the excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): The following is a summary of the August 1988 radiological survey conducted at Building 4042:

- As part of the DOE SSFL Site Survey, Building 4042 was surveyed to determine if any residual activity was accidentally left behind as a result of operations in support of the SNAP program. Measurements, including exposure rate measurements, were made in Building 4042. The maximum gamma radiation detected was 4.4 μR/hr. (corrected for background and statistically tested against an acceptance limit of 5 μR/hr). The average gamma radiation measured 0.1 μR/hr. Based on the median value of exposure rate measurements in the vicinity of Building 4042, the ambient background value for gamma was determined to be 7.1 μR/hr in 1988.[624]

  The maximum total-average alpha measured 12.6 dpm/100 cm^2 (statistically tested against an acceptance limit of 5,000 dpm/100 cm^2), where the average total-average alpha measured 4.0 dpm/100 cm^2. The maximum removable alpha measured 5.9 dpm/100 cm^2 (statistically tested against an acceptance limit of 1,000 dpm/100 cm^2). The average removable alpha measured 0.5 dpm/100 cm^2. The maximum total-average beta measured 1,200 dpm/100 cm^2 (statistically tested against an acceptance limit of 5,000 dpm/100 cm^2), and the average total-average beta measured 775 dpm/100 cm^2. Based on the results of the survey of Building 4042, the conclusion was made that this area passed the criteria for unrestricted use at that time.[625,626]

Radiological Use Authorizations: Use Authorization 62 was obtained for a period of one year, from February 6, 1973, to February 6, 1974. The authorization was for 15,000 pounds of uranium in the form of UO_2 powder for the Lower Axial Blanket Shielding Experiment.[627,628] It is unclear whether this experiment was ever conducted.

[621] An incident involving mercury occurred at Building 4024 on February 24, 1965, but did not involve any radioactive materials.
[622] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[623] Unknown, Job B (B4039, B4032, and B4042) Statement of Work, March 3, 2003. HDMSP00038237.
[624] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[625] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[626] ETEC DOCUMENT, GEN-ZR-0015, "Executive Summary of the DOE SSFL Site Radiological Survey," October 10, 1988. Pg 19
[627] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[628] Rockwell International Document, Use Authorization 62, February 6, 1973.

Former Radiological Burial or Disposal Locations: None.

Aerial Photographs: The Building 4042 area is vegetated until the 1965 aerial photograph when the building has been constructed and is in use. In 1967, the substation Building 4742 is visible on a concrete pad at the southwest corner of the building. An additional concrete pad is located at the southeast corner of the building. Possible overhead pipes appear to connect Building 4042 to Building 4023 across 12th Street in 1978. In addition, a possible horizontal tank is visible at the southeast corner of the building, and two probable horizontal tanks are located south of Building 4042. A possible liquid collection area is located between the two concrete pads located south of the building. In 1980, the two horizontal tanks are clearly visible and the possible liquid collection area is still present between the two concrete pads. Also, a structure appears to be visible on the concrete pad at the southeast corner of the building; however, the structure is not identifiable. The possible horizontal tank at the southeast corner of the building is not visible in 1980. In 1988, the two horizontal tanks remain present, but the possible liquid collection area is no longer visible; however, in 1995, the aerial photographs show a vegetated depressed area in the location of the former possible liquid collection area. The building is no longer visible in aerial photographs after 2002 and in 2005, a large ground scar remains where Building 4042 was previously located.[629]

Radionuclides of Concern: Possible radionuclides at Building 4042 include U-235 and U-238.[630] All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: According to aerial photographs, a possible liquid collection area was located between two concrete pads located south of Building 4042. In addition, a plot plan of Building 4042 shows the presence of three trenches within the building; however, the purpose or the outfall of these trenches remains unknown. The building was surrounded on the east and west with drain lines and an emergency shower was located east of the building.[631]

Radiological Contamination Potential: 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.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.4 provide a convenient reference for the following recommendations.

Soil sampling is recommended in the Building 4042 area. Information is lacking regarding the excavation activities at Building 4042. In addition, previous characterization studies for the Building 4042 area were focused on delineating the extent of contamination to standards that were applicable at the time. Therefore, additional characterization is recommended for the Building 4042 area. This includes the following Building 4042 areas and appurtenances:

[629] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[630] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[631] Atomics International, Santa Susana Facility Plot Plan, Drawing 303-GEN-C38, Sheet 4 of 14, June 4, 1964.

- The possible liquid collection area located between two concrete pads located south of Building 4042 should be evaluated. In 1978, aerial photographs show the presence of an unknown liquid between the two concrete pads located south of the building. In 1988, the possible liquid collection area is no longer visible; however, in 1995, the aerial photographs show a vegetated depressed area in the location of the former possible liquid collection area. Should radioactive material have flowed to this area, it possible residual contamination above background values may exist in the depressed area south of Building 4042.

- The sanitary sewer lines located west of Building 4042. Three trenches were located within Building 4042. Drainage from the trenches could not be determined; however, it is possible the effluent from the trenches flowed to the sanitary sewer lines. If radioactive materials were released into the sewer system, residual contamination above background values may exist in the materials surrounding the sewer lines.

- The drain lines located west and east of the building, as well as the emergency shower. As with the sanitary sewer lines, if the trenches within Building 4042 flowed to the drains located on the east and west side of the building, it is possible if radioactive materials were released, residual contamination above background values may exist to the east of the building.

2.4.3 Building 4048

Note: To date, the research team has been unable to locate documents relating to the construction and operation of Building 4048.

Site Description: The Building 4048 area includes Building 4048 and the surrounding area. Building 4048 was a small structure located southeast of Building 4005.[632] Figure 2.4.3a provides a current photograph of the former Building 4048 location. Plate 1 presents a summary of all identified features for this site.

Building Features: No information was located.

Former Use(s): Building 4048 appears to have been constructed in approximately 1978 and was constructed as a Government-owned facility. The building is identified in a 1978 industrial planning map as the plant development unit (PDU) instrumentation building.[633] As indicated above, according to a 1992 environmental monitoring program plan, 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 above for Building 4005. Source documents do not provide additional information to identify the operations of Building 4048 in support of the PDU; however, it should be noted that the PDU was a non-radioactive facility that operated from November 1978 to June 1981.[634]

[632] SSFL Area IV, ETEC Industrial Planning Maps, 1962-1992.
[633] SSFL Area IV, ETEC Industrial Planning Maps, 1962-1992.
[634] Rockwell International, *Environmental Monitoring Program Plan, Santa Susana Field Laboratory, Area IV*, ER-AN-0006, September 30, 1992.

Information from Interviewees: None to date.

Radiological Incident Reports: There have been no radiological incident reports located associated with the operations in Building 4048.

Current Use: Building 4048 is no longer depicted in industrial planning maps after the middle 1990s and is no longer visible in aerial photographs in 1995.[635] According to a 1992 environmental monitoring program plan an unidentified commercial demolition company completed disposal of all plant equipment and foundations in 1991 and returned the site to its "original" condition.[636] The program plan does not define "original" condition. Based on available information, the dimensions of the excavation made during building demolition are unknown.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): There have been no radiological surveys conducted at Building 4048, to date; however, the area surrounding adjacent Building 4005 has been assessed. The results of these investigations are summarized above.

Radiological Use Authorizations: None.

Former Radiological Burial or Disposal Locations: None.

Aerial Photographs: Very little detail can be seen in aerial photographs at or near Building 4048. The building is located within an industrial or processing area with numerous open storage areas, overhead pipes, stains, and storage tanks.[637]

Radionuclides of Concern: As indicated above, the PDU was a non-nuclear facility at the SSFl that operated from November 1978 to June 1981.[638] The research team has not identified any radionuclide use at Building 4048.

Drainage Pathways: According to the aerial photograph interpretation, a drainage channel carried runoff from the area into an impoundment located south of the intersection of G and 17th Streets in 1965 and 1967.

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4048 area is Class 1 because of its location within ETEC and proximity to Building 4005.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.4 provide a convenient reference for the following recommendation.

[635] SSFL Area IV, ETEC Industrial Planning Maps, 1962-1992.
[636] Rockwell International, *Environmental Monitoring Program Plan, Santa Susana Field Laboratory, Area IV*, ER-AN-0006, September 30, 1992.
[637] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[638] Rockwell International, *Environmental Monitoring Program Plan, Santa Susana Field Laboratory, Area IV*, ER-AN-0006, September 30, 1992.

It is recommended that Building 4048 be included in the sampling plan for Building 4005. As discussed above, there is limited information available regarding the operations of Building 4048. Given the building's proximity to Building 4005 and the drainage pathways in the area, it is recommended the former Building 4048 footprint be evaluated for contamination.

2.4.4 Building 4049 Area

Site Description: Located south of B Street and northwest of Building 4005, the Building 4049 area includes Building 4049, an adjacent structure, and the surrounding area. Building 4049 was constructed around 1959. Figures 2.4.4a through 2.4.4c provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4049 was an 800-square-foot structure with concrete walls, a concrete slab floor and a concrete foundation. The ceiling height was 10.5 feet with a 2-ton jib crane.[639]

Former Use(s): Building 4049 was constructed in 1959 as a hydraulic test facility control center for an outdoor vertical test stand. 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.[640] An undated table listing buildings that generate waste at the SSFL site indicates that Building 4049 also served as a computer services building.[641] By 1988, according to the August 1988 radiological survey, the building was abandoned. [642]

Information from Interviewees: Interviewee 101 began working at the SSFL in 1986 and provided information on inactive facilities including Building 4049. Of Building 4049, interviewee 101 stated the following:

> There were several inactive buildings on site, some of which were under my management. One involved a lithium hydride shield, developed in building 049 in the 1950s, which was designed to protect people in space from neutrons near a reactor. When the project ended decades earlier, much expensive equipment remained idle in the building. There were many other project specific buildings, government funded, that were very expensive yet were inactive.

Radiological Incident Reports: There have been several incidents associated with Building 4049 that could have resulted in a release to the environment. The following table provides

[639] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[640] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[641] Unknown, Table of SSF Waste Generators, Undated.
[642] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.

information presented in an incidents database provided by Boeing. Summaries of the incident reports are provided following the table, when available.

Building 4049 Incident Report Summary

Incident File Name	Date of Incident	Location of Incident	Isotopes	Description of Incident
A0425	3/31/1960	Support Lab	Activation Corrosion Products*	"Empty" pipe opened in clean lab contaminated employee with H.B.R.
A0479	4/1/1960	Building 4049 HBR	Activation Corrosion Products*	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).[643]

- 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).[644]

- 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 or radiation. The shirt was returned to the employee (A0476).[645]

- On April 27, 1960, an employee opened the high boiler residue line and had high boiler residue spray on the employee's shows, 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).[646]

Current Use: Building 4049 was demolished in 1999.[647] Based on available information, the dimensions of the excavation made during building demolition are unknown.

[643] Warren, J.W., Internal Letter Re: Radiological Safety Incident Report,A0425, April 22, 1960.
[644] Warren, J.W., Internal Letter Re: Radiological Safety Incident Report A0479, May 19, 1960.
[645] Warren, J.W., Internal Letter Re: Radiological Safety Incident Report A0476, May 19. 1960.
[646] Warren, J.W., Internal Letter Re: Radiological Safety Incident Report, Building 049 Pad-SS, April 27, 1960.
[647] 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 referencing Boeing Document, EID-04366, "Removal of DOE Buildings, Demo Pak A," May 18, 1999. p. 5.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): The following is a summary of the August 1988 radiological survey conducted at Building 4049:

- Building 4049 was included as part of the 1988 DOE SSFL Site Survey to determine whether any residual activity remained as a result of operations at Building 4005, which was known to be contaminated in certain locations. Building 4049 was located within the fence-line boundary of Building 4005, which was known to be contaminated in certain locations. The radiological survey of Building 4049 concluded that the inside ambient exposure rate was 9.3 +/- 1.02 μR/hr (gross). This was much less than the average local outside background of 15.3 μR/hr (gross). According to the report, therefore the 1988 acceptable gamma exposure limit of 5 μR/hr (net) was met.

  The maximum total alpha contamination measured 17.5 dpm/100 cm^2 (statistically tested against an acceptance limit of 5,000 dpm/100 cm^2). The maximum total beta contamination measured 1,080 dpm/100 cm^2 (statistically tested against an acceptance limit of 5,000 dpm/100 cm^2). The maximum removable alpha contamination was found to be 1.7 dpm/100 cm^2 (statistically tested against an acceptance limit of 1,000 dpm/100 cm^2), and the maximum removable beta contamination measured 7.1 dpm/100 cm^2 (statistically tested against an acceptance limit of 1,000 dpm/100 cm^2). Based on these results, Building 4049 was judged to be free of contamination and available for unrestricted use.[648]

Radiological Use Authorizations: The research team did not locate any use authorizations for Building 4049.

Former Radiological Burial or Disposal Locations: None found.

Aerial Photographs: Aerial photographs show undeveloped land until the 1959 photograph when Building 4049 and the area surrounding it have been developed. In 1959, a drainage channel is visible leading south-southwest toward 17th Street and then along 17th Street toward a liquid-filled impoundment in Area III. The 1959 aerial photographs also show a possible storage tank, possible overhead pipes, and stains surrounding the buildings. In 1962, overhead pipes and open storage areas have been identified and a possible storage tank remains present.[649]

Radionuclides of Concern: An undated laboratory status report identified burning high boiler residue contamination at Building 4049, including the following radionuclides: C-14, S-35, P-32, Fe-59, and Co-60.[650] Activation corrosion products have also been identified as radionuclides of concern in past incident reports. According to correspondence with Boeing, activation corrosion products at the SSFL include, at a minimum, Co-60, Mn-54, Ni-59, Ni-63, and Fe-55. As a result, these are included in the list of radionuclides of concern associated with Building 4049 operations. All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

[648] ETEC Document, GEN-ZR-0013, "Radiological Survey of Buildings T049, T042, T027, T032, and T025," August 26, 1988.
[649] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[650] Unknown Author, "Laboratory Status Report, Building 049," circa 1959, 1 page.

Drainage Pathways: In 1959, a drainage channel is visible leading south-southwest toward 17th Street and then along 17th Street toward a liquid-filled impoundment in Area III. A Building 4005 surface drainage map shows "inactive DOE PDU gasifier drains" leading from Building 4049 to an open-grated catch basin located adjacent to 17th Street that leads south through a "field" to what is identified as the "R-2A Pond."[651]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4049 area is Class 1 because of previous incident reports, the location of the building within ETEC, and stains and open storage surrounding building in aerial photographs.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.4 provide a convenient reference for the following recommendations.

Soil sampling is recommended in the Building 4049 area. As discussed above, there were several radiological incidents at Building 4049 involving high boiler residue and documented evidence of radiological releases. Significant information is lacking regarding the excavation activities at Building 4049.

In addition, previous characterization studies for the Building 4049 area were focused on delineating the extent of contamination to standards that were applicable at the time. Therefore, additional characterization is recommended for the Building 4049 area. This includes the following Building 4049 areas and appurtenances:

- Areas of staining and open storage surrounding building. The nature of the storage activities surrounding the building is unknown. Additionally, information regarding operations that may have resulted in staining at and around the building during peak operations could not be located. As a result, if radioactive materials were released from this open storage, residual contamination above background values may exist to the south of the building.

- The drainage channel leading south-southwest toward 17th Street should be evaluated, and is included in the HSA-5B technical memorandum. In 1959 aerial photographs the drainage channel is visible. Subsequent photographs do not provide enough detail to determine whether the drainage channel remains throughout building operations. If radioactive materials were released from the open storage at the building, residual contamination above background values may have entered the drainage pathways around the building.

- The "inactive DOE PDU gasifier drains" leading from Building 4049 to an open-grated catch basin. The nature of the use of these drains is unknown. There is also limited information on the operation of the PDU in this area. Given the presence of open storage at the Building 4049, the "inactive DOE, PDU gasifier drains" should be evaluated to determine if residual contamination above background values entered the drains.

[651] Rocketdyne Report, 005-ZR-0001, "Final Radiological Survey of Building 005," September 21, 1993.

2.4.5 Building 4185 (1982-1983) Area

Note: Building 4185 is identified as a building feature on a 1983 Industrial Planning Map south of Building 4005; however, all available information indicates Building 4185 was located in the SRE complex. Aerial photographs from 1983 do not clearly show a building, and the research team could not locate any information about the building depicted in the 1983 Industrial Planning Map. As a result, operational summaries of this building are not available. The May 2005 HSA could not locate information relating to this building either.[652]

Site Description: The Building 4185 area comprises Building 4185, which was depicted on a 1983 Industrial Planning Map. The building, located near the southeast corner of Building 4005, is located within an industrialized area that includes Building 4005, Building 4048, Building 4049, Building 4705, and Building 4793 (1992). Aerial photographs show the area as being very active, and, as a result, structures are difficult to discern within the area. Figure 2.4.5a provides a current site photograph. Plate 1 presents a summary of all identified features for this site.

Building Features: No information was located.

Former Use(s): The operations of Building 4185, located south of Building 4005, have not been identified.

Information from Interviewees: None to date.

Radiological Incident Reports: There have been no incident reports associated with operations in Building 4185 located to date.

Current Use: Aerial photographs do not clearly show a building present in the area depicted in the 1983 Industrial Planning Map.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): There have been no radiological surveys identified in association with this Building 4185. However, numerous radiological investigations have been conducted in relation to the operations at Building 4005. See Section 2.4.1, above, for a description of these investigations.

Radiological Use Authorizations: None.

Former Radiological Burial or Disposal Locations: None.

Aerial Photographs: As indicated above, 1983 aerial photographs do not clearly identify a building present in the area depicted in the 1983 Industrial Planning Map. However, the area is very active in 1983.[653]

Radionuclides of Concern: None.

[652] 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.
[653] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

Drainage Pathways: In 1959, a drainage channel is visible leading south-southwest from Building 4049 toward 17th Street and then along 17th Street toward a liquid-filled impoundment in Area III. This drainage channel would have crossed through the Building 4185 area. A Building 4005 surface drainage map shows drains leading from Building 4049 to an open-grated catch basin located adjacent to 17th Street that leads south through a "field" to what is identified as the "R-2A Pond."[654,655]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4185 area is Class 1 because of the location of the building within ETEC and its proximity to Building 4005, as well as the unknown nature of the building operations.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.4 provide a convenient reference for the following recommendation.

It is recommended that Building 4185 be included in the sampling plan for Building 4005. As discussed above, there is limited information available regarding the operations of Building 4185. Given the building's proximity to Building 4005 and the drainage pathways in the area, it is recommended the former Building 4185 footprint be evaluated for contamination.

2.4.6 Parking Lot 4501 Area

Site Description: The Parking Lot 4501 Area comprises Parking Lot 4501 and time clock Building 4823. This area is located at the corner of G Street and 17th Street. Parking Lot 4501 was constructed between August 1957 and August 1959.[656] Figures 2.4.6a and 2.4.6c provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: There are no building features to report for Parking Lot 4501. Building 4823 was located on the west side of the parking lot and served as a time clock.

Former Use(s): Parking Lot 4501 appears to have been mainly used for its intended purpose; however, a 1987 Industrial Planning Map refers to this area as "Coal Storage" and beginning in May 1978 aerial photographs show dark mounded material that appears to be coal at this location until 1995 when the site has been cleared.[657] The coal storage would have been in support of the Molten Salt Test Bed and the Process Demonstration Unit (PDU).[658] The molten salt test facility, according to a 1992 environmental monitoring program plan, was a general purpose molten salt combustion pilot plant constructed in 1973 in Building 4005 to permit investigation of new processes using engineering scale equipment. The molten salt gasification plant (or 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. The total operating time from November 1978 to

[654] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[655] Rocketdyne Report, 005-ZR-0001, "Final Radiological Survey of Building 005," September 21, 1993.
[656] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[657] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[658] Rockwell International, *Decontamination and Decommissioning of the Uranium Carbide Fuel Facility – Building T005*, 005-AN-002, September 28, 1993.

June 1981 was approximately 1,500 hours at an average coal feed rate of 0.25 tons per hour.[659] As a result, Parking Lot 4501 would have provided adequate coal storage for these operations.

Information from Interviewees: None to date.

Radiological Incident Reports: There have been no incident reports associated with Building 4501 located to date.

Current Use: According to the May 2005 HSA, Parking Lot 4501 is used as a storage yard; however 2005 aerial photographs appear to indicate the area of the paved parking lot is no longer present and appears to be partially re-vegetated.[660]

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): None.

Radiological Use Authorizations: None.

Former Radiological Burial or Disposal Locations: No formal burial or disposal locations have been identified at or around Parking Lot 4501.

Aerial Photographs: Parking Lot 4501 first appears in aerial photographs in August 1959. Drainage channels are visible on the western boundary of the parking lot adjacent to 17th Street. These drainage channels originate from the area surrounding Building 4005, discussed above. Beginning in May 1978, a probable coal storage bin is located at the northeast half of the parking lot, and a probable conveyor connects the parking lot to an industrialized area east of Building 4005 associated with the PDU. Outside storage is visible on the southwest half of the parking lot. In 1980, a coal storage bin is no longer visible and there are three probable coal storage piles. A stain is located in the center of Parking Lot 4501. The conveyor remains present and a probable horizontal tank is located at the former location of the time clock building. Numerous other small structures appear to be present and a possible pipeline is located at the northeast corner of the former parking lot.

By 1983, the area includes areas of dark toned material and possible staining is visible on the northeast half of the site. The conveyor and possible horizontal tank remain. The areas use continues to be for coal storage in 1988. A number of small structures or outside storage are also located at the area and the possible horizontal tank appears to be a vertical tank. The site has been cleared significantly by 1995. There is no longer any dark toned material or coal storage, the conveyor is longer present, and the area is mostly free of any outside storage. The vertical tank is no longer present; however a new vertical tank appears on the southern portion of the parking lot area. A drainage channel and pipeline run northeast-southwest along between the Parking Lot 4501 area and G Street. In 2005, the site is mostly vegetated with an area of ground scarring in the central portion of the former parking lot.[661]

Radionuclides of Concern: None.

[659] Rockwell International, *Environmental Monitoring Program Plan, Santa Susana Field Laboratory, Area IV*, ER-AN-0006, September 30, 1992.
[660] 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.
[661] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

Drainage Pathways: Two drainage channels appear to surround this area. The western boundary of Parking Lot 4501 is bordered by the Building 4005 drainage channel that originates from Building 4005 and runs to Pond 2A. Another drainage channel appears to be present along the southern boundary of Parking Lot 4501 between the parking lot and G Street following the installation of unknown pipelines along G Street.[662]

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Parking Lot 4501 area is Class 2 because of the use of heavy industrial use of the parking lot from 1978 to 1995, and the potential of radioactive material migration via surface water flow or airborne release from Building 4005.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.4 provide a convenient reference for the following recommendations.

Due to the potential of radioactive material migration via surface water flow or airborne release from Building 4005 and the lack of site investigation, additional characterization is recommended for the Parking Lot 4501 area.

- The perimeter of the former Parking Lot 4501. Parking lots are generally constructed to have drainage flow to the perimeter of the structure. As a result, should radioactive materials have drained from facilities to the north to the parking lot, or should any of the industrial activities at the parking lot included radioactive materials, residual contamination above background values may exist along the perimeter of the former Parking Lot 4501.

- The drainage channel and unknown pipelines located along G Street. Should radioactive materials have drained from facilities northeast of the parking lot to the drainage channel along G Street, residual contamination above background values may exist within the drainage channel.

- The Building 4005 drainage channel along 17th Street that is adjacent to the Parking Lot 4501 area. Should radioactive materials have drained from facilities north of the parking lot, namely Building 4005, to the drainage channel along 17th Street, residual contamination above background values may exist within the drainage channel.

2.4.7 Parking Lot 4536 Area

Site Description: The Parking Lot 4536 area includes Parking Lot 4536, time clock Building 4836, and guard shack Building 4636, as well as the surrounding area to the intersection of 12th and G Streets. Parking Lot 4536 was constructed between 1962 and 1965. Figures 2.4.7a and 2.4.7c provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Layout: There are no building features to report for Parking Lot 4536. Buildings 4836 and 4636 were located at the northeast corner of the parking lot and served as a time clock and guard shack, respectively.

[662] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

Former Use(s): Parking Lot 4536 appears to have been mainly used for its intended purpose of serving personnel working in the SNAP facility until approximately 1978. In 1978, the parking lot is also used for outside storage of non-radiological equipment. These storage activities increase until 2005 when the parking lot was removed.[663,664]

Information from Interviewees: None to date.

Radiological Incident Reports: There have been no incident reports associated with operations at Parking Lot 4536 identified to date.

Current Use: June 2005 aerial photographs show the area to have been cleared of all storage materials and the pavement has been removed.

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): Radiological surveys specific to Parking Lot 4536 have not been conducted; however the parking lot was included in the Area IV Radiological Characterization Survey, conducted in 1994 and 1995.

The Area IV Radiological Characterization Survey was designed to locate and characterize any previously unknown areas of elevated radioactivity in Area IV. The study measured background to be 15.6 mR/hr with an acceptable limit less than 5 mR/hr above background. The survey found the area to be below the then-acceptable limits.[665]

Radiological Use Authorizations: None.

Former Radiological Burial or Disposal Locations: None.

Aerial Photographs: As indicated above, Parking Lot 4536 was constructed between 1962 and 1965. Prior to its appearance in 1965, the area is vegetated with no notable features. The parking lot appears to be used for its intended purpose until 1978 when outside storage is visible on the west half of the parking lot. Storage crates appear at the northwest corner of the parking lot in 1980. Outside storage remains visible, and relatively unchanged in 1980, 1983 and 1988. However, in 1988, dark toned material is also visible on the east half of the parking lot. In 1995, the west half of parking lot continues to have some outside storage and possible standing liquid is visible along the western boundary and staining in the southwest corner. Staining and dark-toned mounded material is visible on the east side of the parking lot. The only thing remaining at the site in 2005 is ground scarring, likely a result from demolition activities.[666]

Radionuclides of Concern: None.

[663] 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.
[664] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.
[665] Rocketdyne, Document A4CM-ZR-0011, Rev. A, Area IV Radiological Characterization Survey, August 15, 1996.
[666] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

Drainage Pathways: Aerial photographs from 1983, 1988, and 1995 show a pipeline along the southern boundary of the parking lot. Drainage around the site appears to follow this pipeline from the northeast to the southwest.

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Parking Lot 4536 area is Class 2 because of the presence of storage operations for a number of years in the area.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.4 provide a convenient reference for the following recommendations.

Due to the potential of radioactive material migration via surface water flow or airborne release from buildings northwest of the parking lot, including Building 4023, and the lack of site investigation, additional characterization is recommended for the Parking Lot 4536 area.

- The perimeter of the former Parking Lot 4536. Parking lots are generally constructed to have drainage flow to the perimeter of the structure. As a result, should radioactive materials have drained from facilities to the north to the parking lot, or should any of the industrial activities at the parking lot included radioactive materials, residual contamination above background values may exist along the perimeter of the former Parking Lot 4536.

- The outside storage areas located at Parking Lot 4536. Should radioactive materials have been contained in the storage containers at Parking Lot 4536, residual contamination above background values may exist at the former Parking Lot 4536 area.

2.5 GROUP 5

The Group 5 index map is presented in Figure 2.5. Following Figure 2.5, the site photograph and layout drawings for each building area within HSA-5A Group 5 are presented. HSA-5A Group 5 includes one building area, Building 4029, the radiation measurement facility.

2.5.1 Building 4029 Area

Site Description: The Building 4029 area includes Building 4029 and the surrounding area. Building 4029, the radiation measurement facility, is a single open bay, Butler-type building with a steel frame, corrugated metal siding and roofing. An undated photograph shows the presence of a drum and/or barrel storage area south of Building 4029. Figures 2.5.1a through 2.5.1i provide a current photograph and the best available building-specific drawing(s) that the research team could find. Plate 1 presents a summary of all identified features for this site.

Building Features: Building 4029 measured 20 by 40 feet with a 12-foot eave. The ceilings and walls are insulated with fiberglass mat. The floors were originally tiled with asphalt tiles that were subsequently removed. Following removal of the tiles, the floor remained bare concrete slab. Ventilation is provided by an exhaust blower through two absolute filters. Three below-grade enclosures were constructed to hold radioactive calibration sources: a 10-foot deep, 12-inch diameter concrete well with three separate galvanized pipe casings for source storage, a 10-foot deep concrete and lead well with a 4-foot above-grade section (14 feet total) with

galvanized pipe casing for instrument calibration, and a 3- by 3-foot concrete pit two feet deep for source storage.[667,668]

Building 4029 has also been referred as the old calibration facility, the hazardous waste storage facility, and the hazardous waste management facility.

Former Use(s): Constructed between 1962 and 1965, Building 4029 was originally constructed to store radioactive source materials, including PoBe, PuBe, Co-60, Ra-226, and Cs-137, for instrument calibration.[669] 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
1 – Ra-226*	24.8	1960
2 – Ra-226	132	1960
3 – Ra-226	930	1960
4 – Co-60	Unknown	Not Applicable
5 – PoBe	Unknown	Not Applicable
6 – PuBe	Unknown	Not Applicable
7 – Cs-137	5310	September 1963
8 – Cs-137	5260	September 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 1996 D&D report, the Ra-226 sources were replaced with two Cs-137 sources and were not used in the facility concurrently. The encapsulated Co-60 source was used in the early 1960s and was used on a limited basis. It was removed from the facility in about 1965.[670,671,672]

The PoBe and PuBe neutron sources were fully encapsulated and stored in a small concrete pit in the northeast corner of the building, approximately 3- by 3-foot wide and 2 feet deep. The pit 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 materials were handled and stored in encapsulated form and leak tests were performed every six months. All radioactive source materials were removed

[667] ETEC Document, 029-AR-0001, "Final D&D Report for Building T029," March 28, 1996.
[668] ETEC Document, GEN-ZR-0006, "Radiological Survey of the Old Calibration Facility – Building T029," August 19, 1988.
[669] ETEC Document, 029-AR-0001, "Final D&D Report for Building T029," March 28, 1996.
[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.

by April 29, 1974, and transferred to another facility, and Building 4029 was partially decommissioned.[673,674,675,676]

Beginning in 1974, Building 4029 was later 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. During a June 1989 DHS inspection of the SSFL Site, DHS reported Rockwell and Rocketdyne received a state permit on December 30, 1983, for a sodium waste storage area at Building 4029. According to a 1988 DOE memorandum, ten cold traps containing sodium, a reactive hazardous waste, were being stored in an unpermitted storage area. The memorandum indicated the traps 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 the RCRA storage regulations. As a result, ETEC was in the process of developing sawing techniques to cut the traps so that they could be oxidized at the burn facility.[677,678,679,680]

The 1997 Annual Site Environmental Report indicated the facility received a renewed RCRA Part B permit (CAD0000629972 [3-3-TS-002]) to operate the facility from the California Department of Toxic Substances Control in 1993. In 1997, the facility was reported to be in final closure; however, according to the 1998 Annual Site Environmental Report, the facility entered final closure in 1998 and a closure plan was submitted to DTSC in January 1999.[681,682,683684]

Following an independent verification survey, DOE determined Building 4029 satisfied the requirements for release without radiological restrictions on February 5, 1993.[685] DHS

[673] Rockwell Health and Safety, Letter, "Transfer of Radioactive Sources from T029," from J. D. Moore (Rockwell Health and Safety) to W. F. Heine, May 1, 1974.
[674] ETEC Document, GEN-ZR-0006, "Radiological Survey of the Old Calibration Facility – Building T029," August 19, 1988.
[675] ETEC Document, 029-AR-0001, "Final D&D Report for Building T029," March 28, 1996.
[676] Rockwell International, Document N001DWP000024, "Radiological Decontamination of Building 029," July 31, 1989.
[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.
[681] ETEC Document, GEN-ZR-0006, "Radiological Survey of the Old Calibration Facility – Building T029," August 19, 1988.
[682] The Boeing Company, *Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1997*, A4CM-ZR-0012, November 23, 1998.
[683] The Boeing Company, *Rocketdyne Propulsion and Power DOE Operations Annual Site Environmental Report 1998*, RD99-115, September 22, 1999.
[684] DOE, "Environmental Assessment for Cleanup and Closure of the Energy Technology Engineering Center, Final," March 2003.
[685] ORISE, Letter, "Type A Verification of Building T029, Santa Susana Field Laboratory, Rockwell International, Canoga Park, California," from T. Vitkus (ORISE) to A. Kluk, February 5, 1993.

concurred that Building 4029 met the approved standards for unrestricted release on December 21, 1995.[686] DOE released Building 4029 without radiological restrictions on April 21, 1997.[687]

In 1996, a D&D report documented the work performed to remove residual radioactive contamination from a relatively inaccessible area of Building 4029. All below-grade enclosures were removed and disposed of as low level waste, the exhaust system was removed for reuse, and the excavations were backfilled to allow for continued use of the facility. Details regarding this removal effort are provided below.[688]

Information from Interviewees: None to date.

Radiological Incident Reports: There have been several incidents associated with Building 4029 that could have resulted in a release to the environment. The following table provides information presented in an incidents database provided by Boeing.

Building 4029 Incident Report Summary

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 by-product material.
A0032	3/24/1964	Source well	Ra-226	Leaking calibration source contaminated facility and personnel.
A0367	6/24/1965	Calibration Facility	Ra-226	Alarm failed when source failed to return to safe storage.
A0577	11/20/1970	Calibration Facility	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 listed the following sources as being present in Building 4029: one 5.01 mC Ra-226 source, one 0.177 mC Ra-226 source, two 1.0 mC Co-60 sources, one 0.1 mC Co-60 source, and one Sb-125 source. The inventory, however, was found to be incorrect. All the sources were eventually 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, Headquarters) a year earlier. The incident report does not provide any indication that a release occurred as a result of this incident (A0029).[689]

- 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 24.8 mCi of Ra-226 as a bromide salt. The other sources contain 132 mCi and 930 mCi of Ra-226 in the bromide chemical form as well. All three sources were

[686] Wong, Gerald, DHS Letter regarding release of Building T029, T028, and OCY, January 2, 1996.
[687] Liddle, Roger, DOE, Letter Re: release of Facilities for Unrestricted Non-Radiologic Use," April 21, 1997.
[688] ETEC Document, 029-AR-0001, "Final D&D Report for Building T029," March 28, 1996.
[689] Badger, F.H., Internal Letter Re: Investigation of Reported Missing Radioactive Sources, January 8, 1964.

encapsulated in platinum iridium alloy of 1.0 mm wall thickness, except for the 930 mCi of Ra-226, which has a wall thickness of 1.5 mm of platinum alloy.

On March 24, 1964, a 24.8 mCi Ra-226 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 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 contamination below detectable levels with one exception at the source storage well at the floor level was 6 dpm/100 cm2 alpha.
According to the report, the source was believed to be at the bottom of the storage well as the gamma activity at the top of the North storage well was approximately 1.5 mR/hr. A high volume air sample showed normal background alpha activity of 2.5 x 10-11 uc/cm3.

On March 25, 1964, the source was recovered from the source well and was placed in a lead shipping container to await disposition (A0032).[690]

- 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, five 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 on June 25, 1965, 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).[691]

- 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).[692]

During a June 1989 DHS inspection of the SSFL Site, DHS reported Rockwell and Rocketdyne received a state permit on December 30, 1983 for a sodium waste storage area at Building 4029. The inspection also stated that "[Rockwell and Rocketdyne] 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 posted indicating radioactive contamination.[693] The research team could

[690] Busick, D.D., Internal Letter Re: Report of Radioactive Contamination Incident of the Radiation Measurement Facility – Building 029, April 10, 1964.
[691] Wildanger, A.W., Incident Report Re: Radiation Measurement Facility, A0367, July 9, 1965.
[692] Owen, R.K., Internal Letter Re: Incident Report – Sealed Source Capsule Failure at T029, December 2, 1970.
[693] Motiafard, V., State of California, Department of Heath Services, Addendum Report, Rockwell International Corporation Rocketdyne Division, November 30, 1989.

not locate additional information regarding the contamination referenced by the Industrial Hygienist at Building 4029.

Current Use: The hazardous waste management facility, including Buildings 4133 and 4029 was scheduled to be demolished in 2007. Physical closure activities began on March 26, 2007; however, a stop work order was issued and Building 4029 was placed into "safe shutdown" pending the completion of an environmental impact study.[694,695] The research team assumes the building remains in "safe shutdown."

Previous Radiological Investigation(s) and Decontamination/Cleanup of Release(s): A chronology of radiological investigations at this building is as follows:

- Rocketdyne performed a Radiological Survey in 1988 measuring the gamma exposure rate of the building, surrounding area and entrance road to clarify and identify areas needing further radiological inspection or requiring remedial action. The Ra-226 source wells were surveyed for alpha contamination, and an area south of Building 4029 used for storing barrels in the early 1960s was also surveyed for residual radioactive material.

  The average gamma measurements were 14.4 ± 1.55 μR/hr (–0.84 ± 1.55 μR/hr corrected for background at the time). The measurements were below the 1988 DOE (20 μR/h above background) and NRC (5 μR/hr above background) limits. It was found that source wells were contaminated (2,800 α- dpm/100 cm^2) and it was recommended that they be remediated during the final decommissioning and demolition of the facility. The survey concluded that with the exception of the wells, the facility and surrounding areas, including the drum storage area, are "clean" of any residual radioactive contamination.[696]

- According to a 1989 Rockwell International factual perspective, the contaminated Ra-226 thimble was removed and disposed of in October 1989.[697] The information was referenced from Rocketdyne Report N704SRR990029.

- In 1993, ORISE performed a Type A verification of Building 4029. ORISE reviewed the decontamination and radiological survey report and supporting documentation and performed scans of the floor surfaces contiguous with the source well's former location. According to the report, the surface scans did not identify any locations of elevated direct radiation. ORISE determined the building satisfied the 1993 requirements for release without radiological restrictions.[698]

[694] The Boeing Company, "Site Environment Report for Calendar Year 2007 DOE Operations at The Boeing Company Santa Susana Field Laboratory, Area IV," September 2008.
[695] DOE, Letter, "Response to Letter Dated, may 23, 2007, regarding Closure of Hazardous Waste Management Units in the Radioactive Materials Handling Facility (RMHF), Boeing, Santa Susana Field Laboratory, Simi Valley, California," from T. Johnson (ETEC) to N. Riley (Boeing), June 1, 2007.
[696] ETEC Document, GEN-ZR-0006, "Radiological Survey of the Old Calibration Facility – Building T029," August 19, 1988.
[697] Rockwell International, N001ER000017, "Nuclear Operations at Rockwell's Santa Susana Field Laboratory – A Factual Perspective," December 20, 1989. p. 45.
[698] ORISE, Letter, "Type A Verification of Building T029, Santa Susana Field Laboratory, Rockwell International, Canoga Park, California," from T. Vitkus (ORISE) to A. Kluk, February 5, 1993.

- DHS performed verification sampling in 1995 and found no residual contamination exceeding the limits for unrestricted release in January 1996. According to the survey summary, the survey results were all less than twice the 1995 background levels for the structure and surrounding area.[699][700]

- In 1996, the D&D report documented the work performed in 1989 to remove residual radioactive contamination from a relatively inaccessible area of Building 4029. This work included the excavation of the Ra-226 source storage well and the Ra-226 source holder, which were disposed of as low-level radioactive waste. A rectangular area of the floor surrounding the Ra-226 source storage well was excavated using concrete saws and jack-hammers. A backhoe was used to dredge the soil from the cut-up area. A vacuum cleaner removed the soil in the immediate vicinity of the 12-inch diameter casing. Once the casing was loosened from the soil ("with the inner contents of contaminated source thimble tubes still intact"), a sling was attached to the casing and a forklift moved the casing to the floor. The casing was covered with plastic bags, tagged as radioactive material and transported to the RMHF.

  At the RMHF, routine smear surveys on the surfaces of the thimbles showed "normal" background activity. Swabs from the interiors of the thimble tubes after the casing was excavated shows alpha-contaminated interiors, requiring the disposal of the casing as low-level radioactive waste. The casing was cut into two pieces and the concrete embedment was separated from the casing's three inner tubes. All components were packaged for disposal as low-level radioactive waste at an authorized site.

  Additionally, the work included the demolition of the housing used for the Co-60 source and disposal of the uncontaminated debris as nonradioactive waste. The storage well of the Co-60 source cell was partially excavated to a depth of approximately 2 feet below grade. The Co-60 structure was "eliminated to an extent that provides an obstruction-free floor-space for future storage of nonradioactive materials." The exhaust system outside the building was also removed, surveyed and determined to be "clean" for reuse. Smear surveys on the Co-60 source and exhaust system showed no activity above 1996 background levels.

  All excavated areas were refilled and resurfaced, although the D&D report does not provide information regarding the type of fill used or its origin. The volume of contaminated waste from the three source storage locations was approximately 40 cubic feet. An additional 60 cubic feet of contaminated waste was generated from areas adjacent to the storage locations and soil and asphalt.

  Rocketdyne took soil samples as part of the D&D effort. The survey found all radiation to be in "acceptable ranges" around 1996 background levels. Excavation sampling results for Pb-214 were 0.28 and 0.27 pCi/g compared to a background measurement of 0.84 pCi/g. Excavation sampling results for K-40 were 23.1 and 23.6 pCi/g compared to a background measurement of 22.2 pCi/g. Based on these measurements and the 1988

[699] Lupo, Roger, DHS, "Verification Survey of Building T029," September 14, 1995.
[700] Wong, Gerald, DHS Letter regarding release of Building T029, T028, and OCY, January 2, 1996.

radiological survey, the facility was released for unrestricted use and the excavated area was refilled.[701][702]

- EPA conducted an oversight verification survey in 2001 for alpha and beta contamination. The survey included scans for alpha and beta and fixed point measurements for alpha and beta. Six swipe samples were collected and dust samples were collected from two ventilation ducts. Swipe samples were analyzed for removable contamination and dust samples were analyzed for the presence of radium daughter products. The contaminant of concern for Building 4029 was Ra-226 on the floors and walls. Acceptable limits for the survey were consistent with NRC Regulatory Guide 1.86 (Ra-226 levels of 100 dpm/100 cm^2 average, 300 dpm/100 cm^2 maximum, and 20 dpm/100 cm^2 removable) and the proposed site wide release criteria in accordance with Area IV survey.[703] None of the field measurements indicated the presence of radionuclides above the 2001 acceptable limits. The EPA field measurements confirmed the conclusions reached by both Rocketdyne and ORISE.[704]

Radiological Use Authorizations: None found.

Former Radiological Burial or Disposal Locations: No known disposal or burial locations have been identified at or near Building 4029. It is important to note, however, that barrels and drums were stored outside the building for a short period of time in the early 1960s. Surveys of the storage area found no detectable activity.[705] 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 (illegible). There were also apparently 20 'cold traps' containing reactive sodium metal stored outside Building 029." The area where the traps were stored was not within the permitted hazardous waste storage area.[706]

Aerial Photographs: Based on aerial photographs, Building 4029 was constructed between 1962 and 1965, which is inconsistent with information presented in the 2005 HSA. The 1962 aerial photographs do not show any construction activities in the vicinity of Building 4029; however, by 1965, the building is present. In 1980, four small containers are visible directly west of the building. They do not appear in subsequent photographs. Significant ground scarring that is located south-southwest of the building is visible in 1995 aerial photographs. The ground scar is no longer present in 2005.[707]

Radionuclides of Concern: Constructed in 1959, Building 4029 was originally constructed to store radioactive source materials, including Co-60, Ra-226, and Cs-137, for instrument

[701] Rockwell International, N704SRR990029, "Final Decontamination and Radiological Survey of Building T029," June 28, 1990.
[702] ETEC Document, 029-AR-0001, "Final D&D Report for Building T029," March 28, 1996.
[703] Rocketdyne Document, A4CM-ZR-0011, Rev. A, "Area IV Radiological Characterization Survey," August 15, 1996.
[704] Tetra Tech EM Inc., "Final Oversight Verification and Confirmation Radiological Survey Report for Buildings T-012, T-029, and T-363," December 20, 2002.
[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.
[707] U.S. EPA, Environmental Photographic Interpretation Center Draft Report, March 2010.

calibration.[708][709] All radionuclides of concern listed are included in the August 2009 Final Field Sampling Plan for the Santa Susana Field Laboratory radiological background study. Table 3.3 presents a summary of contaminants of concern.

Drainage Pathways: Based on aerial photographs, drainage at and around Building 4029 is to the south. There do not appear to have been any floor drains at Building 4029.

Radiological Contamination Potential: The preliminary MARSSIM Classification for the Building 4029 area is Class 1 based on its previous use and the unknown source of the fill material used to backfill excavations during D&D activities.

Recommended Locations for Soil/Sediment Sampling: Plate 1 and Figure 2.5 provide a convenient reference for the following recommendations.

Soil sampling is recommended in the Building 4029 area. As discussed above, there were several radiological incidents at Building 4029 involving calibration sources and documented evidence of radiological releases. Information is lacking regarding the excavation activities at Building 4029.

In addition, previous characterization studies for the Building 4029 area were focused on delineating the extent of contamination to standards that were applicable at the time. Therefore, additional characterization is recommended for the Building 4029 area. This includes the following Building 4029 areas and appurtenances:

- In 1980, four small containers are visible directly west of the building. Given the building's use as a storage area of radioactive source materials, calibration facility, and hazardous waste management facility, and because the contents of these containers are unknown, it is possible the containers west of the building may have contained radioactive materials. Any leaks from these containers may have left residual contamination above background values in the area.

- Ground scarring located south-southwest of the building in the vicinity of a former storage area in 1995 aerial photography is recommended for sampling.

- Sampling within Building 4029 should be localized at the former location of the source wells, which were excavated and backfilled with fill from an unknown source and to confirm all residual contamination was removed during D&D operations.

[708] ETEC Document, 029-AR-0001, "Final D&D Report for Building T029," March 28, 1996.
[709] PoBe and PuBe were also sealed radioactive sources at Building 4029; however polonium-210 has a half life of 210 days and, therefore has been omitted from the list of radionuclides of concern.

3.0 RADIONUCLIDE LIST

3.1 U.S. ATOMIC ENERGY COMMISSION SPECIAL NUCLEAR MATERIAL LICENSE

The first license issued by the U.S. Atomic Energy Commission (AEC) for the SSFL site was Special Nuclear Material License No. SNM-21. It was initially issued on April 6, 1956 for use at the Canoga Park site. License No. SNM-21 authorized Atomics International Division of North American Aviation, Inc. (Atomics International) to receive and possess 50 grams of uranium enriched in uranium-235 (U-235) for use in fission counter tubes. License No. SNM-21 was amended eight times to increase the number and type of nuclear materials that could be handled at the Canoga Park and SSFL sites. This license was terminated on September 27, 1996. In February 1975, the AEC became known as the Nuclear Regulatory Commission (NRC) and License No. SNM-21 became an NRC license.

3.2 U.S. ATOMIC ENERGY COMMISSION CRITICAL EXPERIMENTS FACILITY LICENSE

On October 3, 1960, the AEC authorized Atomics International, under License No. CX-17, to possess and operate a separable-half type critical experiments facility at power levels not exceeding 200 watts (thermal) in Building 100 (now known as Building 4100). Atomics International conducted this research under contract to the Southwest Atomic Energy Associates of Shreveport, Louisiana. The license permitted the possession "and use of special nuclear materials as follows:

- 25 kilograms of U-233 and 110 kilograms of U-235 as fuel for the reactor;
- 135 grams of U-233, 1,135 grams of U-235, and 135 grams of Pu-239 in foils and capsules for use in connection with operation of the reactor;
- 0.5 gram each of U-233, U-235, and Pu-239 in fission counters for use in connection with operation of the reactor; and
- 32 grams of Pu in encapsulated neutron sources for use in connection with operation of the reactor."

License No. CX-17 also permitted the possession "and use of source materials as follows:

- 656 kilograms of Th-232 for use in the core and buffer regions of the reactor;
- 700 grams of natural uranium in foils and capsules for use in connection with operation of the reactor; and
- 0.5 gram each of U-234, U-236, and U-238 in fission counters for use in connection with operation of the reactor."

License No. CX-17 also permitted the possession "and use of 0.5 gram of Np-237 in fission counters for use in connection with operation of the reactor and to possess, but not to separate such byproduct materials as may be produced by operation of the reactor."

License No. CX-17 was amended ten times before it was terminated on October 6, 1980.

3.3 CALIFORNIA DEPARTMENT OF PUBLIC HEALTH RADIOACTIVE MATERIAL LICENSE

On September 11, 1963, the State of California, Department of Public Health issued Radioactive Material License No. 0015-59 to Atomics International. This license authorized the possession and use of a wide range of radioactive materials at the De Soto Avenue, Canoga Park, and SSFL sites as listed in Table 3.1, below.

Table 3.1
Radioactive Materials Covered by License No. 0015-59

Radioactive Material (element and mass number)	Chemical and/or Physical Form	Maximum Quantity that Licensee may Possess
Any byproduct material between atomic number 3 and 83	Any	7 curies of each byproduct material between atomic number 3 and 83
Antimony-124	Any	50 curies
Iridium-192	Any	70 curies
Cobalt-60	Sealed sources	10 sources not to exceed 400 curies each
Hydrogen-3	Any	550 curies
Polonium-210	Any	150 curies
Any byproduct material	Separated from irradiated thorium and uranium samples	250 microcuries total
Hydrogen-3	Titanium tritide foil (U.S. Nuclear Corporation)	500 millicuries
Hydrogen-3	Titanium tritide foil (U.S. Radium Corporation)	1 curie
Strontium-90	Sealed source (U.S. Nuclear Corporation Model 312)	5 microcuries
Radium-226	Any	2,000 milligrams
Radium-226	Sealed neutron sources	500 milligrams
Cobalt-60	Sealed source (U.S. Nuclear Corporation Model 338)	1 source not to exceed 5 curies
Cobalt-60	Sealed source (Isotopes Specialties Company Model 338)	1 source not to exceed 5 curies
Cerium-144	Sealed source (Isotopes Specialties Company Model 160)	50 microcuries
Iridium-192	Sealed source (Technical Operations Model A424-1)	1 source not to exceed 20 curies
Radium-226	Sealed sources (NRC Equipment Corporation)	Seven sources not to exceed 0.4 milligram each
Strontium-90	Sealed sources	Two sources of 3 millicuries each
Americium-241	Any	2 millicuries
Natural or depleted uranium	Any	20,000 pounds
Natural thorium	Any	700 pounds

This license is assumed to have covered the use and possession of radioactive materials in SNAP Reactor Building 4059. Up until December 1969, when reactor operations ceased in Building

4059, there had been 39 amendments to this license. The radioactive materials covered in the 39th amendment are listed in Table 3.2, below.

Table 3.2
Radioactive Materials Covered by License No. 0015-59, Amendment No. 39

Radioactive Material (element and mass number)	Chemical and/or Physical Form	Maximum Quantity that Licensee may Possess
Any radionuclide with atomic number 3 through 83	Any	25 curies for any one radionuclide
Antimony-124	Any	100 curies
Iridium-192	Any	100 curies
Cobalt-60	Sealed sources	10 sources not to exceed 400 curies each
Hydrogen-3	Any	10,000 curies
Polonium-210	Any	150 curies
Krypton-85	Any	100 curies
Neptunium-237	Any	100 microcuries
Radium-226	Any except as neutron sources	5 grams
Radium-226	Sealed neutron sources	500 milligrams
Cobalt-60	Sealed source (U.S. Nuclear Corporation Model 338)	1 source not to exceed 5 curies
Cobalt-60	Sealed source (Isotopes Specialties Company Model 338)	1 source not to exceed 5 curies
Cobalt-60	Sealed source (Lockheed Nuclear Products Dwg 442-1001)	25,000 +/- 2,500 curies in 12 sources
Iridium-192	Sealed source (Technical Operations Model A424-1)	4 sources not to exceed 100 curies each
Radium-226	Sealed sources (NRC Equipment Corporation)	Seven sources not to exceed 0.4 milligram each
Califonium-252	Sealed source (Oak Ridge)	2 sources not to exceed 550 microcuries each
Any radionuclide with atomic number 3 through 83	Any	Not to exceed 100 curies for any one radionuclide
Promethium-147	Promethium oxide	150,000 curies
Americium-241	Any	10 curies
Natural or depleted uranium	Any	20,000 pounds
Natural thorium	Any	1,000 pounds
Tantalum-182	Metal	500 curies
Natural or depleted uranium	Any	50,000 pounds
Mixed fission products (Hot Lab)	Any	10,000,000 curies
Any radionuclide with atomic number 3 through 83 (Hot Lab)	Any	100,000 curies for any one radionuclide

This license was amended 64 times up until August 2, 1979 when the license number was changed to No. 0015-70. Up until October 21, 1996, there had been 94 amendments.

3.4 RADIONUCLIDE LIST TO BE USED IN SOIL AND GROUNDWATER SAMPLING

From a review of historical documents and radioactive material licenses issued for the SSFL, all of the radionuclides selected for radiochemical analysis of soil and groundwater samples are likely to have been used or generated on the SSFL. Promethium-147 is yet to be placed on the list, but its short half-life of 2.62 years should not make it a radionuclide of concern.

A historical review of operations in Buildings 4009 and 4020 has not yet been conducted. Additional radionuclides may be identified after these buildings have been investigated.

Table 3.3
Summary of Subarea HSA-5A Sites
Potential Contaminants of Concern

Site No.	Use(s)	Current Status	Potential Radiological Contaminants of Concern	MARSSIM Class
4005	Uranium Carbide Fuel Pilot Plant	Demolished	Potential radioactive contaminants include natural and enriched uranium (U-238, U-234, U-235), activation products (iron-59 (Fe-59), cobalt-60 (Co-60)), isotopes of thorium (Th-231, Th-234), carbon-14 (C-14), manganese-54 (Mn-54), sulfur-35 (S-35), phosphorous-32 (P-32).	1
4023	Liquid Metals Component Test Building	Demolished	Potential radioactive contaminants include natural and enriched uranium (U-234, U-238 and U-235), isotopes of thorium (Th-228, TH-232), isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242), Ne-237, Am-241, fission products (Cs-134, Cs-137, Sr-90), and activation products (Co-60, Fe-55, Eu-152, Eu-154, Ni-59, Ni-63, Ta-182, Mn-54).	1
4024	SNAP Environmental Test Facility	Partially Standing	Potential radioactive contaminants include natural and enriched uranium (U-238 and U-235), isotopes of thorium (Th-232), isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241, Pu-242), Am-241, fission products (Cs-137, Sr-90), and activation products (Co-60, H-3, Fe-55, Eu-152, Eu-154, Ni-59, Ni-63, Mn-54), K-40, Na-22.	1
4027	SNAP Engineering Development Laboratory	Demolished	Radionuclides of concern at the RMHF include all radionuclides that are included in the background study plus any additional radionuclides identified during the HSA.	2
4029	Radiation Measurement Facility	Standing	Potential radioactive contaminants include fission products (Cs-137) and activation products (Co-60), Ra-226	1
4030/ 4035	AE-6 Counting Room and Workshop	Demolished	Potential radioactive contaminants include H-3.	1
4032	Space Environmental Test Facility	Demolished	Potential radioactive contaminants include activation product Co-60.	2

Table 3.3 (continued)
Summary of Subarea HSA-5A Sites
Potential Contaminants of Concern

Site No.	Use(s)	Current Status	Potential Radiological Contaminants of Concern	MARSSIM Class
4036	Non-Nuclear Office Building	Demolished	None specifically identified; however, direct radiation and skyshine from RMHF may affect ambient radiation conditions in the area.	1
4042	SNAP Shield Casting Facility	Demolished	Potential radioactive contaminants include natural and enriched uranium (U-238 and U-235).	1
4046	Material Office Annex	Demolished	None specifically identified.	2
4048	Plant Development Unit Instrumentation Building	Demolished	None specifically identified.	1
4049	Hydraulic Test Control Center	Demolished	Potential radioactive contaminants include activation products (Co-60, Mn-54, Ni-59, Ni-63, Fe-55, Fe-59), C-14, S-35, P-32.	1
4073	Kinetic Experiment Water Boiler Reactor	Demolished	Potential radioactive contaminants include natural and enriched uranium (U-238 and U-235), fission products (Cs-137, Sr-90), and activation products (Co-60, Eu-152, Eu-154).	1
4074	Storage and Film Processing Building	Demolished	Potential radioactive contaminants include natural and enriched uranium (U-238 and U-235), fission products (Cs-137, Sr-90), and activation products (Co-60, Eu-152, Eu-154).	1
4083/ 4103	Control Building	Demolished	None specifically identified.	1
4093	AE-6 Reactor Building	Demolished	Potential radioactive contaminants include natural and enriched uranium (U-238 and U-235), fission products (Cs-137, Sr-90), and activation products (Co-60, Eu-152, Eu-154).	1
4123	KEWB Waste Storage Building	Demolished	Potential radioactive contaminants include natural and enriched uranium (U-238 and U-235), fission products (Cs-137, Sr-90), and activation products (Co-60, Eu-152, Eu-154).	1
4185	Unknown	Demolished	None specifically identified.	1
4453	Fuel Handling Building	Demolished	Potential radioactive contaminants include natural and enriched uranium (U-238 and U-235), fission products (Cs-137, Sr-90), and activation products (Co-60, Eu-152, Eu-154).	1
4501	Parking Lot	Vegetated	None specifically identified.	2
4536	Parking Lot	Evidence remains	None specifically identified.	2
4633	Reactor Cooling Water Pad	Demolished	None specifically identified.	1

Table 3.3 (continued)
Summary of Subarea HSA-5A Sites
Potential Contaminants of Concern

Site No.	Use(s)	Current Status	Potential Radiological Contaminants of Concern	MARSSIM Class
4641	Shipping and Receiving	Demolished	Regulated radioactive material handled in the building; however, a complete list of materials handled in Building 4641 could not be located. As a result, the potential radioactive contaminants include natural and enriched uranium (U-238, U-234, U-235), isotopes of plutonium (Pu-238, Pu-239, Pu-240, Pu-241), Am-241, fission products (primarily Cs-137, Sr-90), and activation products (H-3, Fe-55, Co-58, Co-60, Ni-63, Ba-133, Eu-152, Eu-154, Eu-155, Pm-147, Ta-182).	2
4643	KEWB Exhaust Building	Demolished	Potential radioactive contaminants include natural and enriched uranium (U-238 and U-235), fission products (Cs-137, Sr-90), and activation products (Co-60, Eu-152, Eu-154).	1
4793	KEWB Heating and Air Conditioning	Demolished	Potential radioactive contaminants include natural and enriched uranium (U-238 and U-235), fission products (Cs-137, Sr-90), and activation products (Co-60, Eu-152, Eu-154).	1
4927	Nitrogen Storage Tank	Demolished	None specifically identified.	1

4.0 REACTOR/CRITICALITY FACILITIES WORKS CITED

4.1 BUILDING 4024

Reactor Acronym	Building No.	Facility Name	Power Level (kW)	Period of Operation	Power Generated (MWd)	Radioactivity at End of Operation (10^3 Ci)
S2DR	4024	SNAP Environmental Test Facility	65	4/1961 to 12/1962	13	390
S10FS3	4024	SNAP Environmental Test Facility	37	1/1965 to 3/1966	16	6000

Facility Name	Building No.	Period of Operation	Notes
SNAP Transient Test	4024	1967 to 1969	SNAP transient response tests

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4.2 BUILDING 4073

Reactor Acronym	Building No.	Facility Name	Power Level (kW)	Period of Operation	Power Generated (MWd)	Radioactivity at End of Operation (10^3 Ci)
KEWB	4073	Kinetics Experiment Water Boiler	1	7/1956 to 11/1966	1	6

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4.3 BUILDING 4093

Reactor Acronym	Building No.	Facility Name	Power Level (kW)	Period of Operation	Power Generated (MWd)	Radioactivity at End of Operation (10^3 Ci)
L-85/AE-6	4093	L-85 Nuclear Experimentation Reactor	3	11/1956 to 2/1980	2	18

Building 4093 Cited Documents

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Legend

Subarea 5A Groups

Centerline Roads
- Primary Roads
- Secondary Roads
- Tertiary Roads

Buildings
- Demolished
- Existing
- Parking Lots

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel

Tanks
- Above ground Storage Tank
- Underground Storage Tank
- Unknown Tank Type
- French Drain Holding Tank
- Sump
- Dry Well
- Tank Footprint
- Drain
- Well
- French Drain
- Drainage
- Leach Field
- Septic System

Aerial Photography Data
- Aerial Photography Features
- Septic Tank
- Leach Field
- Other

Utilities
- Gas
- Storm Drain
- Sanitary Sewer
- Sanitary Waste
- Water
- Water (Removed)

Surface Features
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well

Aerial Photography Descriptors

Type	Description
B	Building
CONT	Container
DG	Disturbed Ground
DTM	Dark Tone Material
EX	Excavation
GS	Ground Scar
HT	Horizontal Tank
LTM	Light Toned Material
LTMM	Light Toned Mounded Material
MTMM	Medium Toned Mounded Material
OS	Open Storage
PL	Pipeline
POSS	Possible
PROB	Probable
SS	Smoke Stack
ST	Stain
UO	Unidentified Object
VT	Vertical Tank
WDA	Waste Disposal Area

N

0 50 100 200
Scale In Feet

Historical Site Assessment
Final Technical Memorandum - HSA-5A

Plate 1
Subarea HSA-5A
Santa Susana Field Laboratory

U.S. EPA Region 9

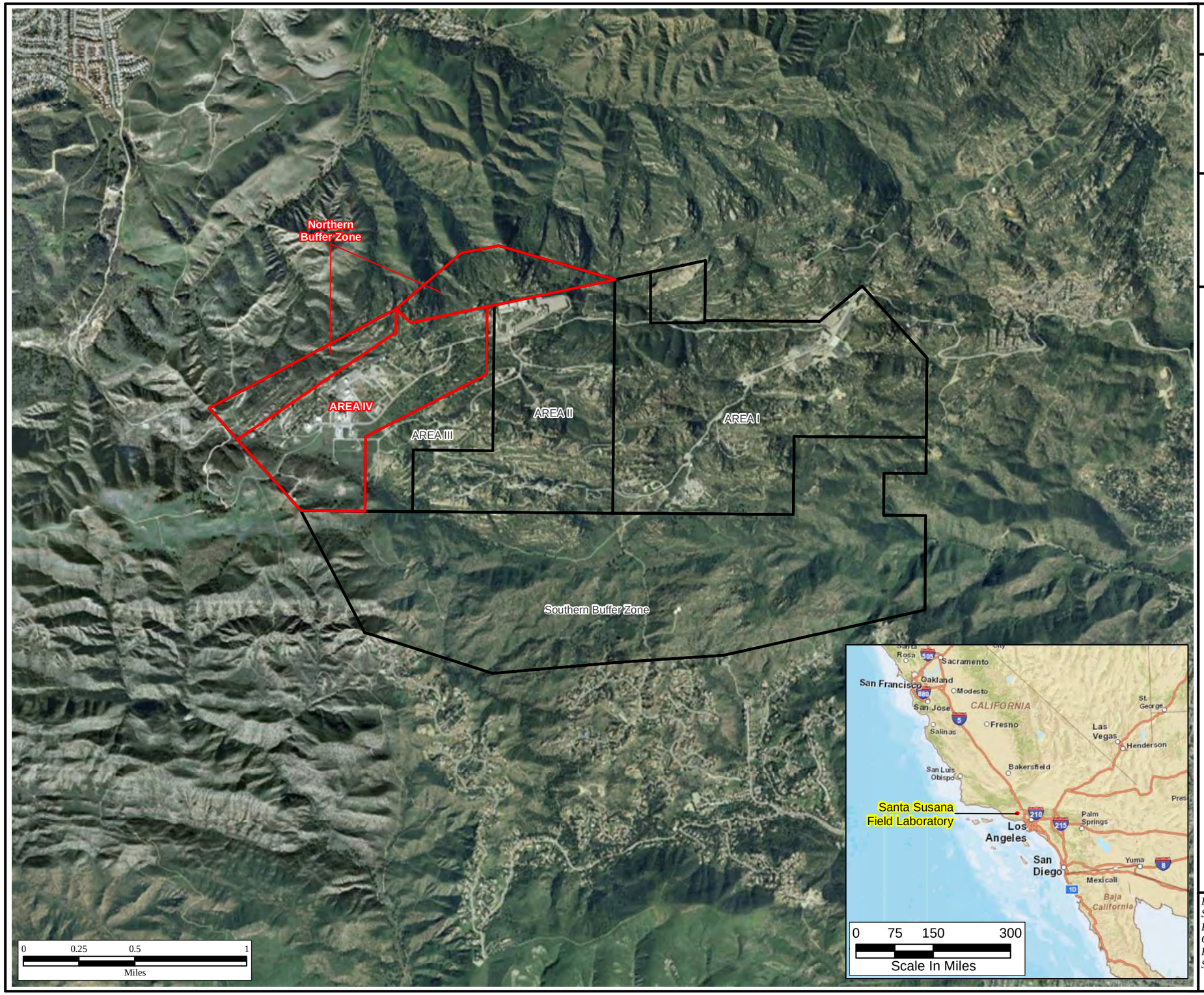
Map Source: HGL
Y:\Santa_Susana\EP9038\TM\HSA_5A\HSA-5A_Plate1.mxd
Updated: 10/19/2010 2:26:01 PM TJ
Source:Boeing Company, 2008
CIRGIS, 2007

HGL HydroGeoLogic, Inc.

Redacted

Figure 1.1
Site Location
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

EPA Study Area Boundary;
Area IV and Northern Buffer Zone

Santa Susana Field Laboratory
Property Boundary

N

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Project: EP9038
Created: CLimoges
Revised: 10/15/2010 TJ
Sorce: CaSil, NAIP 2009; Boeing 2008

HGL HydroGeoLogic, Inc

Figure 1.2
General Site Layout for Area IV/HSA Subareas Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

HSA Subarea

Buildings

Existing

Removed

N

0 250 500 1000

Scale In Feet

Filepath: Y:\Santa_Susana\EP9038\TM\HSA_5A\(1-02)site_layout.mxd
Project: EP9038
Created: CLimoges
Revised: 10/15/2010 TJ
Sorce: Boeing Company, 2008
CIRGIS, 2007

HydroGeoLogic, Inc

Redacted

Figure 1.3
Subarea HSA-5A
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

Buildings

- Existing
- Removed
- Lined Channel
- Intermittent Stream*
- Pipe (Unknown Type)

*Intermittent streams also represent unlined channels.

N

0 50 100 200

Scale In Feet

Filepath:Y:/Santa_Susana/EP9038/TM/HSA_5A/subarea_HSA_5A.mxd
Project: EP9038
Edited: 10/15/2010 TJ
Source:Boeing Company, 2008
CIRGIS, 2007

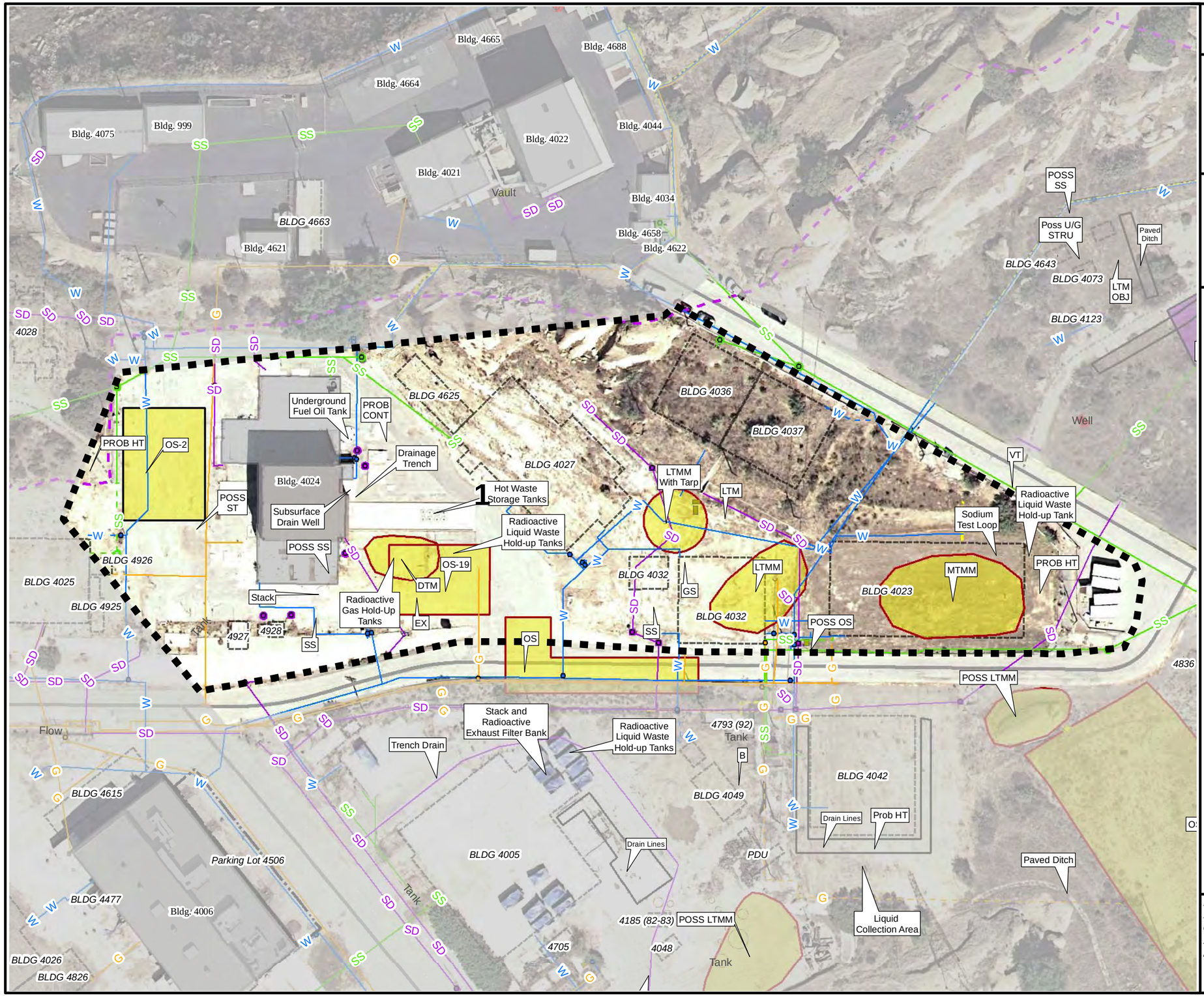
HGL HydroGeoLogic, Inc.

Redacted

Historical Site Assessment
Final Technical Memorandum - HSA-5A

Figure 2.1
Area IV Subarea 5A-1
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

- Subarea 5A-1 Boundary
- Primary Roads
- Secondary Roads
- Underground Storage Tank
- Unknown Tank Type
- Sump
- Dry Well
- Tank Footprint
- Above ground Storage Tank
- Demolished Bldg.
- Existing Bldg.
- Parking Lots
- Drainage
- Drain
- Well

Aerial Photo Features

- Aerial Photography Features
- Leach Field
- Other

Surface Water

- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel
- French Drain
- Drainage
- Leach Field
- Septic System

Utilities

- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well
- Gas
- Storm Drain
- Sanitary Sewer
- Water

B	Building
CONT	Container
CR	Crates
DB	Debris
DG	Disturbed Ground
DTM	Dark Tone Material
EX	Excavation
FA	Fill Area
GS	Ground Scar
HT	Horizontal Tank
IM	Impoundment
MTMM	Medium Toned Mounded Material
OS	Open Storage
PA	Processing Area
PL	Parking Lot
POSS	Possible
PROB	Probable
S-T	Storage Tank
SS	Smoke Stack
ST	Storage
UO	Unidentified Object
VT	Vertical Tank
WDA	Waste Disposal Area

N

0 25 50 100
Scale In Feet

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Revised: 10/19/2010 TJ
Sorce: Boeing Company, 2008
CIRGIS, 2007

HGL HydroGeoLogic, Inc

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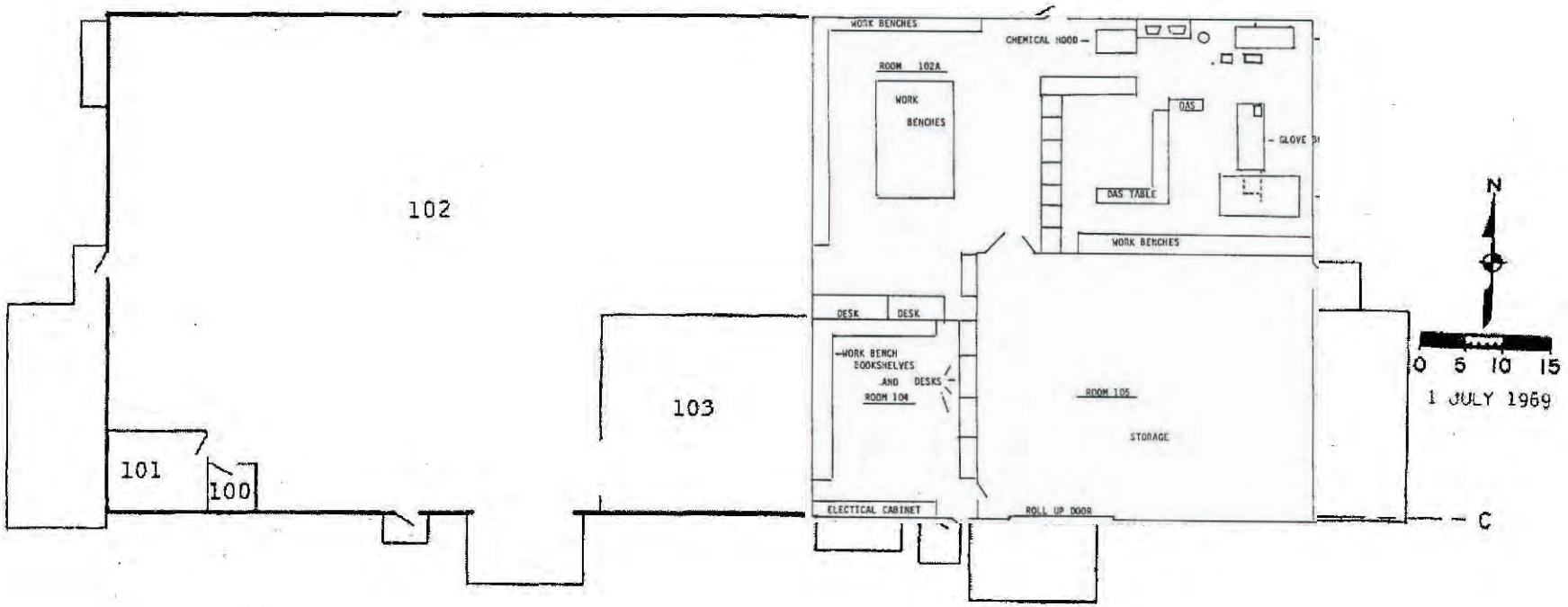
Revised: 10/05/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.1a
Building 4023
Site Photograph



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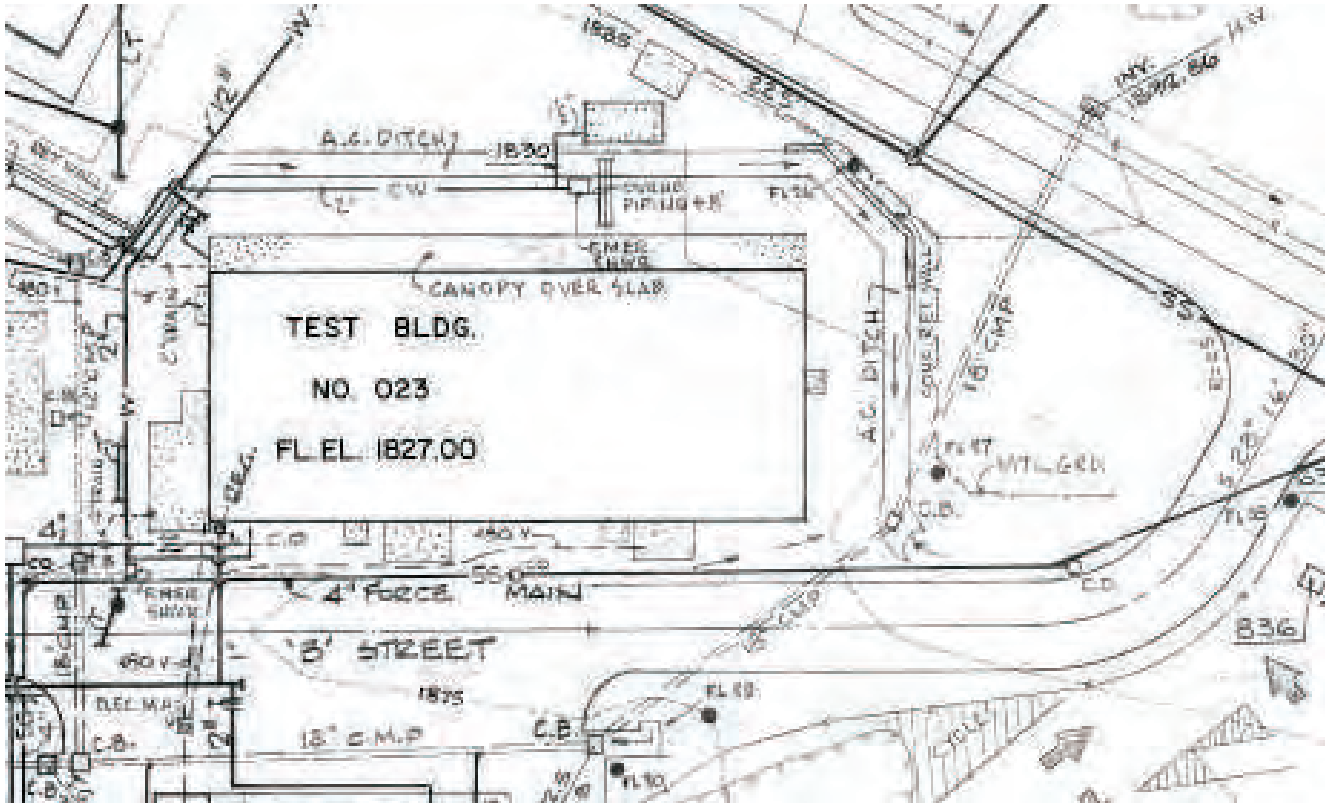
Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.1b
Building 4023
Floor Plan



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SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN		DWG. SIZE E	303 - GEN. - C 38
CHECKED				
ENGINEER	R.P. HAMMAN		SCALE 1"= 40'	
APPROVED				SHEET NO. 4 OF 14

FORM NAA-R-3 REV. (2-61)

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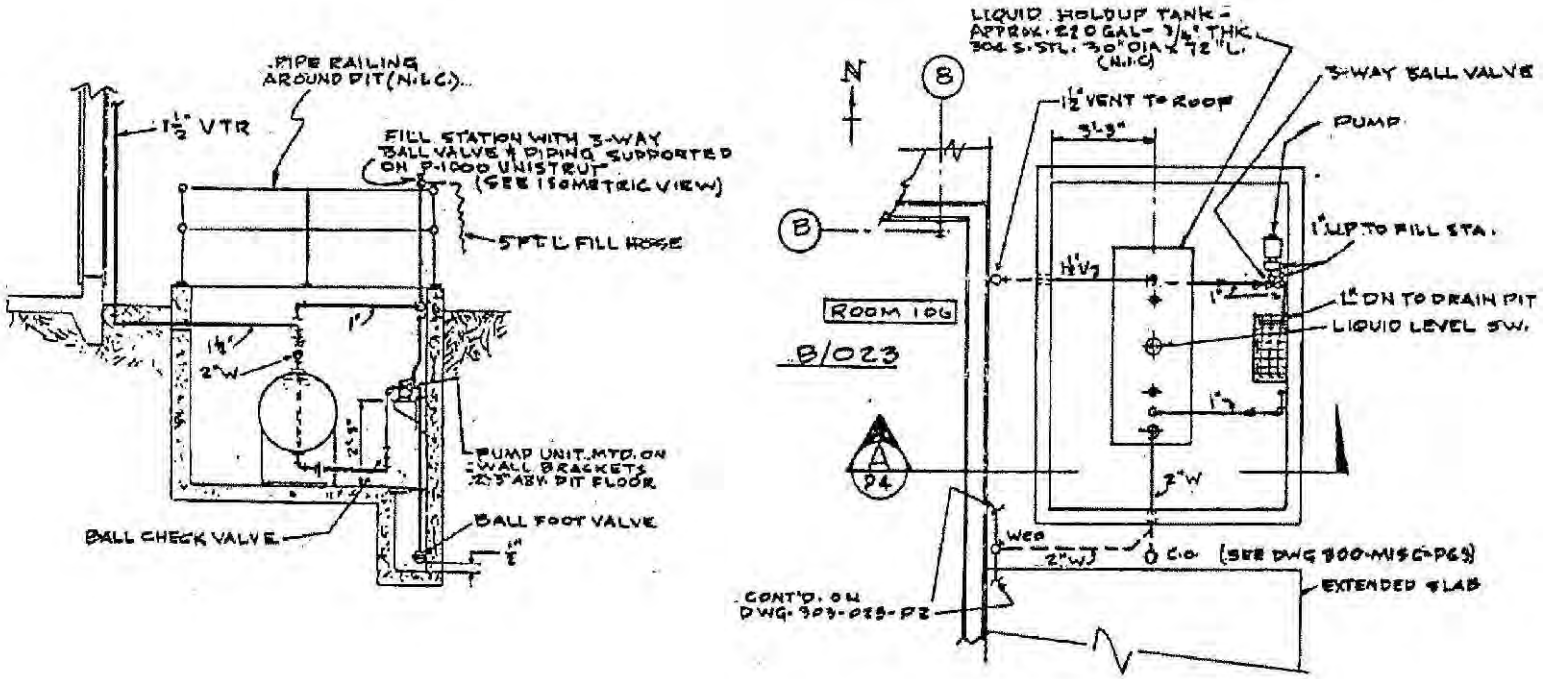
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.1c
Building 4023
Plot Plan



FACILITIES ENGINEERING	Rockwell International Corporation Atomics International Division

PIPING SECTIONS & DETAILS
LAB TEST AREA BLDG. 023
SANTA SUSANA FACILITY, VENTURA CTY., CA.

APPROVED BY	DESIGNED BY C. BENEDICT	RELEASE DATE 11-15-74	REV. NO. PEWR 75194
APPROVED BY	DRAWN BY L. BENEDICT	DRAWING NO. 303-023-P4	REV. NO.
APPROVED BY	CHECKED BY		

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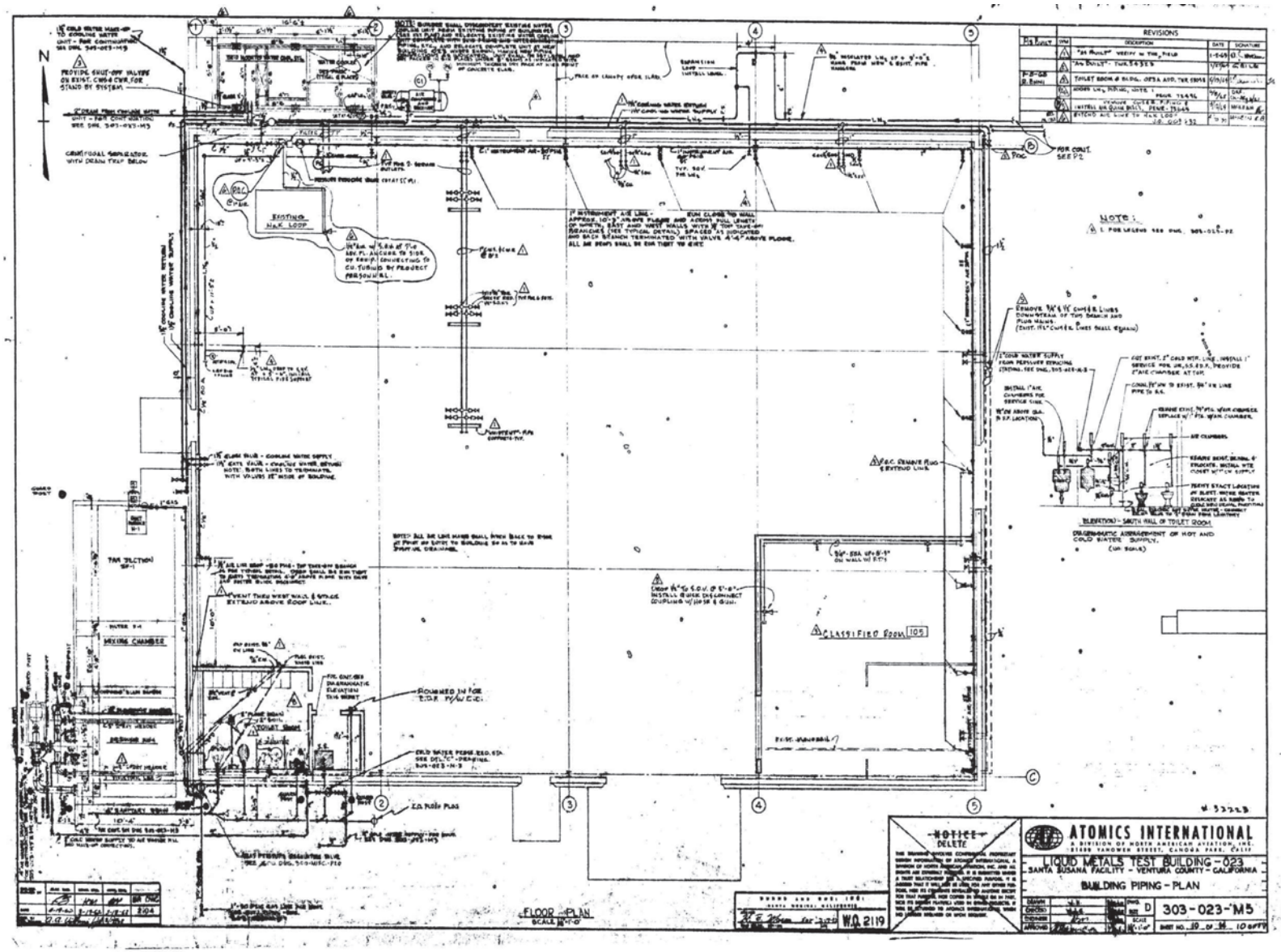
Project:EP9038
Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.1.1d
Building 4023
Radioactive
Holdup Tank



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Revised: 10/18/2010 TJ
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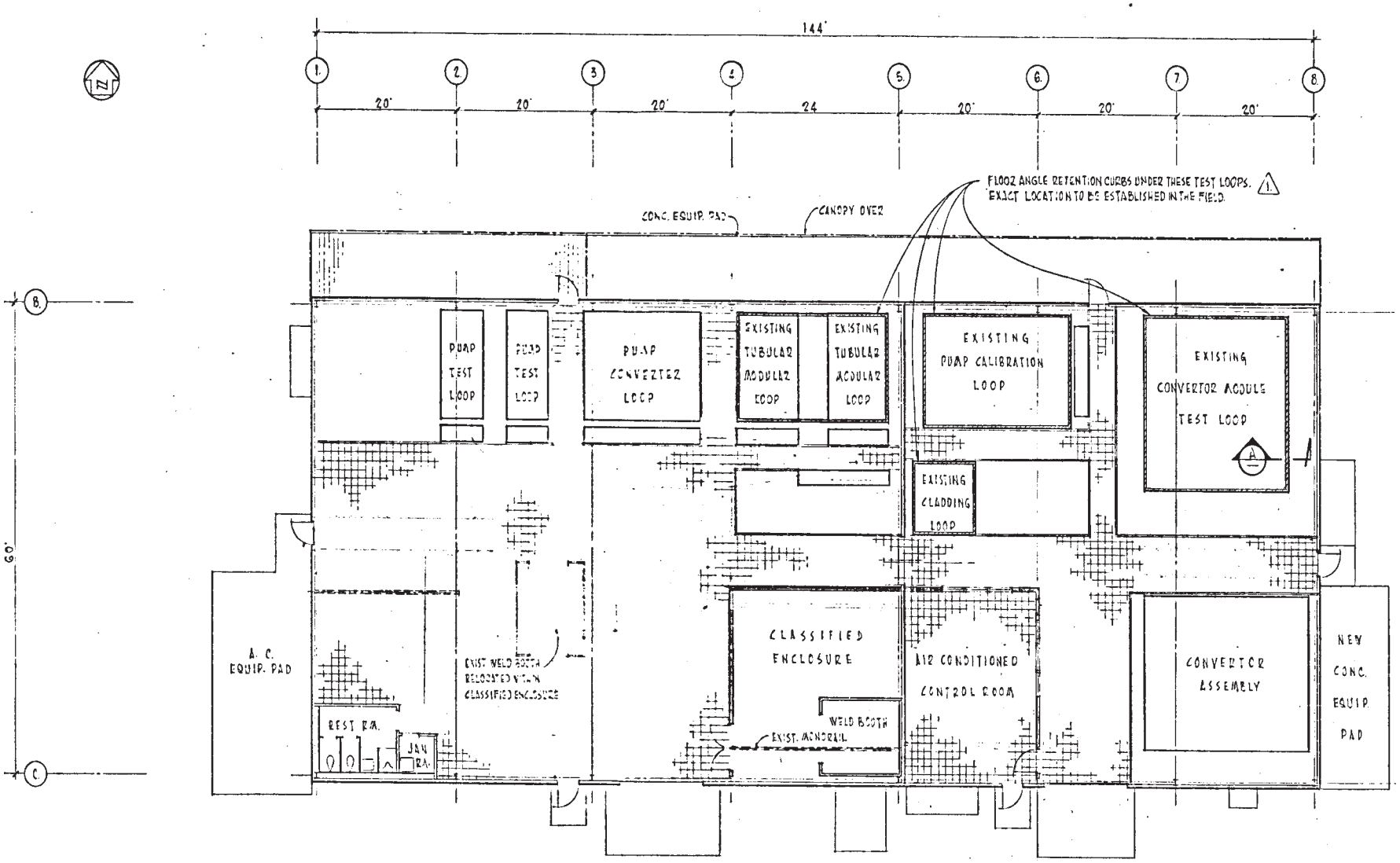
Figure 2.1.1e
Building 4023
Piping Plan



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Revised: 10/18/2010 TJ
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Figure 2.1.1f
Building 4023
Zirconium Hydride
Tests Floor Plan

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Project:EP9038
Revised: 10/05/2010 TJ
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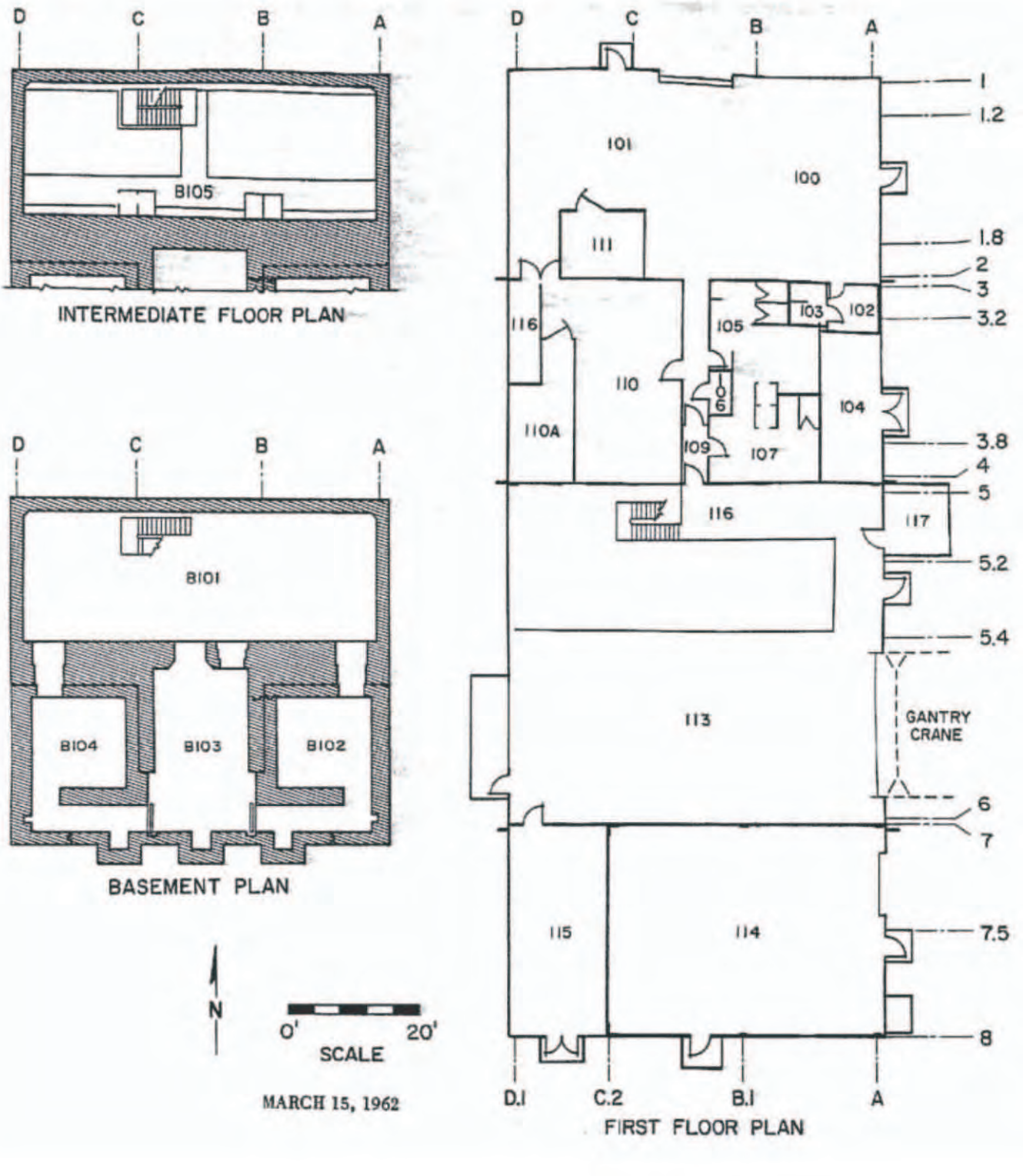
U.S. EPA Region 9

Figure 2.1.2a
Building 4024
Site Photograph



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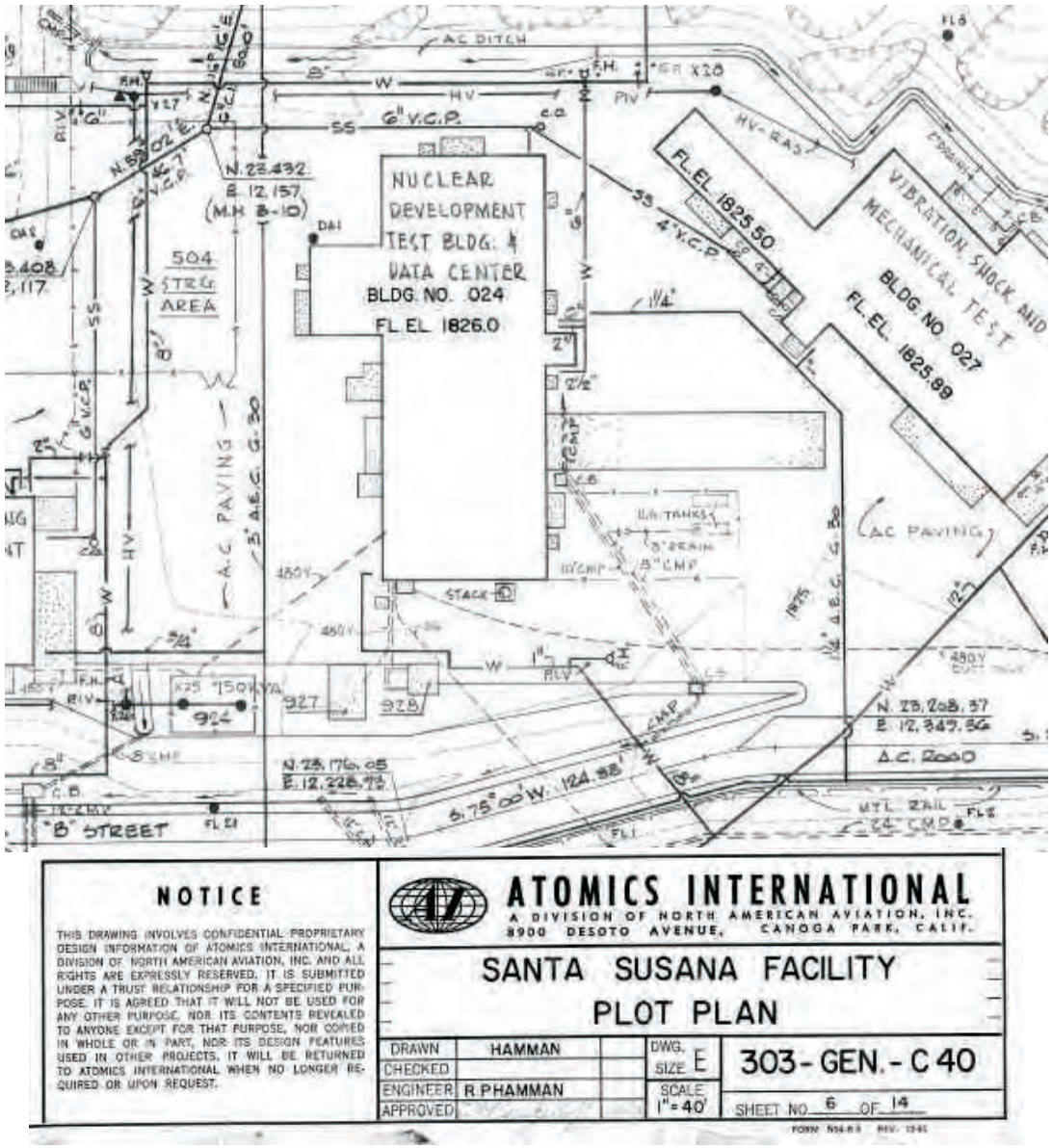
U.S. EPA Region 9

Figure 2.1.2b
Building 4024
Floor Plan



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PLOT PLAN

DRAWN	HAMMAN		DWG. SIZE E	303-GEN.-C 40
CHECKED				
ENGINEER	R PHAMMAN		SCALE 1"=40'	SHEET NO 6 OF 14
APPROVED				

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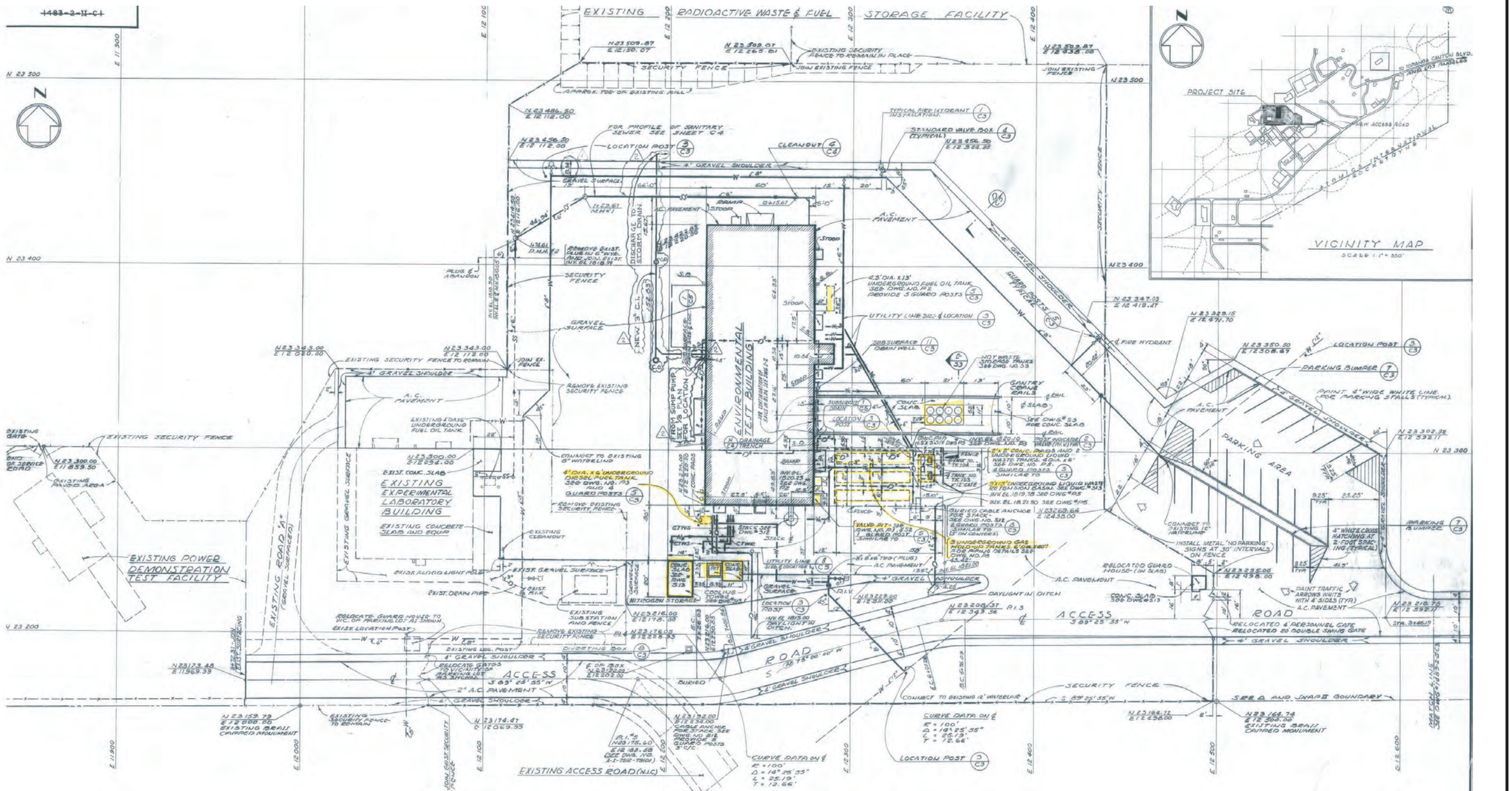
Figure 2.1.2c
Building 4024
Plot Plan



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Source: Boeing Company, 2008

U.S. EPA Region 9

Legend

- PHASE II BUILDING CONSTRUCTION
- SECURITY FENCE LINE (NEW)
- EXISTING SECURITY FENCE LINE
- EXISTING FACILITIES (N.I.C.)
- MANHOLE
- CLEANOUT
- WASTE DRAIN LINE
- NITROGEN GAS LINE
- COOLING TOWER WATER RETURN
- COOLING TOWER WATER SUPPLY
- CONTAMINATED WASTE
- SUBSURFACE DRAIN
- SPLASH BLOCK
- EXISTING WATER SERVICE
- WATER LINE
- GATE VALVE
- POST INDICATOR VALVE
- FIRE HYDRANT
- SANITARY SEWER LINE

Figure 2.1.2d
Building 4024
1961 Site and Utilities Plan

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Project:EP9038
Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

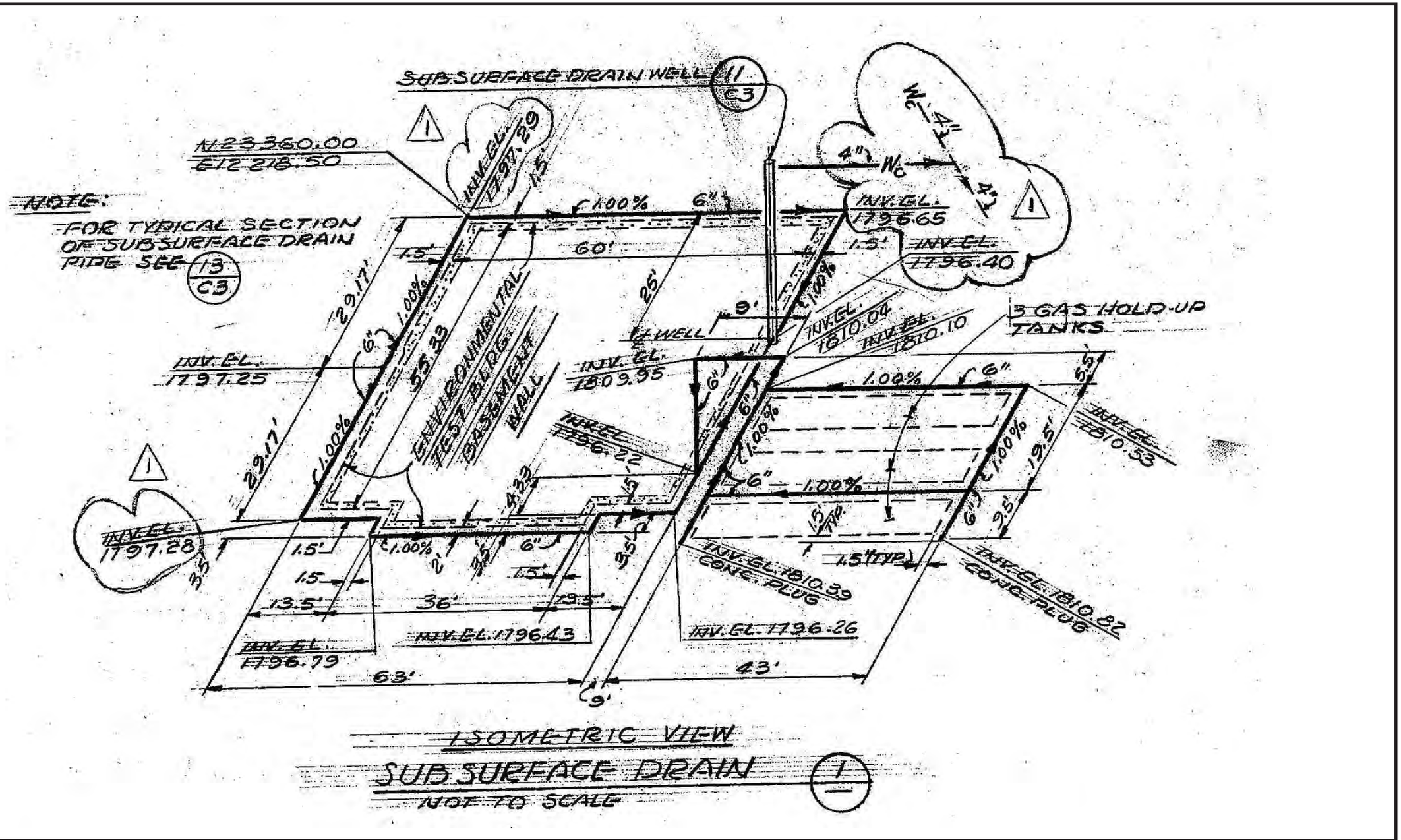
U.S. EPA Region 9

Legend

- BUILDING CONSTRUCTION
- ELEVATION AT FLOW LINE
- ELEVATION FINISHED FLOOR OR SLAB
- ELEVATION SPLASH BLOCK
- NEW SECURITY FENCE
- EXISTING SECURITY FENCE
- EXISTING 1:1 CUT SLOPE IN ROCK OUTCROP
- ROCK OUTCROPPING AT NATURAL GROUND
- EXISTING CONTOUR AT NATURAL GRADE
- GRADING CONTOUR AND ELEVATION
- EXISTING CONTOUR
- EXISTING FACILITIES (M.I.C.)
- SRE Δ AND SNAP II BOUNDARY
- FLOW LINE

Figure 2.1.2e
Building 4024
1961Grading and Drainage Plan

Redacted



ISOMETRIC VIEW
SUB SURFACE DRAIN 1
NOT TO SCALE

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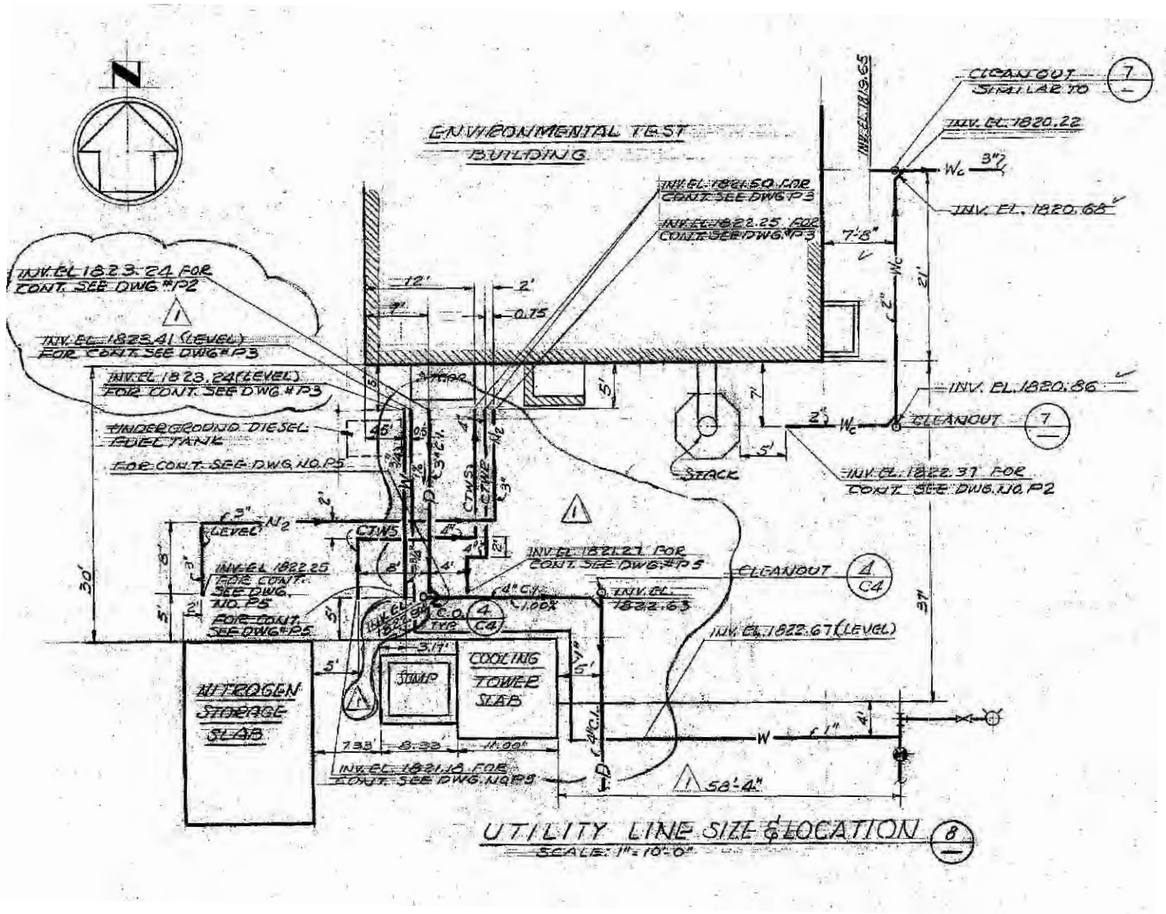
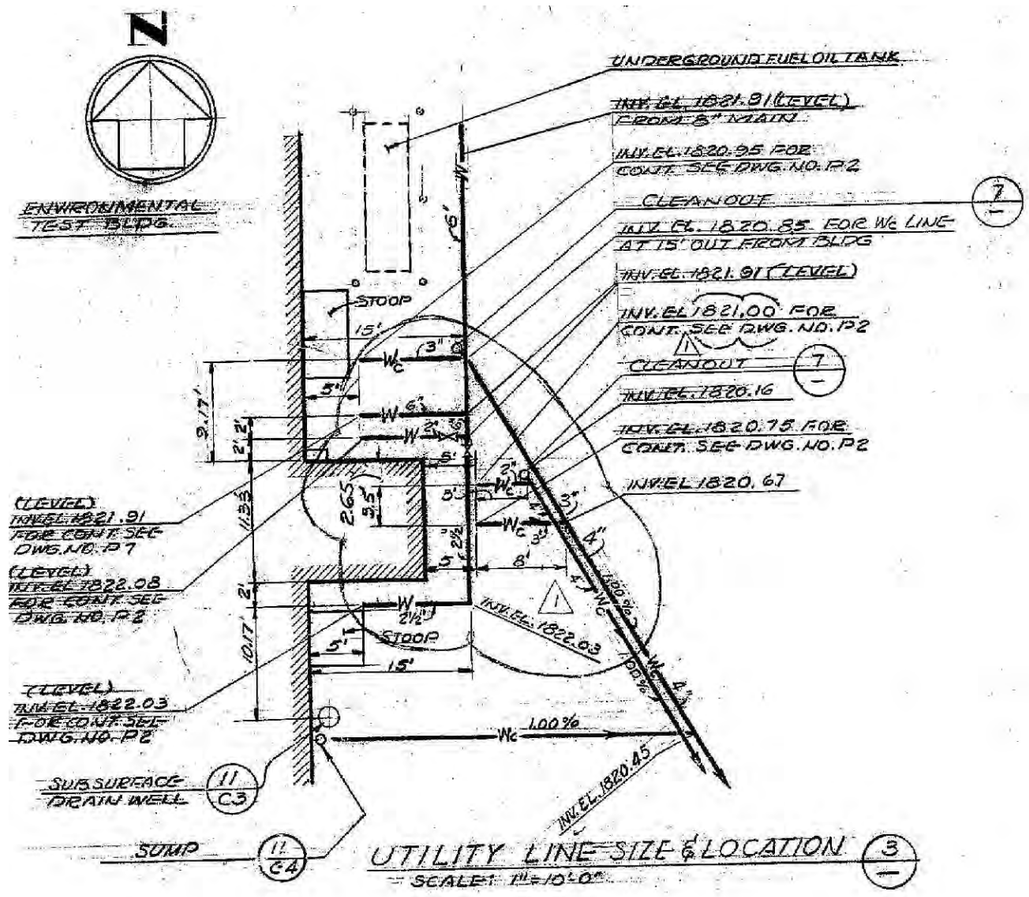
U.S. EPA Region 9

Legend

Figure 2.1.2f
Building 4024
Subsurface
Drainage Plan





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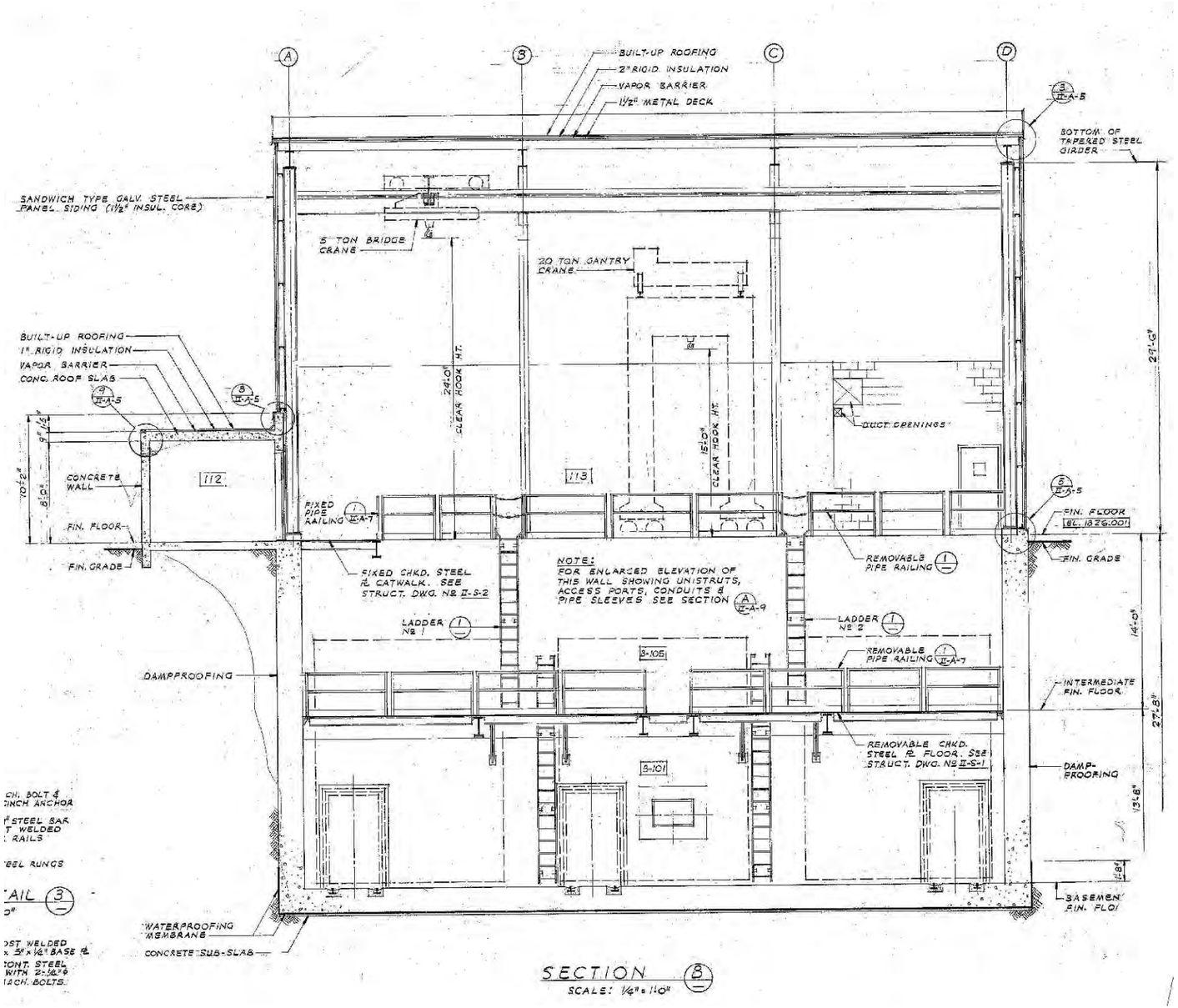
Source: Boeing Company, 2008

U.S. EPA Region 9

Legend

Figure 2.1.2g
Building 4024
1961 Utility Lines



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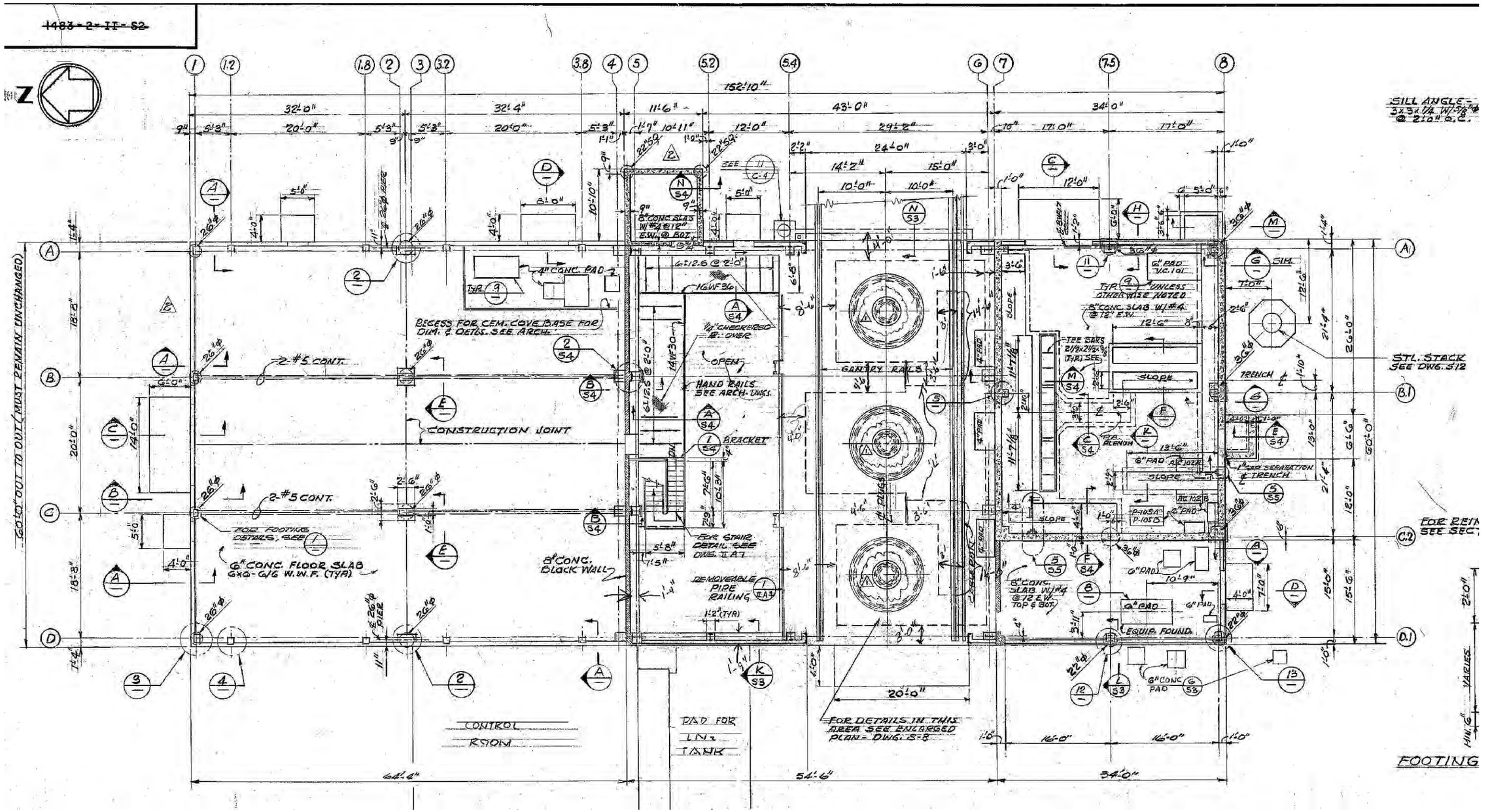
U.S. EPA Region 9

Legend

Figure 2.1.2h
Building 4024
Building Cross Section



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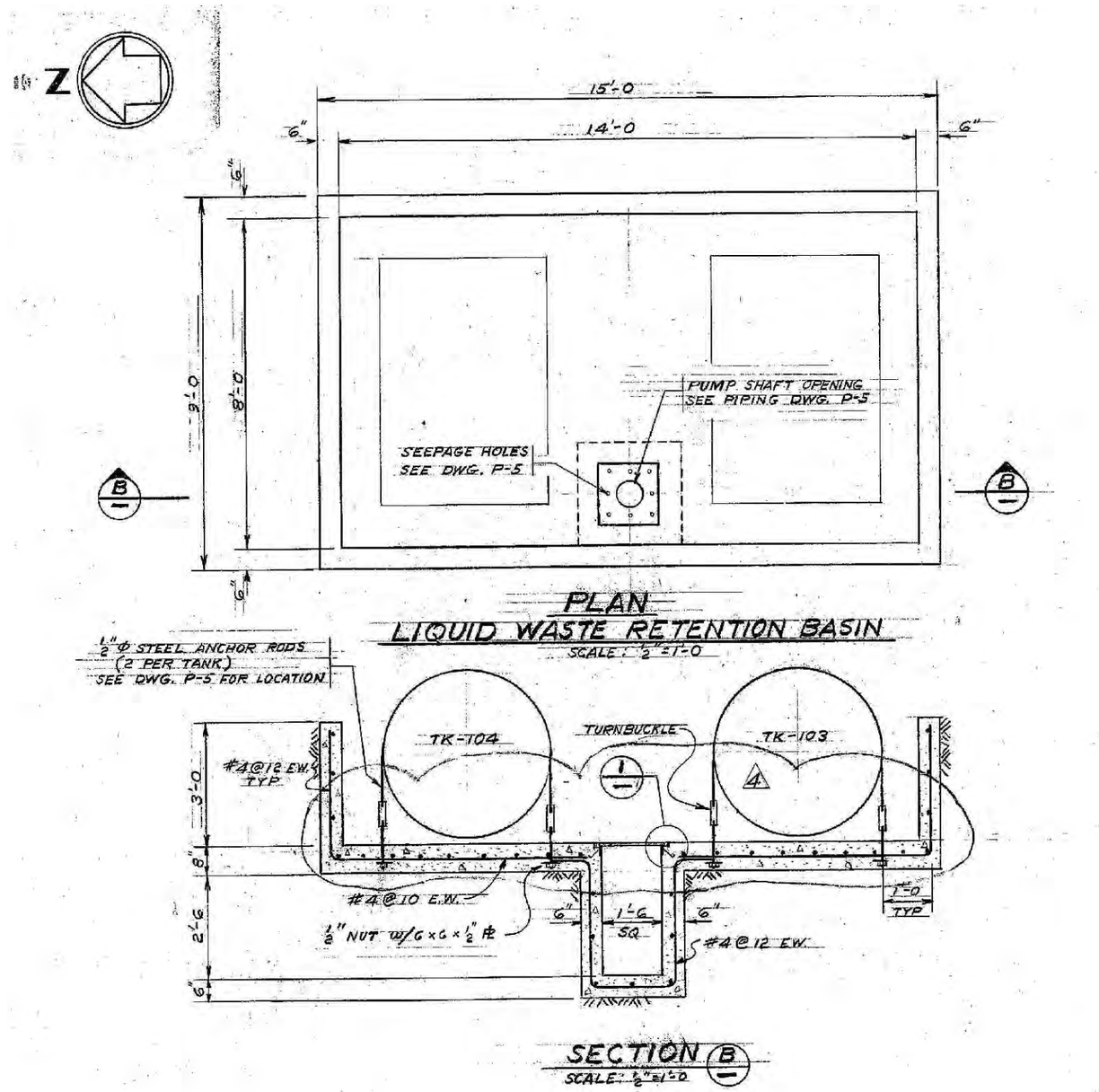
Project:EP9038
Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Legend

Figure 2.1.2i
Building 4024
1961 First
Floor Plan



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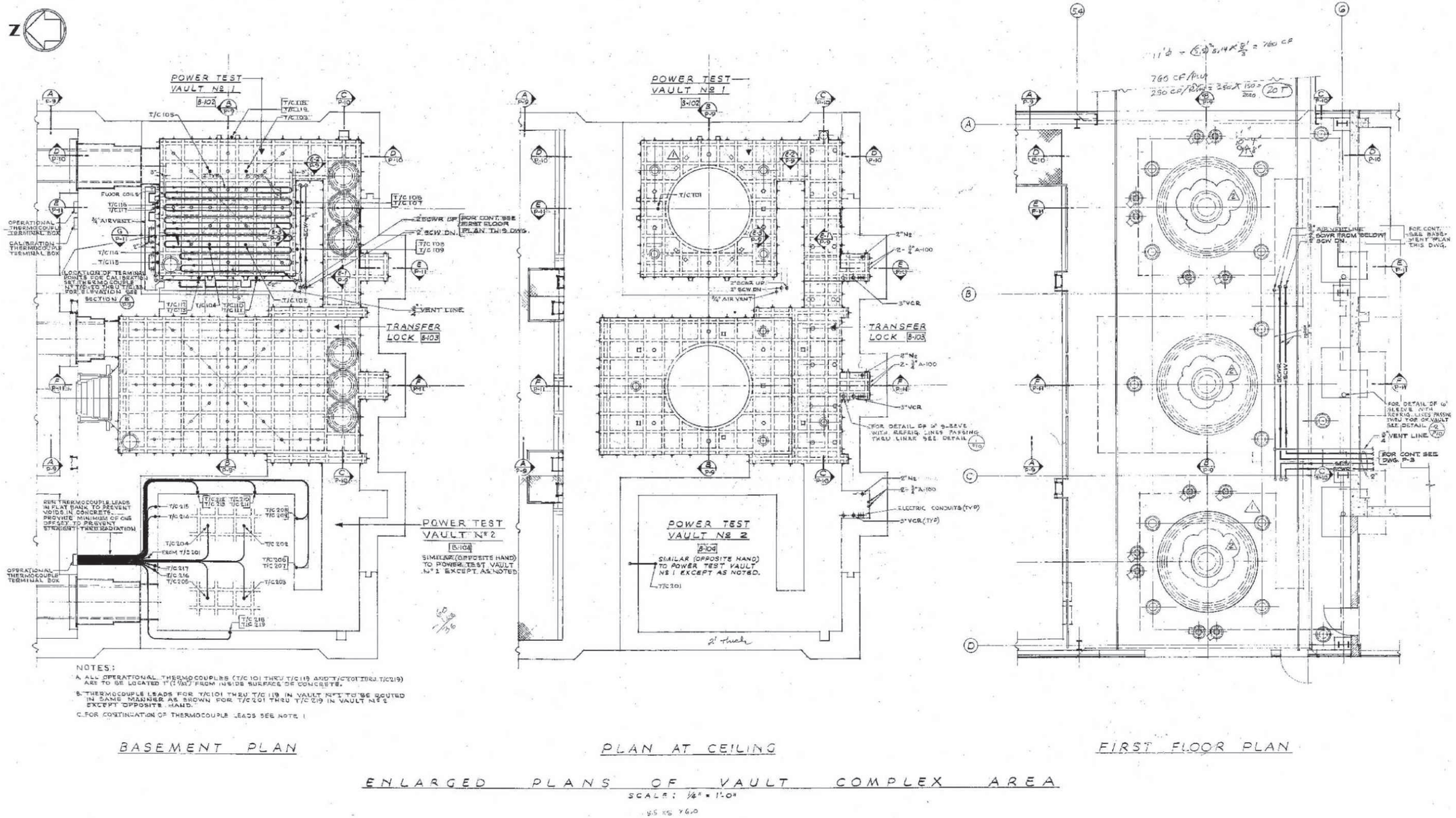
Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Legend

Figure 2.1.2j
Building 4024
1961 Liquid Waste Retention Basin



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Project:EP9038
Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Legend

Figure 2.1.2k
Building 4024
1961 Vault
Complex Area

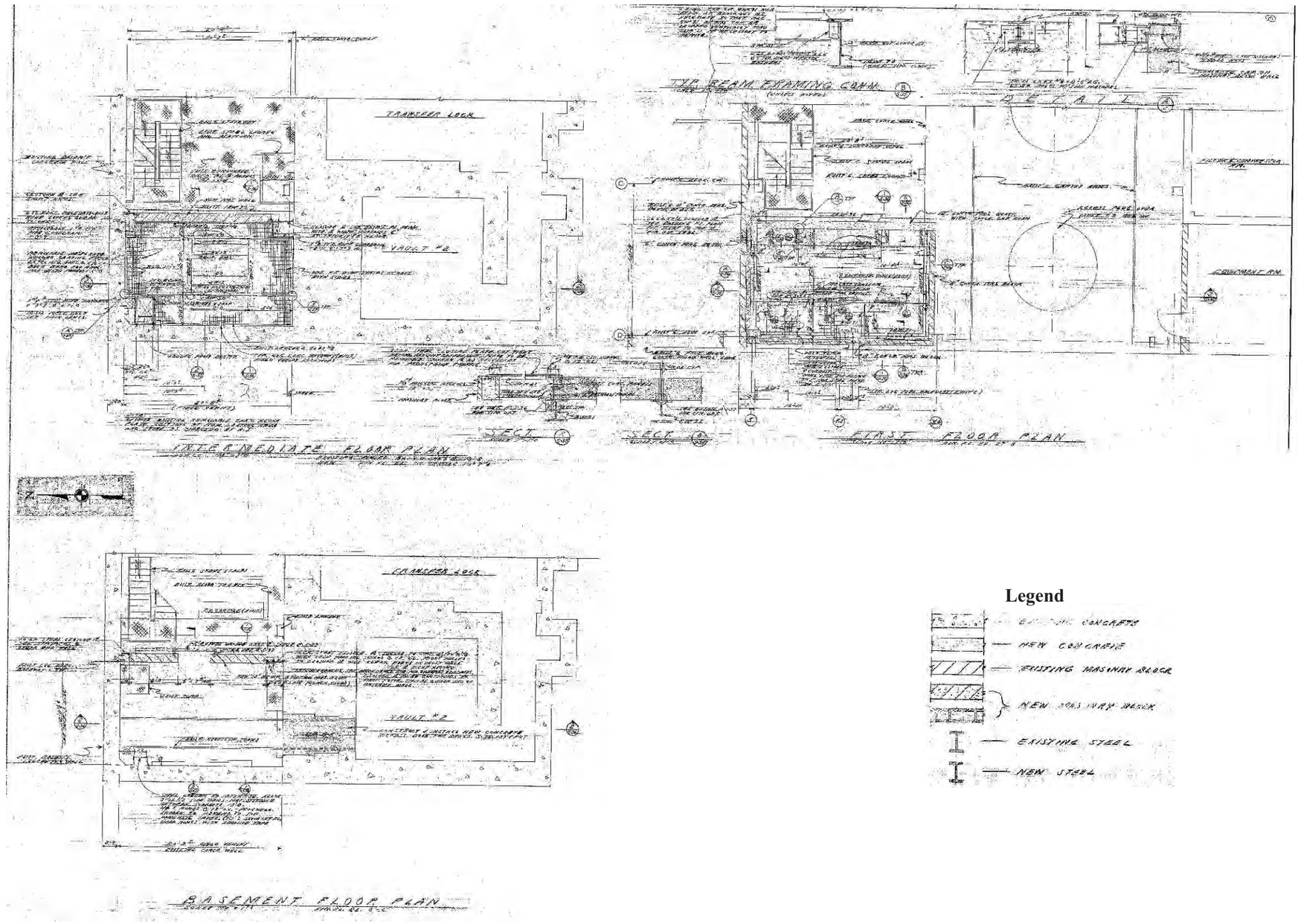

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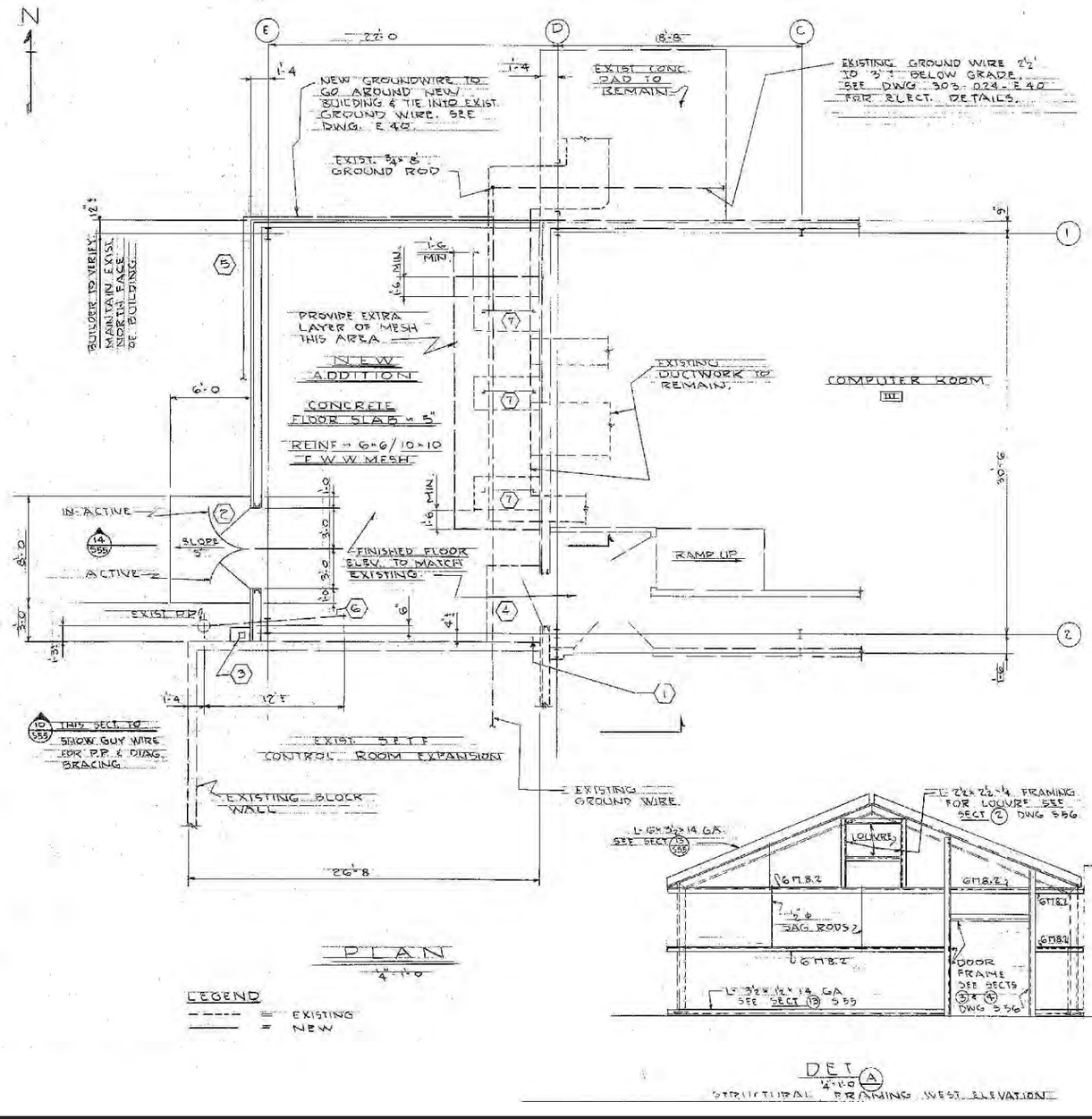
Figure 2.1.2l
Building 4024
1962 SNAP
10FS-1 Floor Plan



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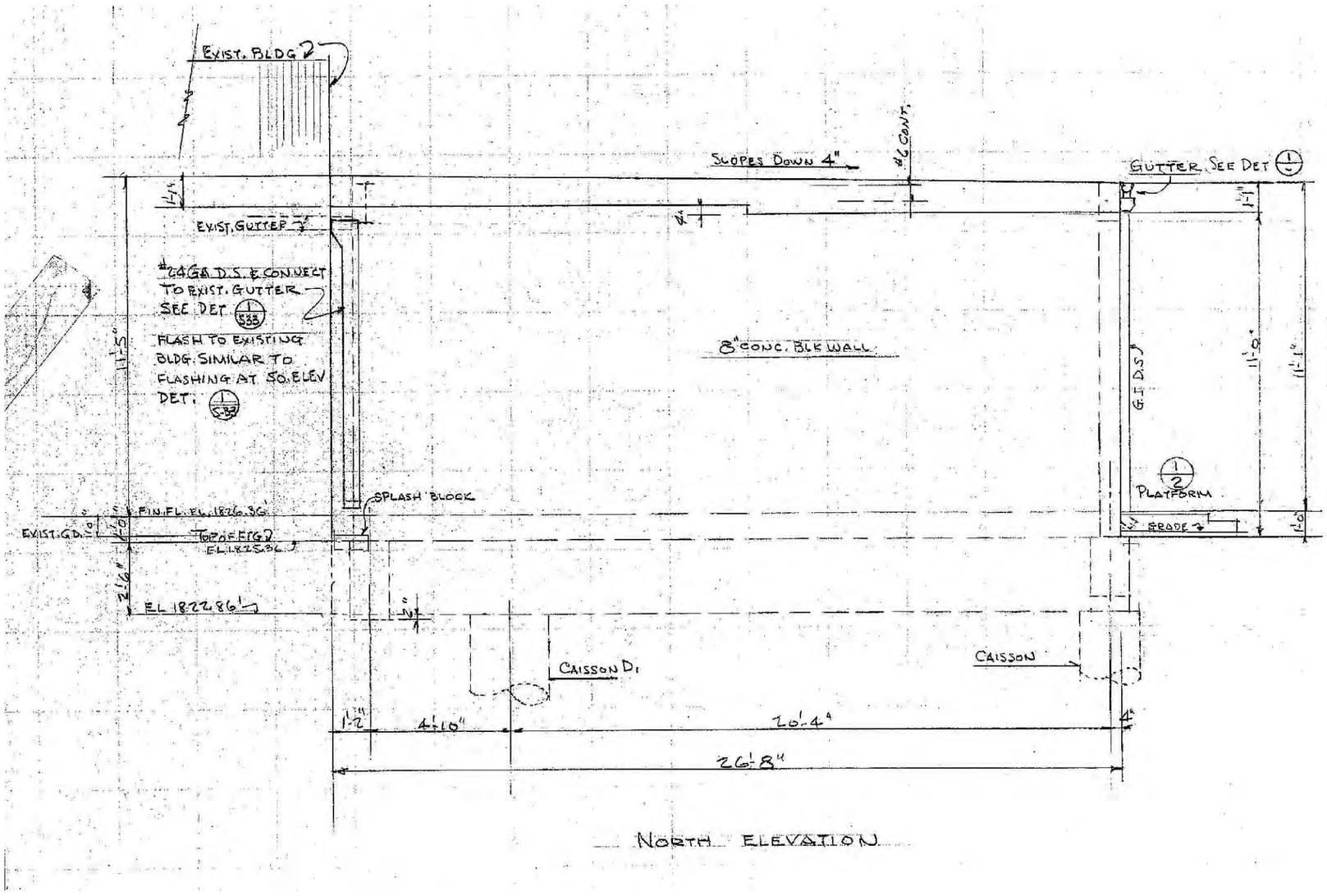
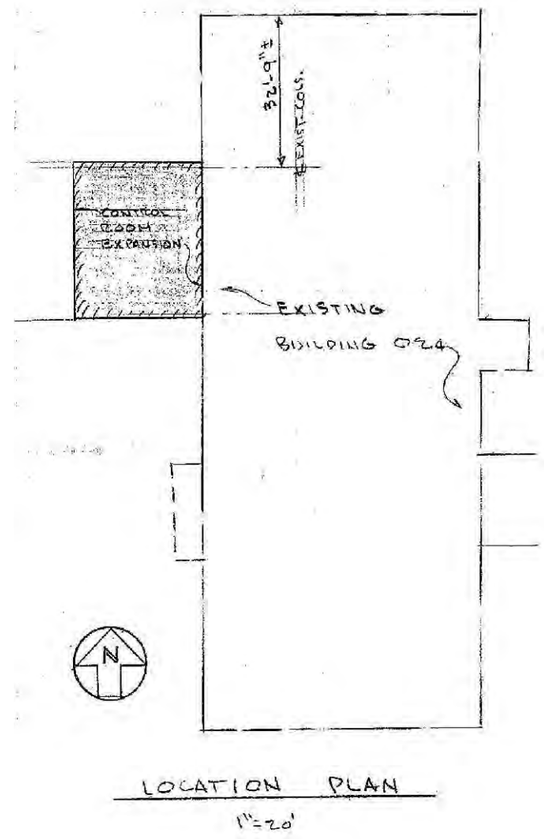
U.S. EPA Region 9

Legend

Figure 2.1.2m
Building 4024
1966 Storage Area Addition





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Source: Boeing Company, 2008

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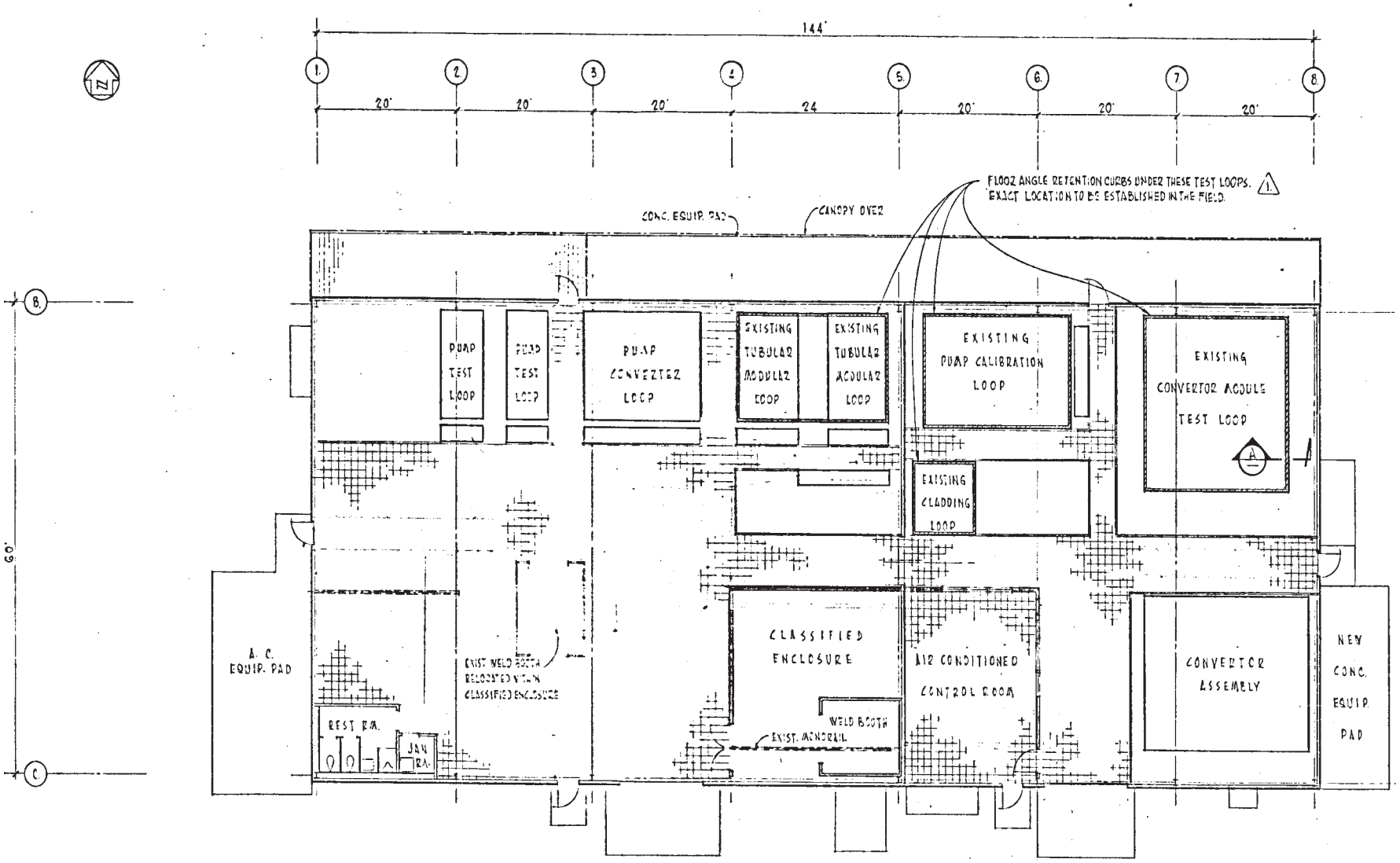
Legend

Figure 2.1.2n
Building 4024
1967 Control Room Expansion



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Source: Boeing Company, 2008

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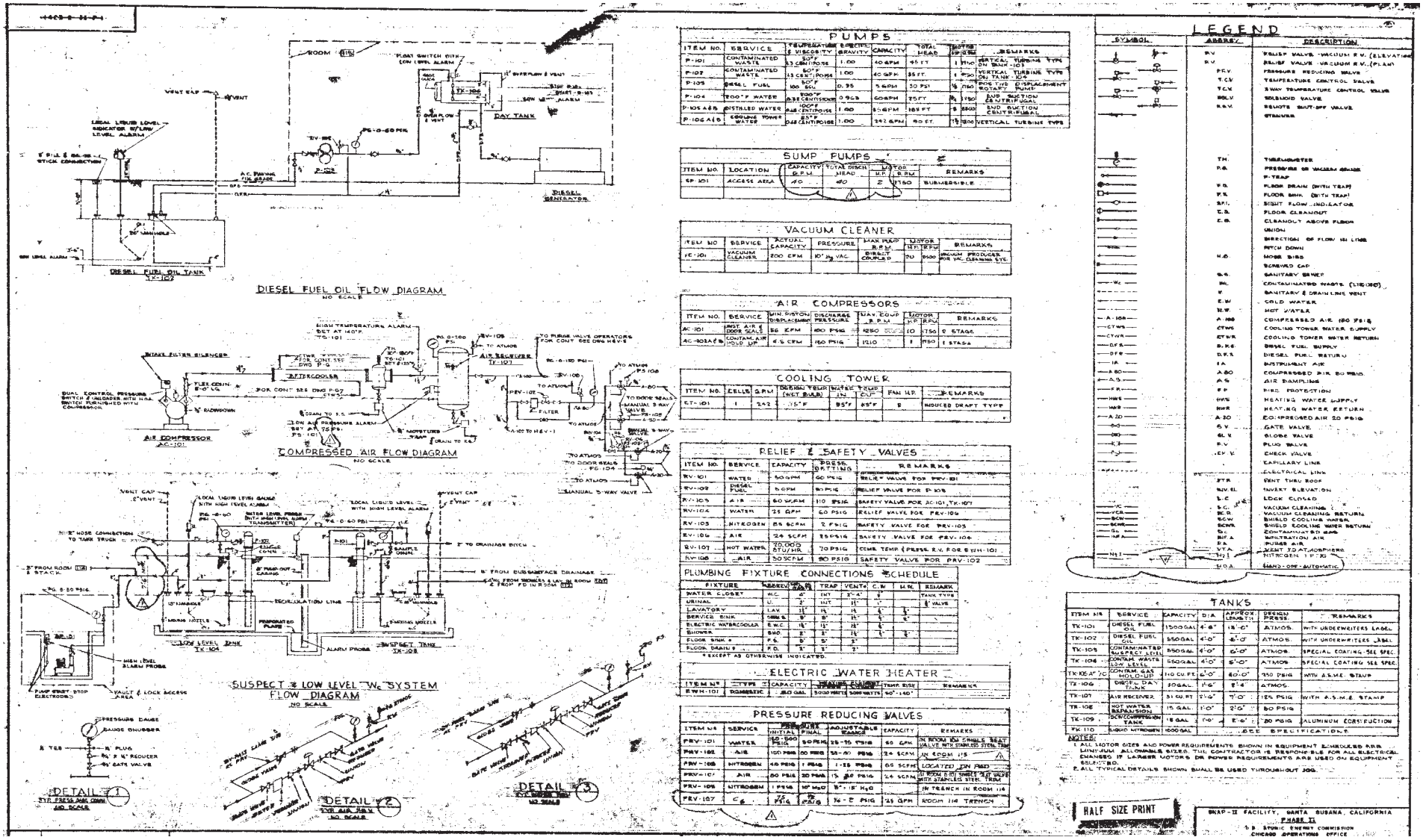
Figure 2.1.2o
Building 4024
Piping Plan



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Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

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Figure 2.1.2p
Building 4024
Flow Diagram

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Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

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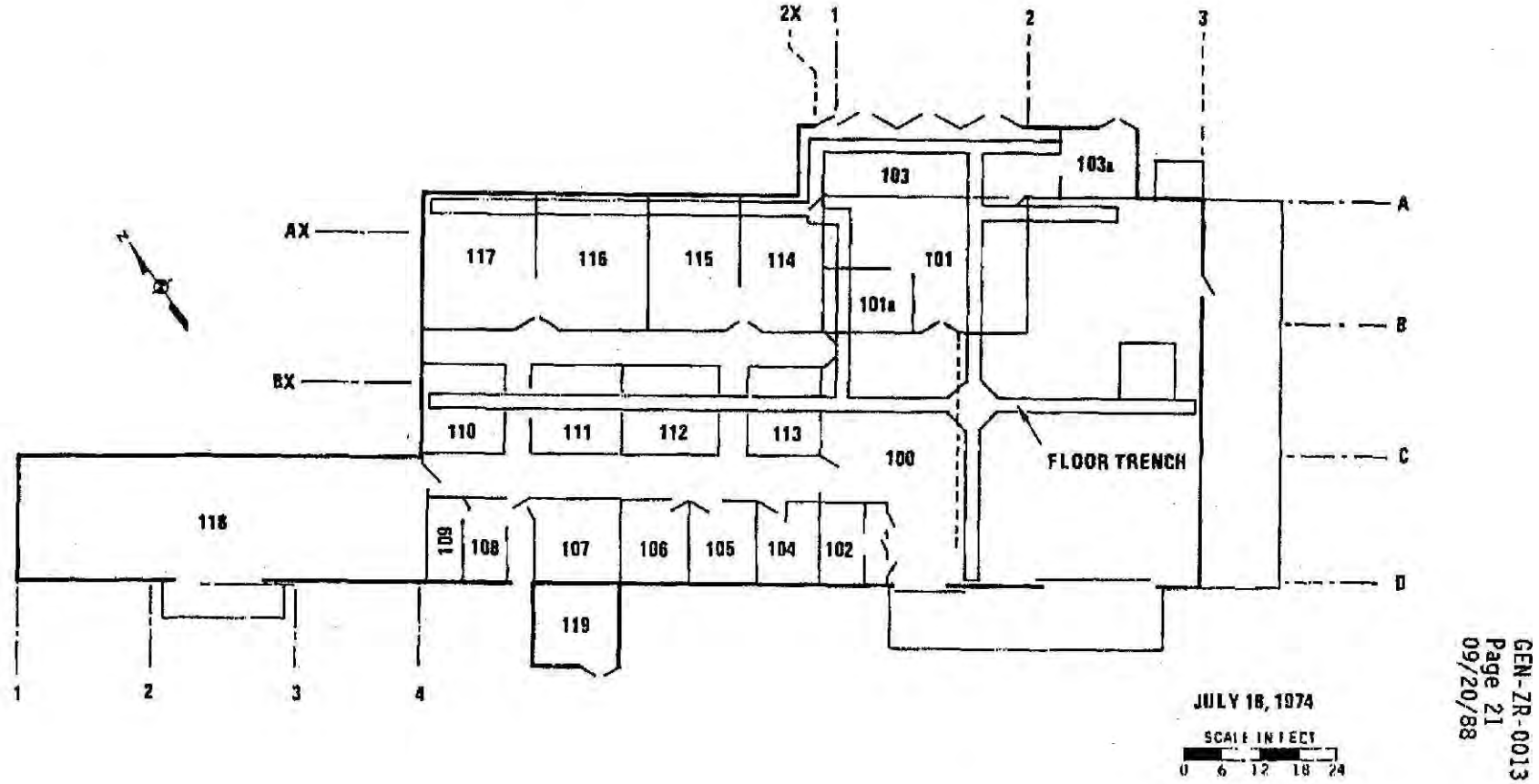
Figure 2.1.3a
Building 4027
Site Photograph



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Source: Boeing Company, 2008

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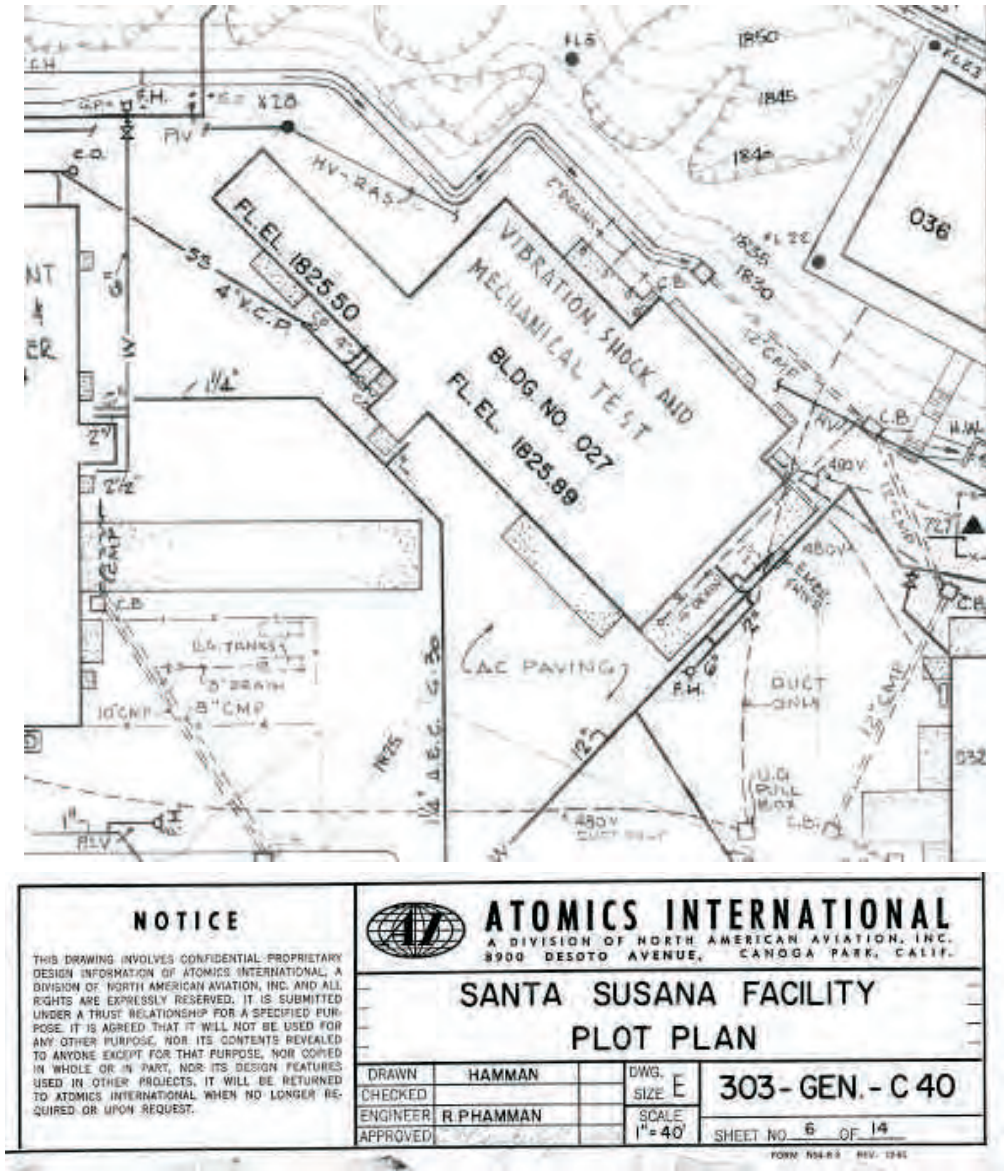
Figure 2.1.3b
Building 4027
Floor Plan



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Source: Boeing Company, 2008

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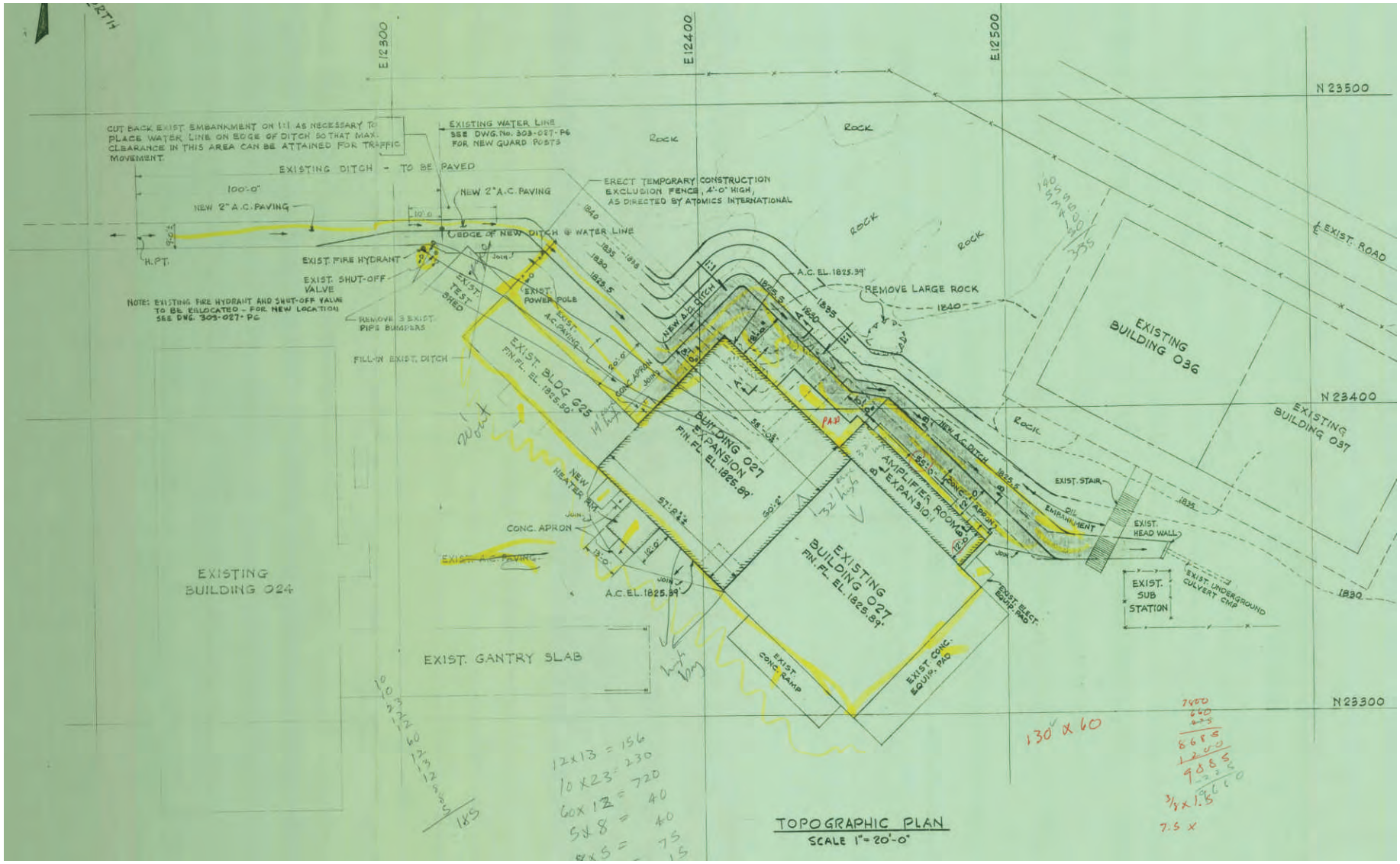
Figure 2.1.3c
Building 4027
Plot Plan



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Source: Boeing Company, 2008

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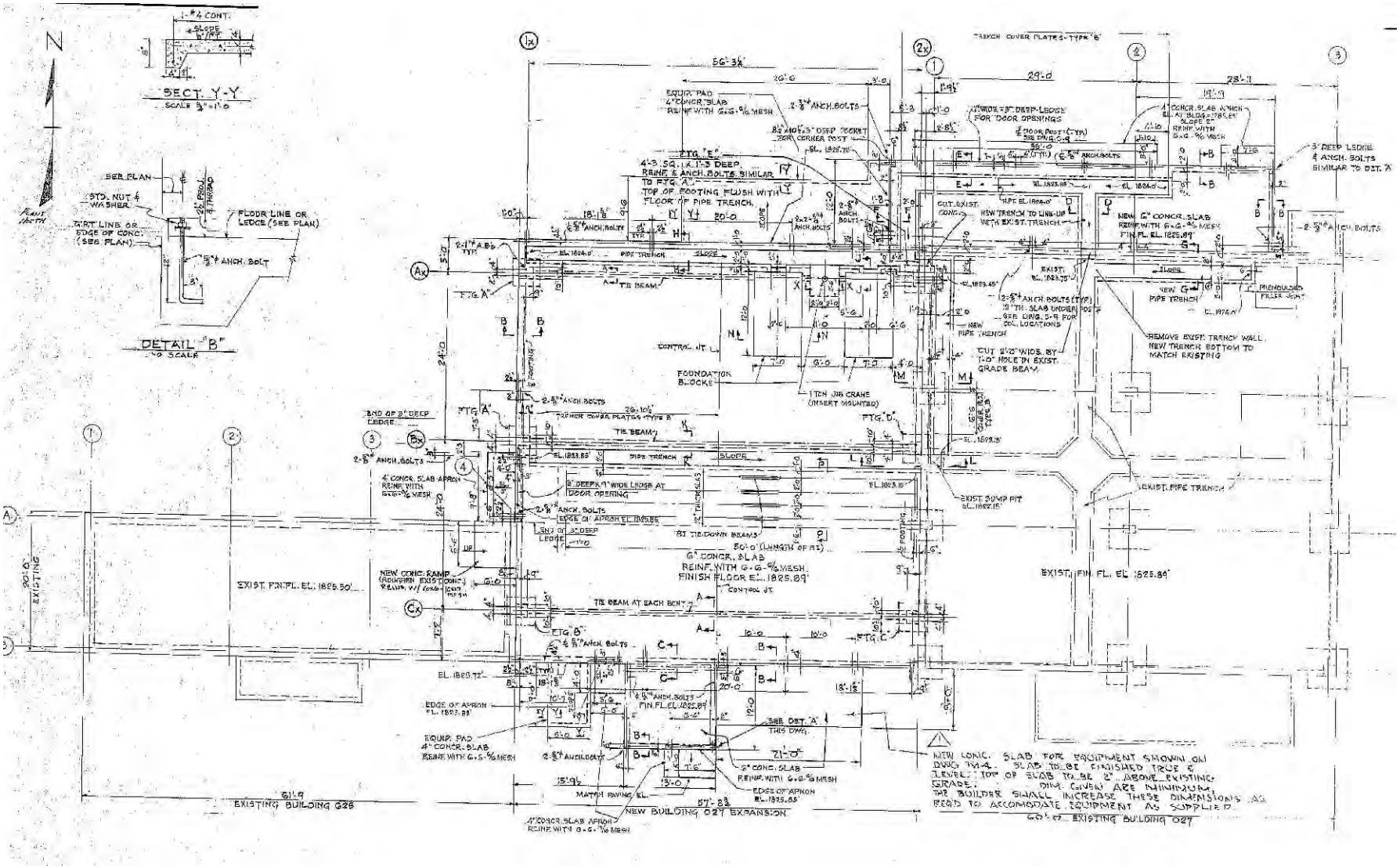
Figure 2.1.3d
Building 4027
1963 Topographical Plan



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Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

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Figure 2.1.3e
Building 4027
1963 Foundation Plan

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-1-4a)bldg4032AP.cdr
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

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Figure 2.1.4a
Building 4032
Site Photograph

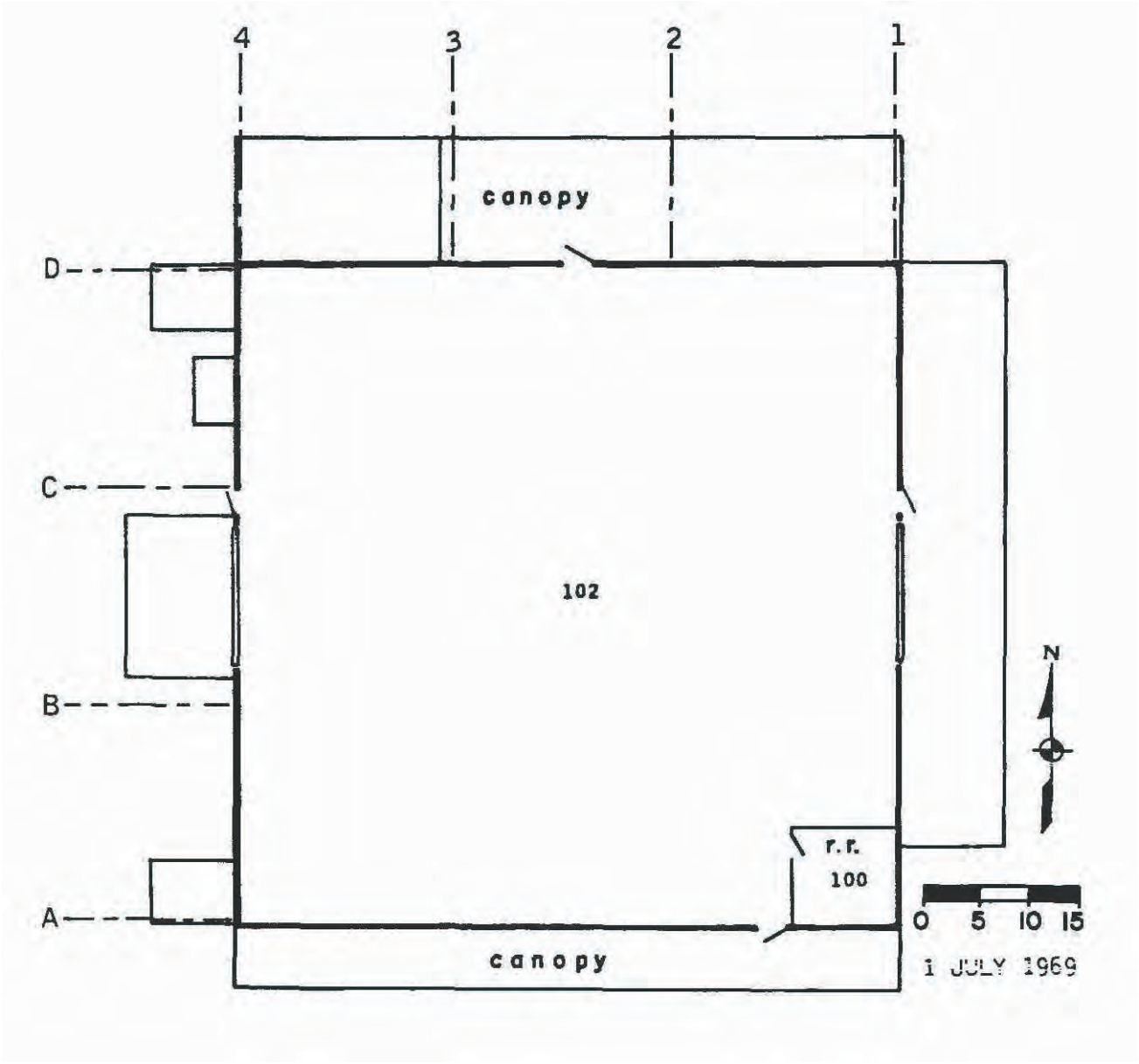

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Figure 2.1.4b
Building 4032
Floor Plan

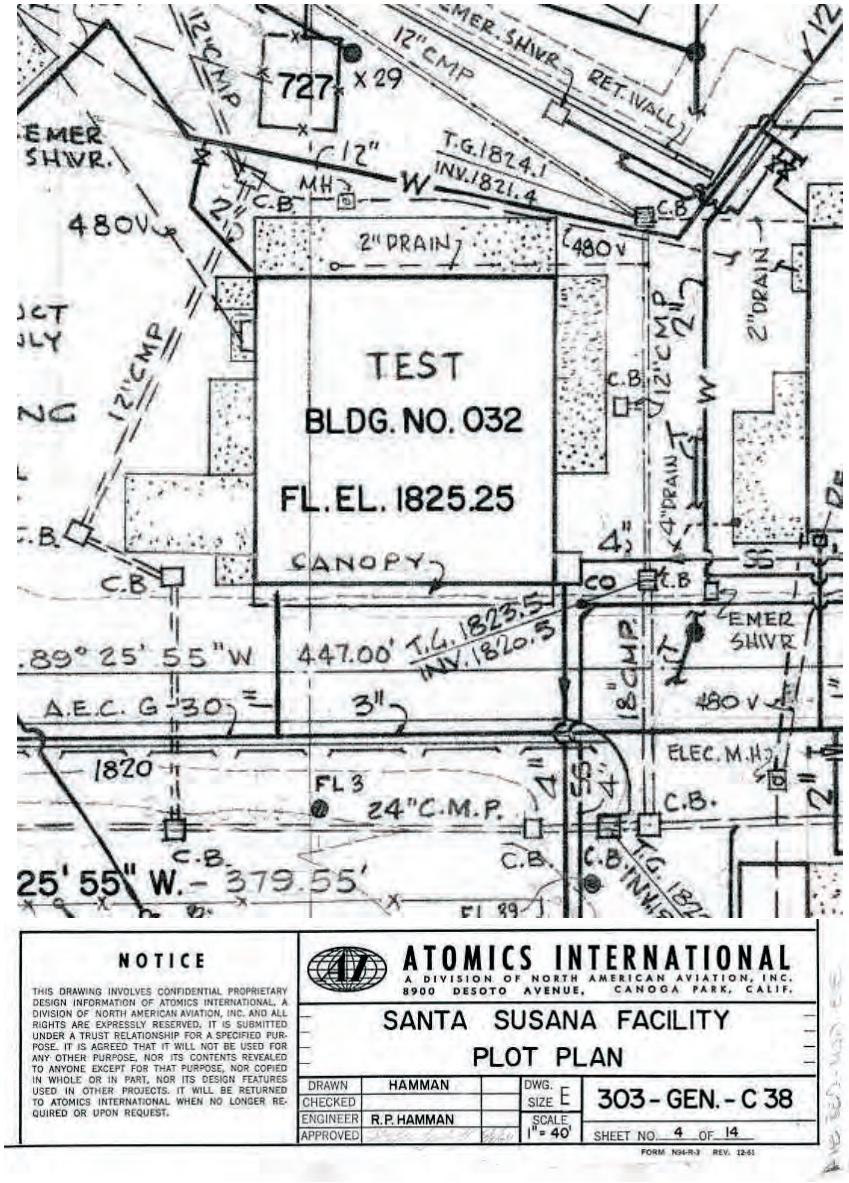

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Figure 2.1.4c
Building 4032
Plot Plan

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Revised: 09/23/2010 TJ
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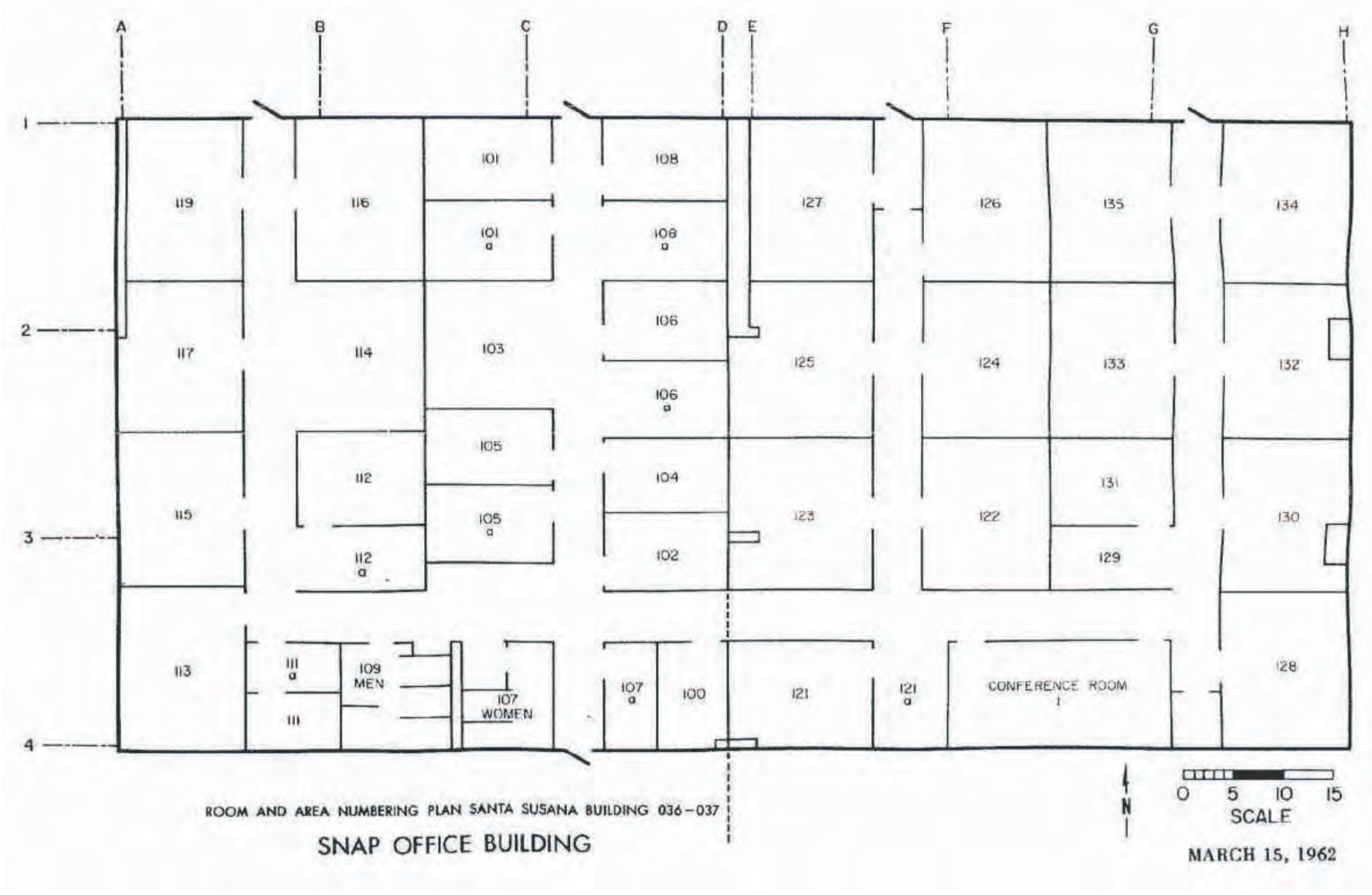
Figure 2.1.5a
Building 4036
Site Photograph



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Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

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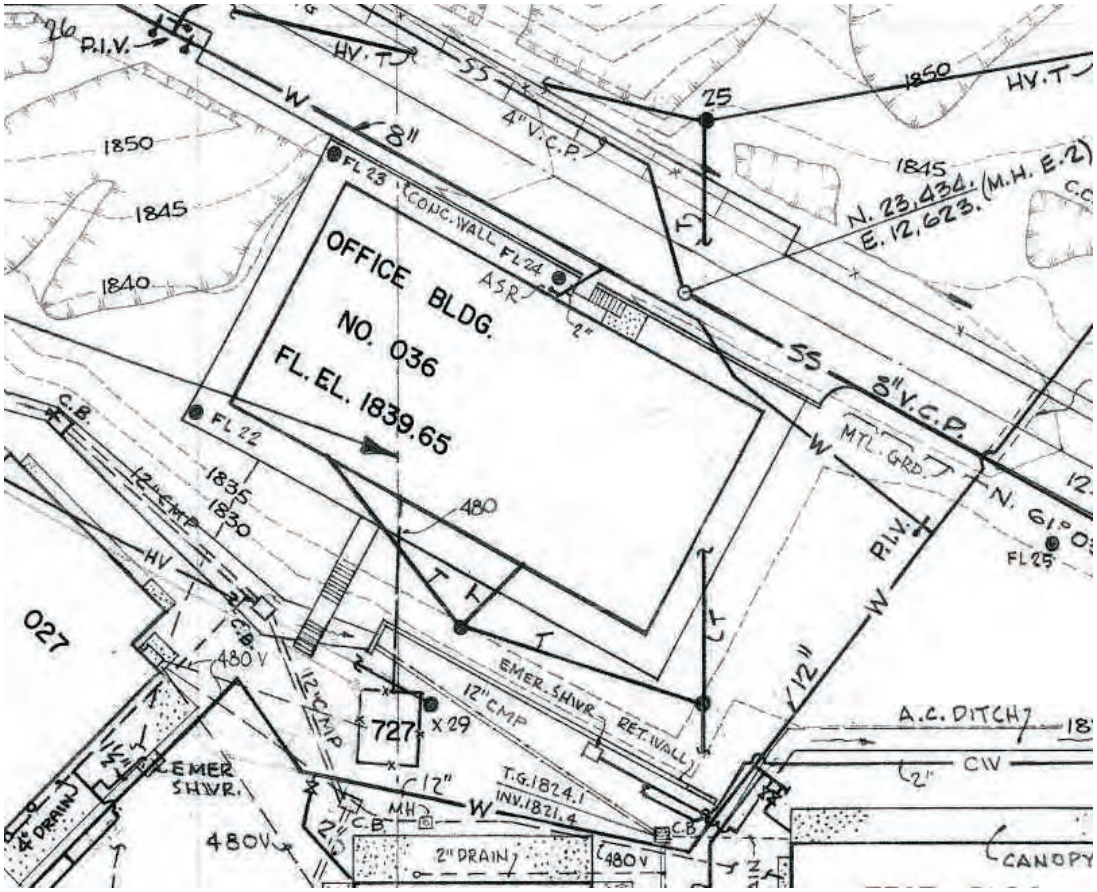
Figure 2.1.5b
Building 4036
Floor Plan



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SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN	DWG. SIZE E	303 - GEN. - C 38
CHECKED			
ENGINEER	R.P. HAMMAN	SCALE 1" = 40'	SHEET NO. 4 OF 14
APPROVED			

FORM NAA-R-3 REV. 12-61

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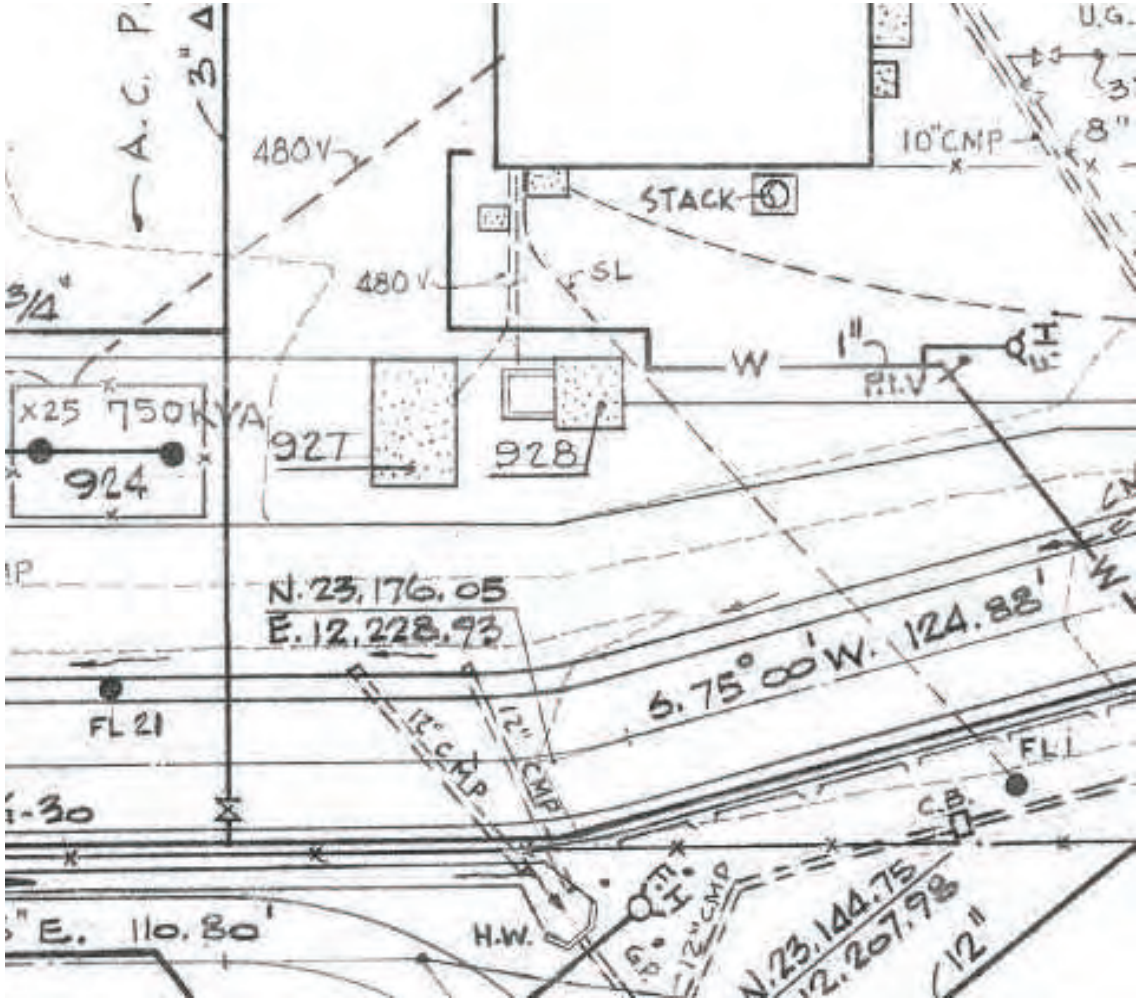
Figure 2.1.5c
Building 4036
Plot Plan



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PLOT PLAN

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CHECKED			
ENGINEER	R PHAMMAN	SCALE 1"=40'	SHEET NO. 6 OF 14
APPROVED			

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U.S. EPA Region 9

Figure 2.1.6a
Site 4927
Plot Plan

Historical Site Assessment
Final Technical Memorandum - HSA-5A

Figure 2.2
Area IV Subarea 5A-2
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

- Subarea 5A-2 Boundary
- Primary Roads
- Secondary Roads
- Underground Storage Tank
- Unknown Tank Type
- Sump
- Dry Well
- Tank Footprint
- Above ground Storage Tank
- Demolished Bldg.
- Existing Bldg.
- Parking Lots
- Drainage
- Drain
- Well

Aerial Photo Features
- Aerial Photography Features
- Leach Field
- Other

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel
- French Drain
- Drainage
- Leach Field
- Septic System

Utilities
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well
- Gas
- Storm Drain
- Sanitary Sewer
- Water

B	Building
CONT	Container
CR	Crates
DB	Debris
DG	Disturbed Ground
DTM	Dark Tone Material
EX	Excavation
FA	Fill Area
GS	Ground Scar
HT	Horizontal Tank
IM	Impoundment
MTMM	Medium Toned Mounded Material
OS	Open Storage
PA	Processing Area
PL	Parking Lot
POSS	Possible
PROB	Probable
S-T	Storage Tank
SS	Smoke Stack
ST	Storage
UO	Unidentified Object
VT	Vertical Tank
WDA	Waste Disposal Area

N

0 25 50 100
Scale In Feet

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Revised: 10/19/2010 TJ
Sorce: Boeing Company, 2008
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HydroGeoLogic, Inc

Redacted

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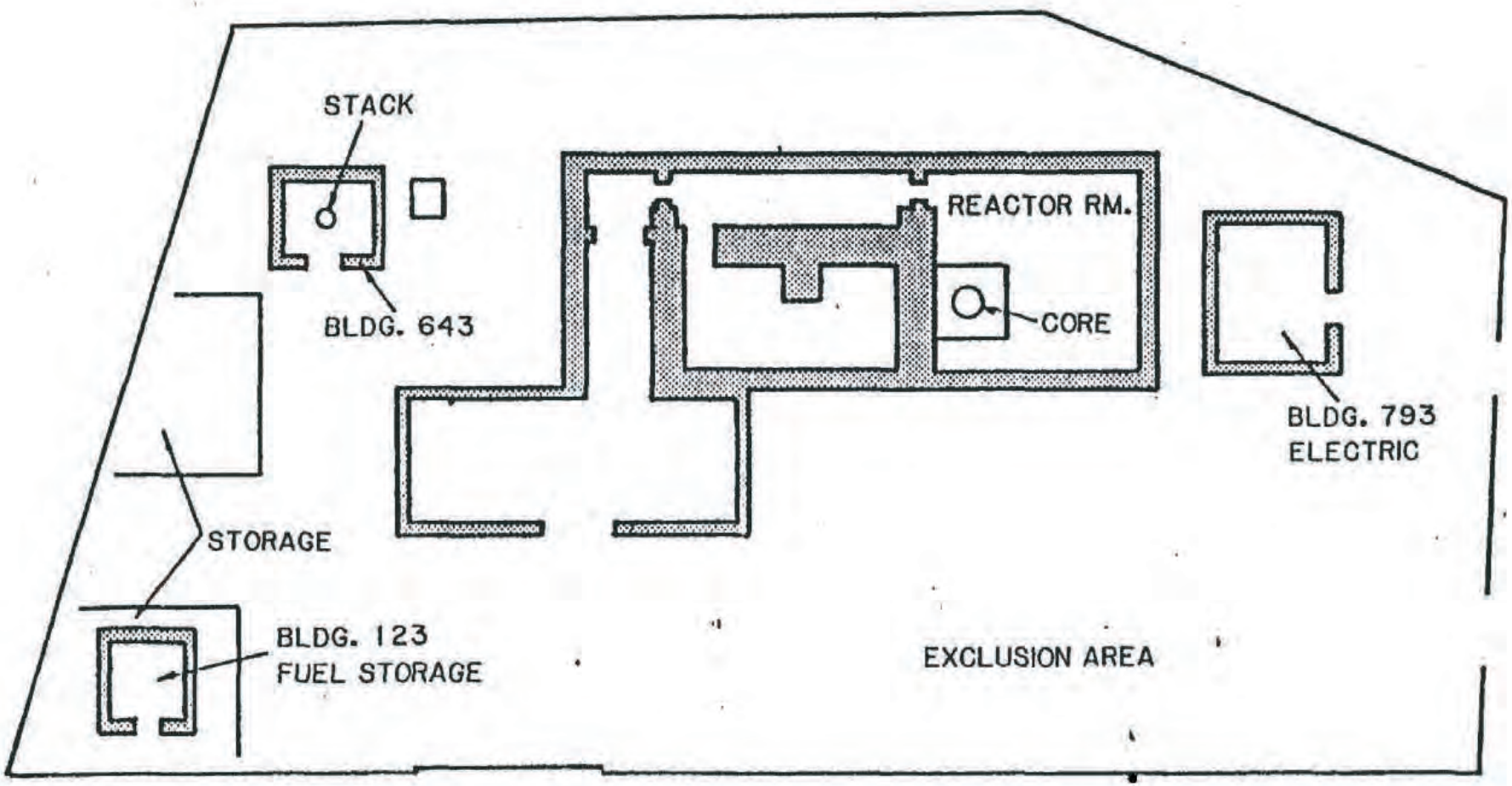
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.1a
Building 4073
Site Photograph



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Source: Boeing Company, 2008

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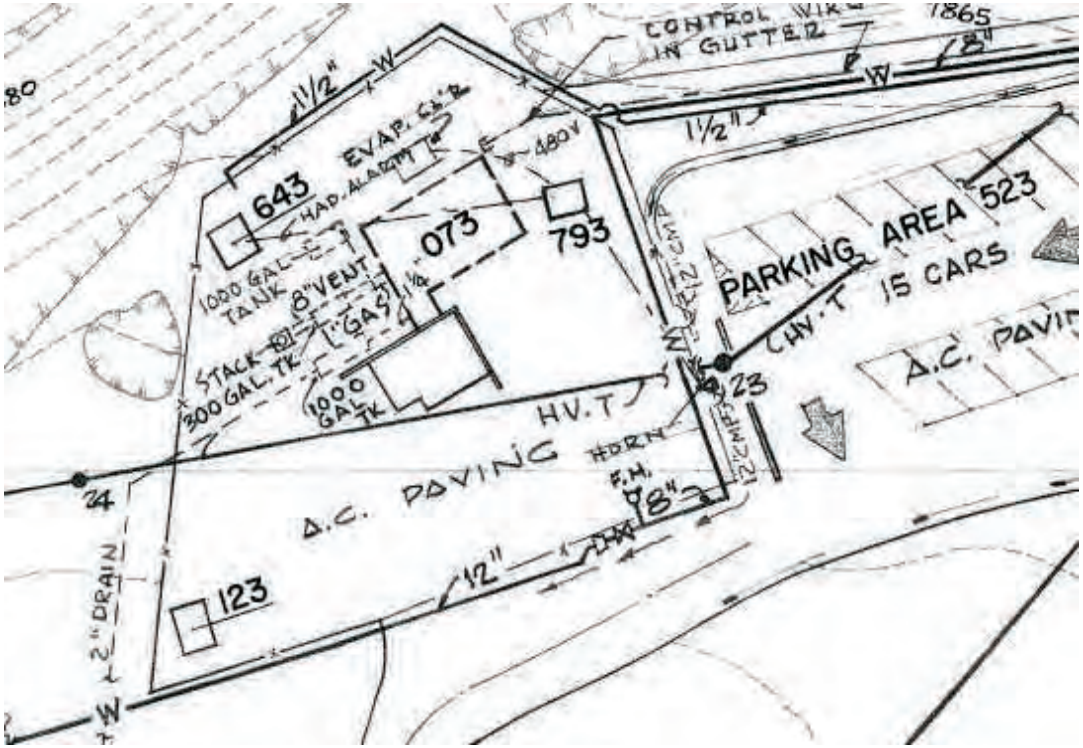
Figure 2.2.1b
Building 4073
Floor Plan



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PLOT PLAN

DRAWN	HAMMAN		DWG. SIZE E	303 - GEN. - C 38
CHECKED				
ENGINEER	R.P. HAMMAN		SCALE 1" = 40'	SHEET NO. 4 OF 14
APPROVED				

FORM N94-R-3 REV. 12-61

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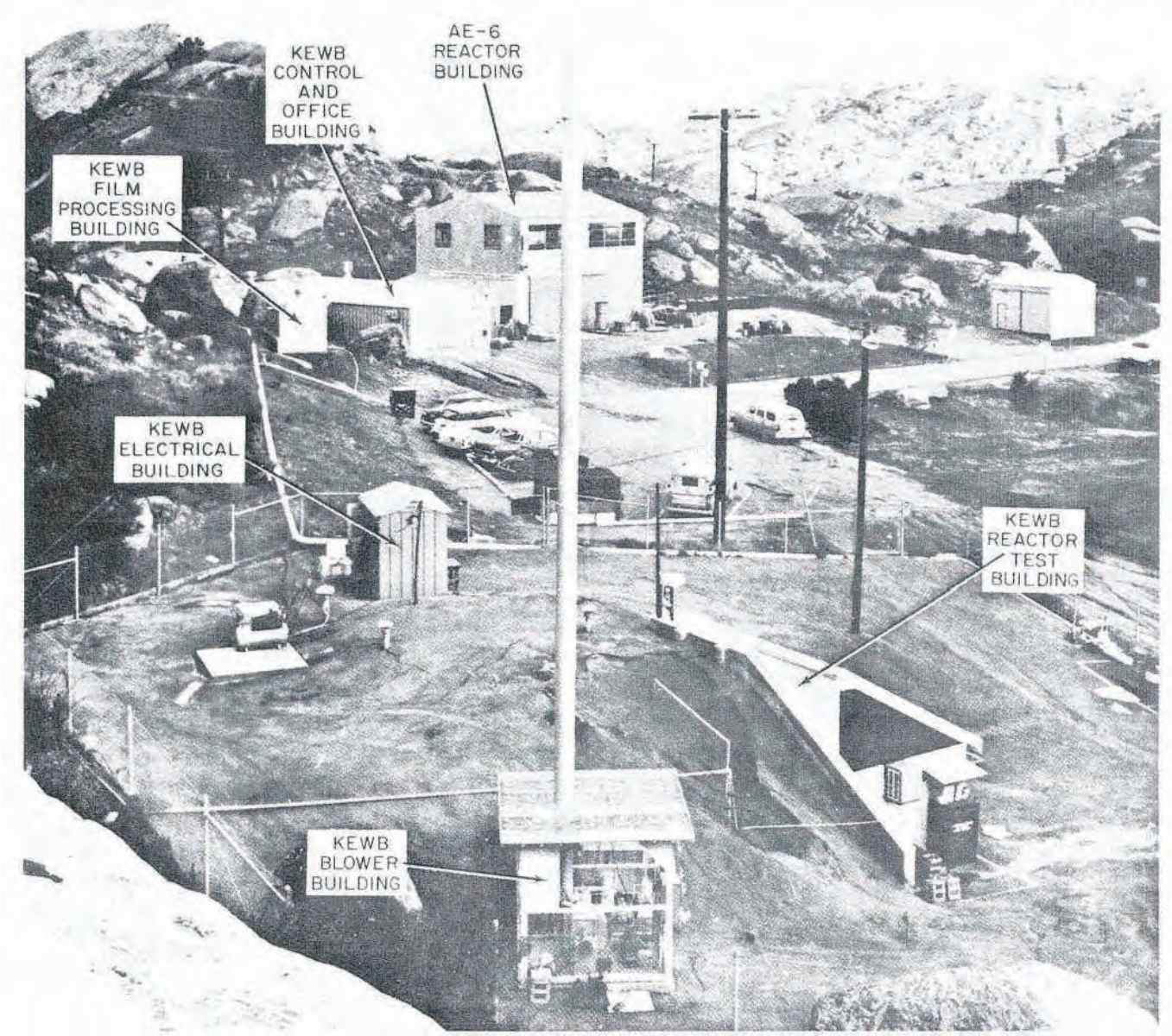
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.1c
Building 4073
Plot Plan



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Source: Boeing Company, 2008

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Figure 2.2.1d
Building 4073
KEWB Reactor
Facilities Photograph

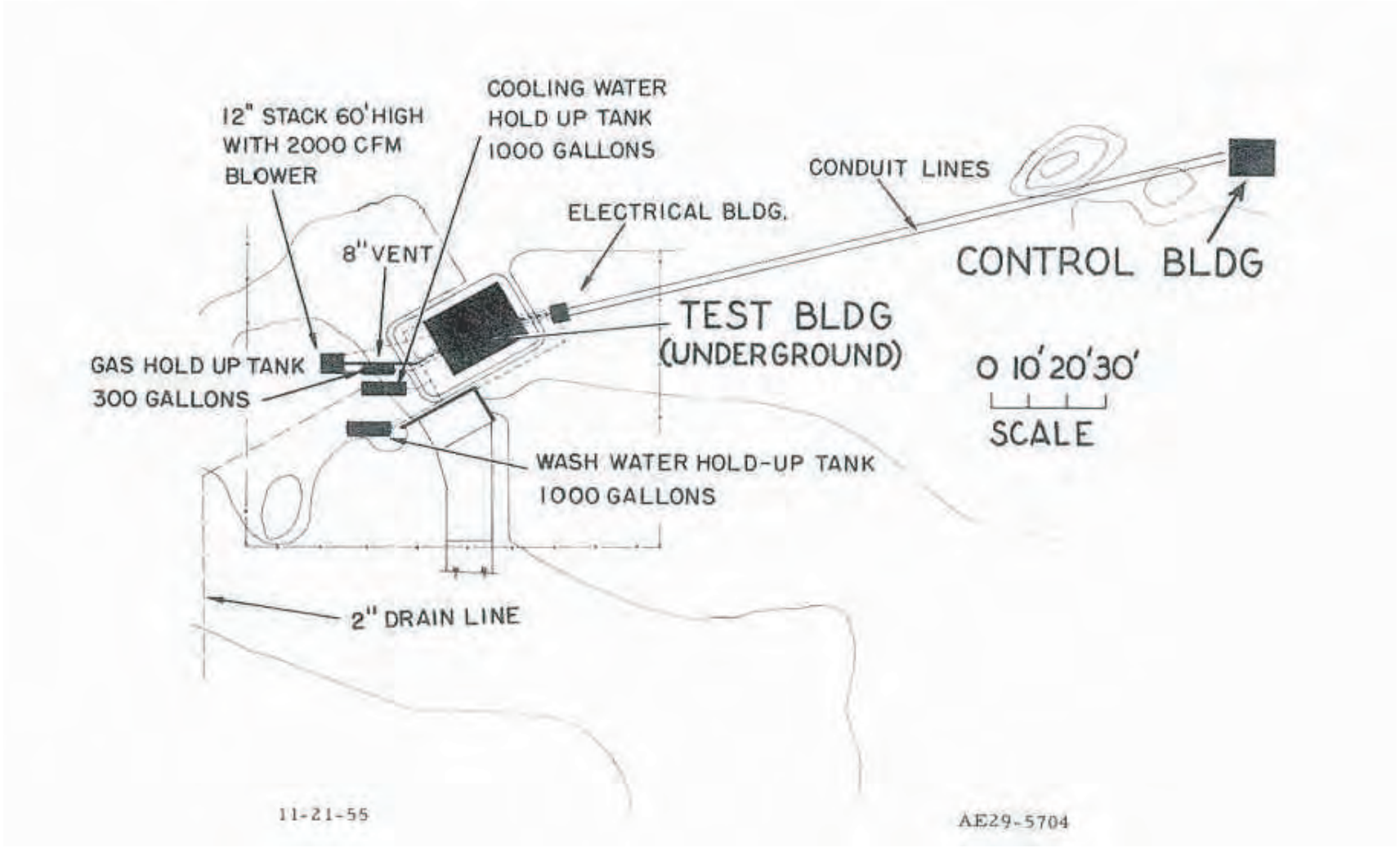

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Figure 2.2.1e
Building 4073
1955 KEWB
Support Facilities

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-1f)bldg4073BD.cdr
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Figure 2.2.1f
Building 4073
Building Demolition

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-1g)bldg4073FG.cdr
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Source: Boeing Company, 2008

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Figure 2.2.1g
Building 4073
Final Grading

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Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

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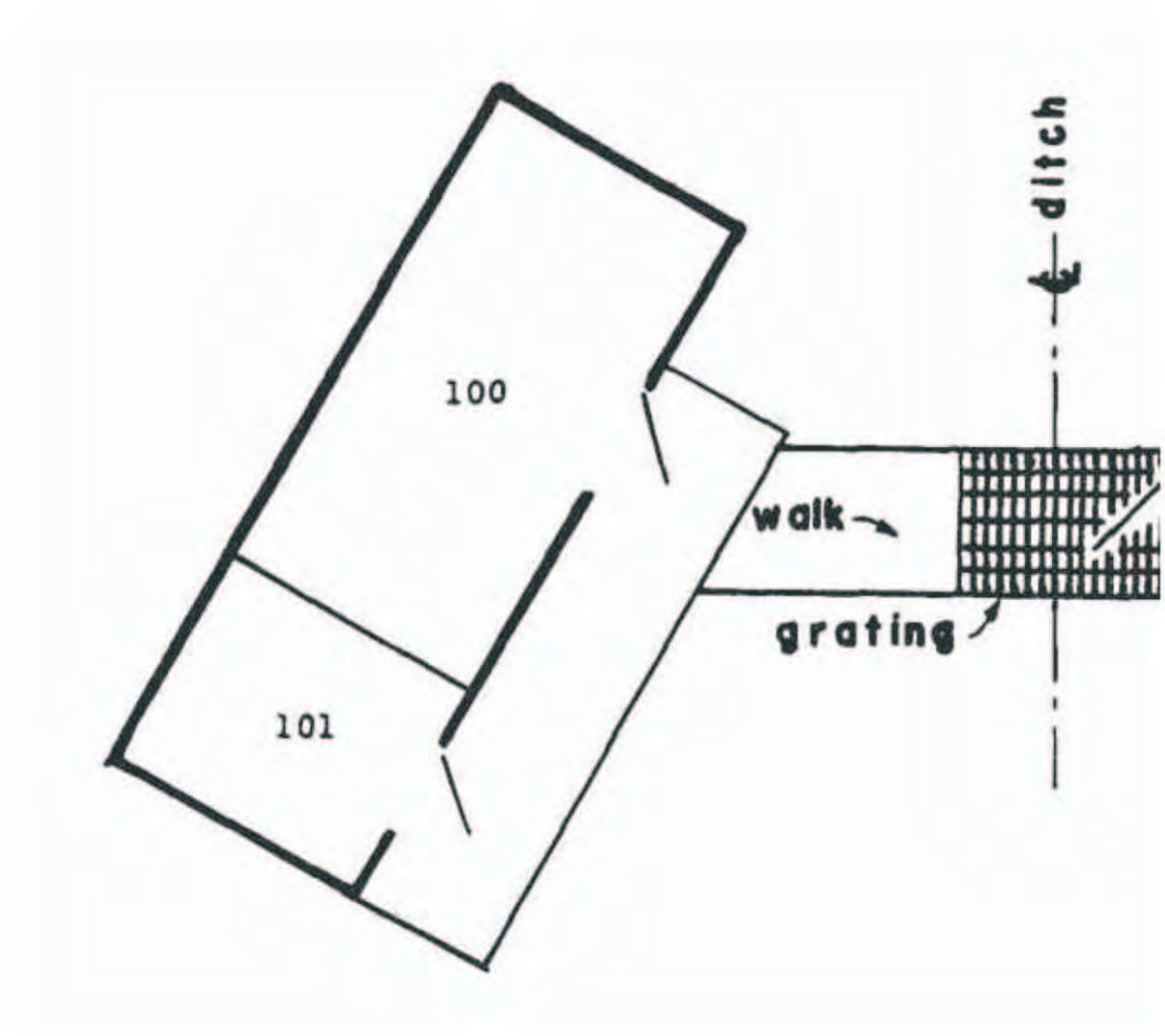
Figure 2.2.2a
Building 4074
Site Photograph



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Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

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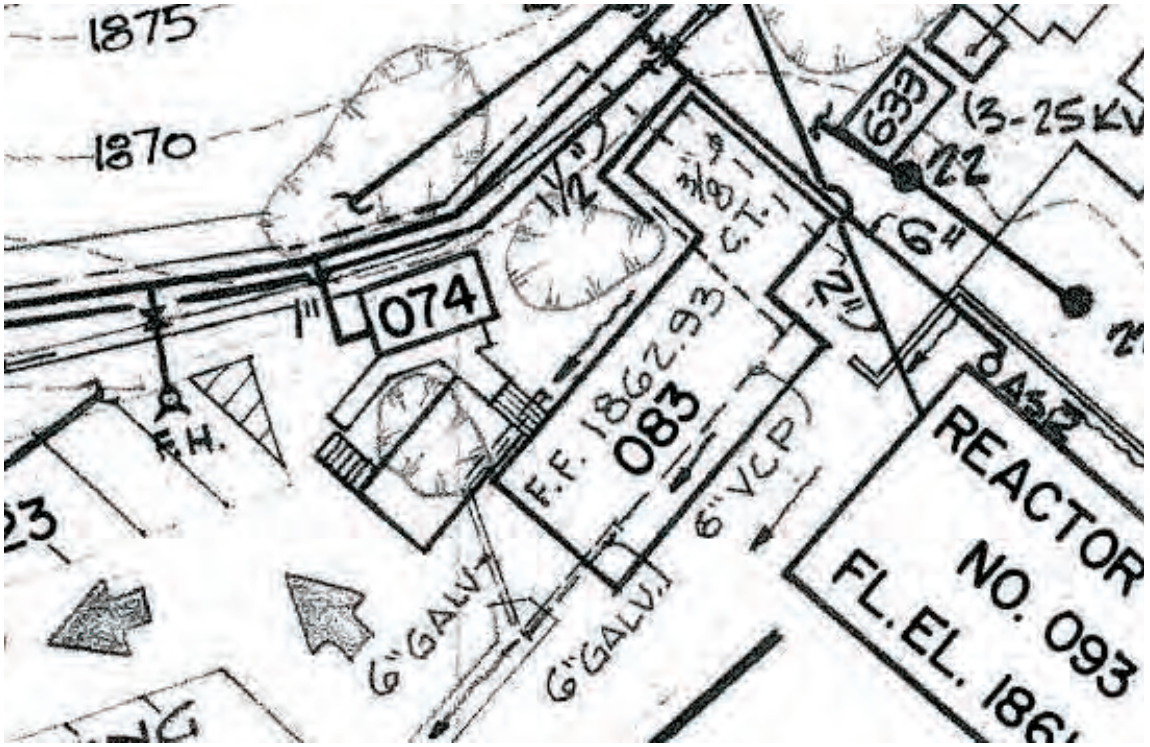
Figure 2.2.2b
Building 4074
Floor Plan



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PLOT PLAN

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CHECKED			
ENGINEER	R.P. HAMMAN	SCALE 1" = 40'	SHEET NO. 4 OF 14
APPROVED			

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Source: Boeing Company, 2008

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Figure 2.2.2c
Building 4074
Plot Plan

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Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

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Figure 2.2.3a
Building 4083
Site Photograph

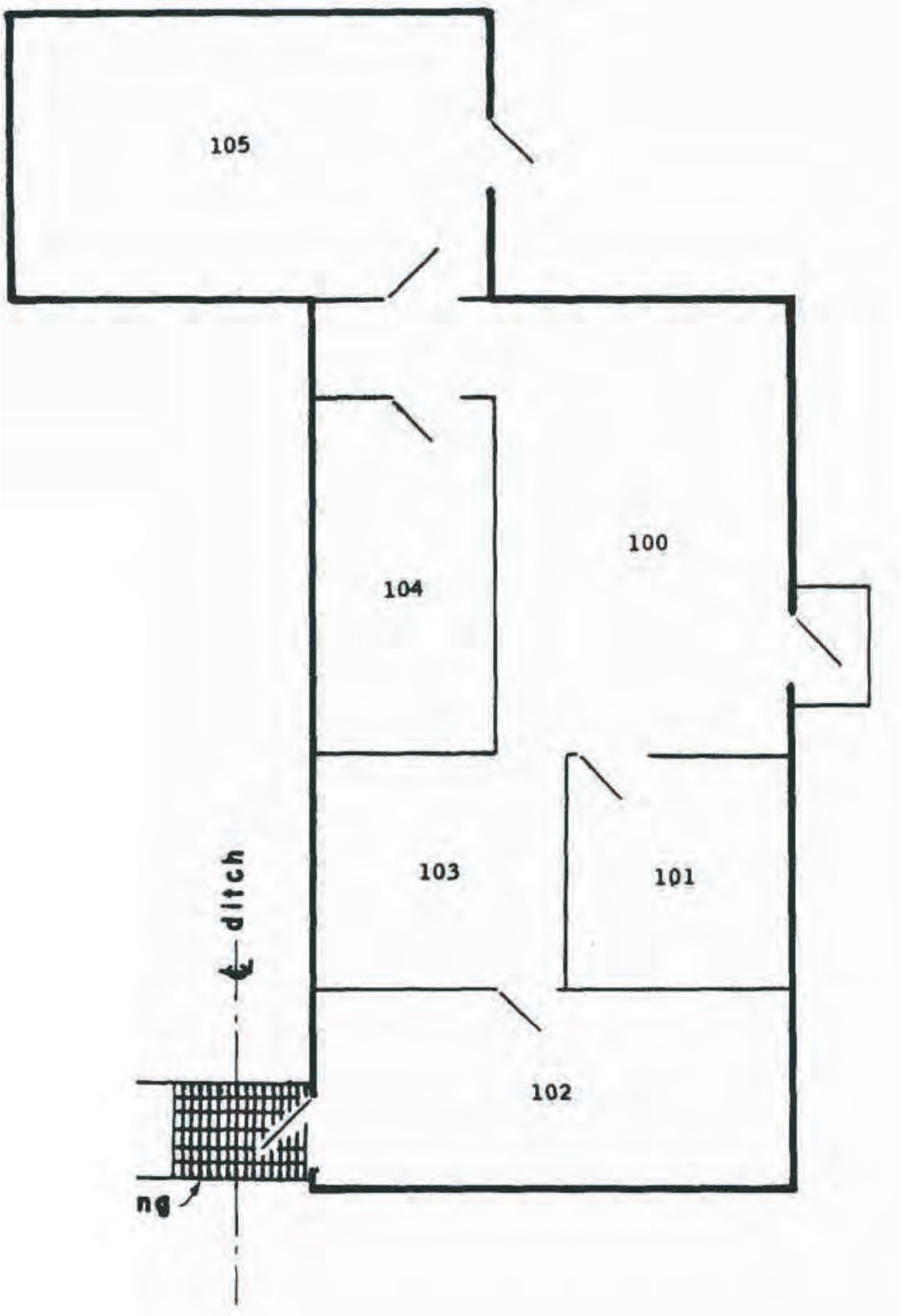

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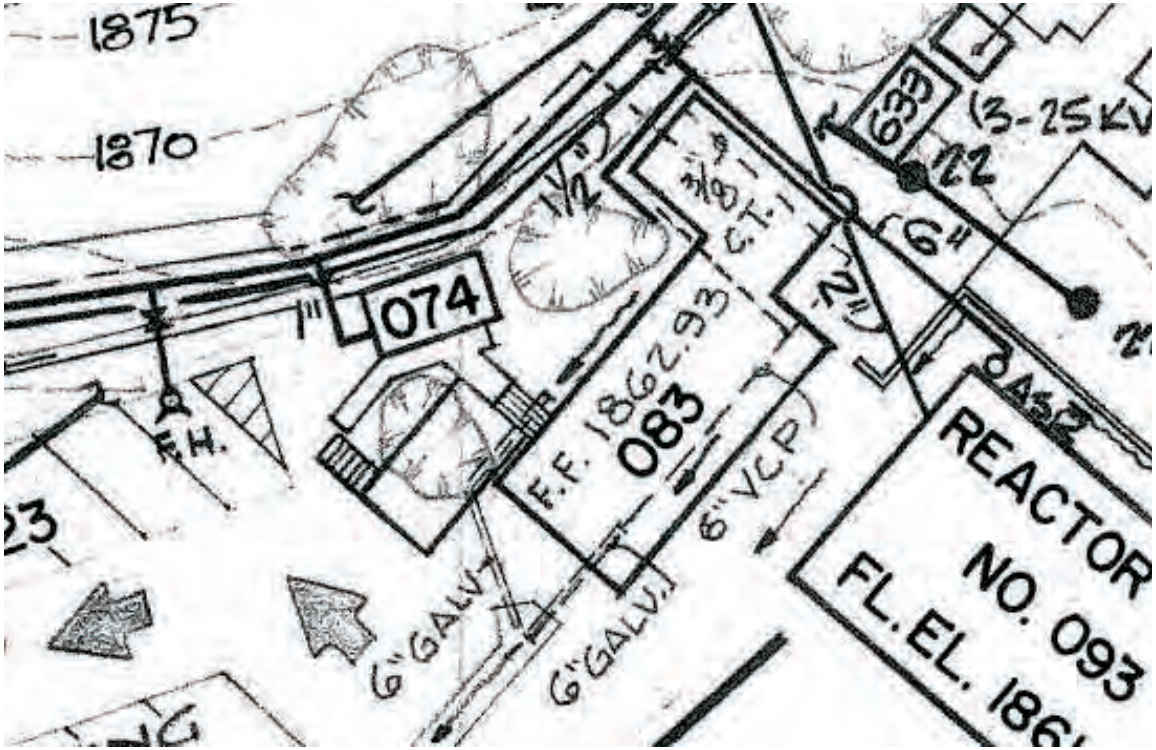
Figure 2.2.3b
Building 4083
Floor Plan



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SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN	DWG. SIZE E	303 - GEN. - C 38
CHECKED			
ENGINEER	R.P. HAMMAN	SCALE 1" = 40'	SHEET NO. 4 OF 14
APPROVED			

FORM N94-R-3 REV. 12-61

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-3c)bldg4083PP.cdr
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.3c
Building 4083
Plot Plan

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-4a)bldg4093AP.cdr
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.4a
Building 4093
Site Photograph

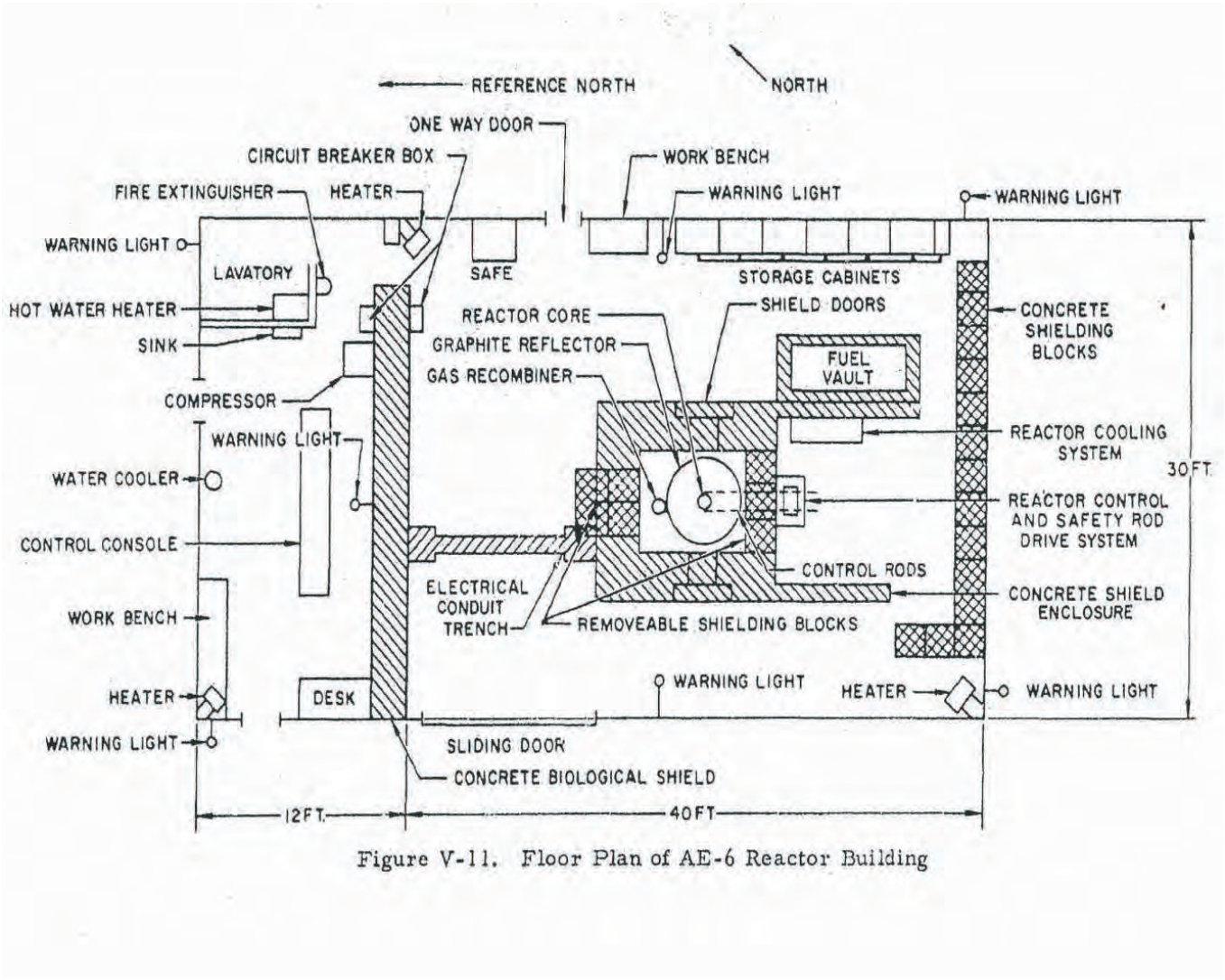


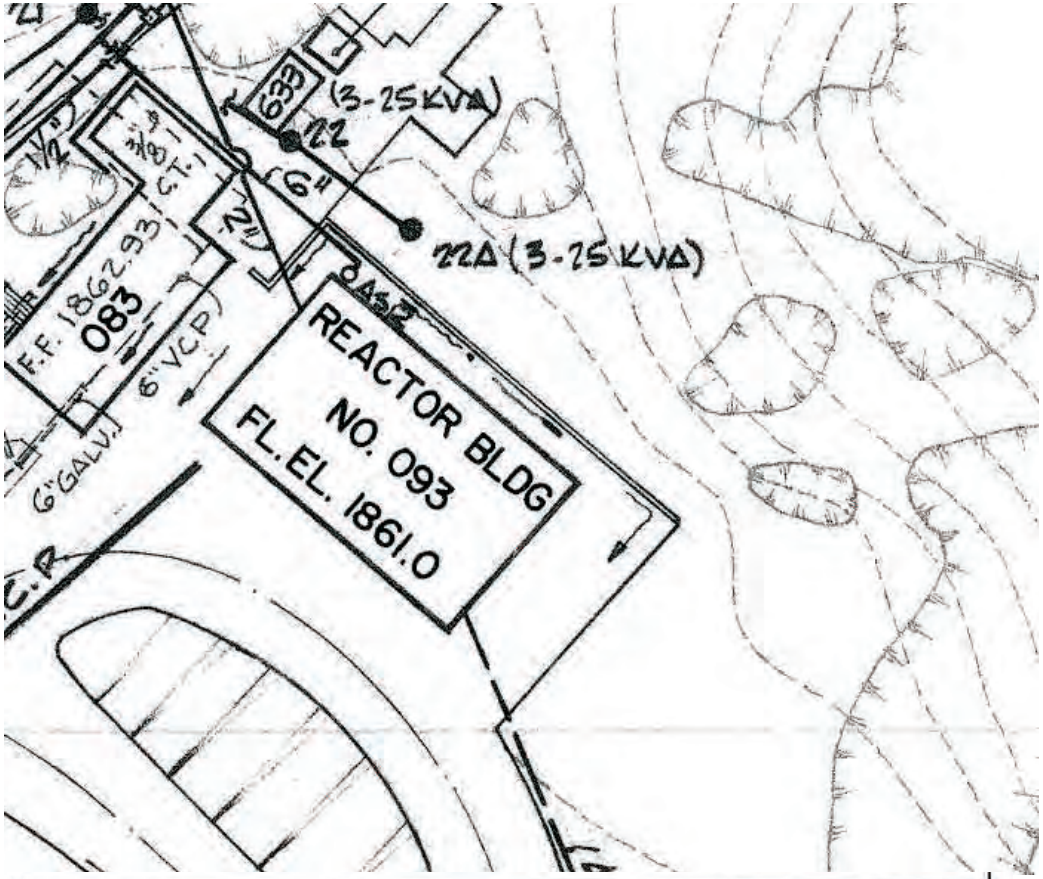
Figure V-11. Floor Plan of AE-6 Reactor Building

Figure not to Scale

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-4b)bldg_4093FP.cdr
Project:EP9038
Revised: 08/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.4b
Building 4093
Floor Plan



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SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN		DWG. SIZE E	303 - GEN. - C 38
CHECKED				
ENGINEER	R.P. HAMMAN		SCALE 1" = 40'	SHEET NO. 4 OF 14
APPROVED				

FORM N94-R-3 REV. 12-61

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-4c)bldg4093PP.cdr
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

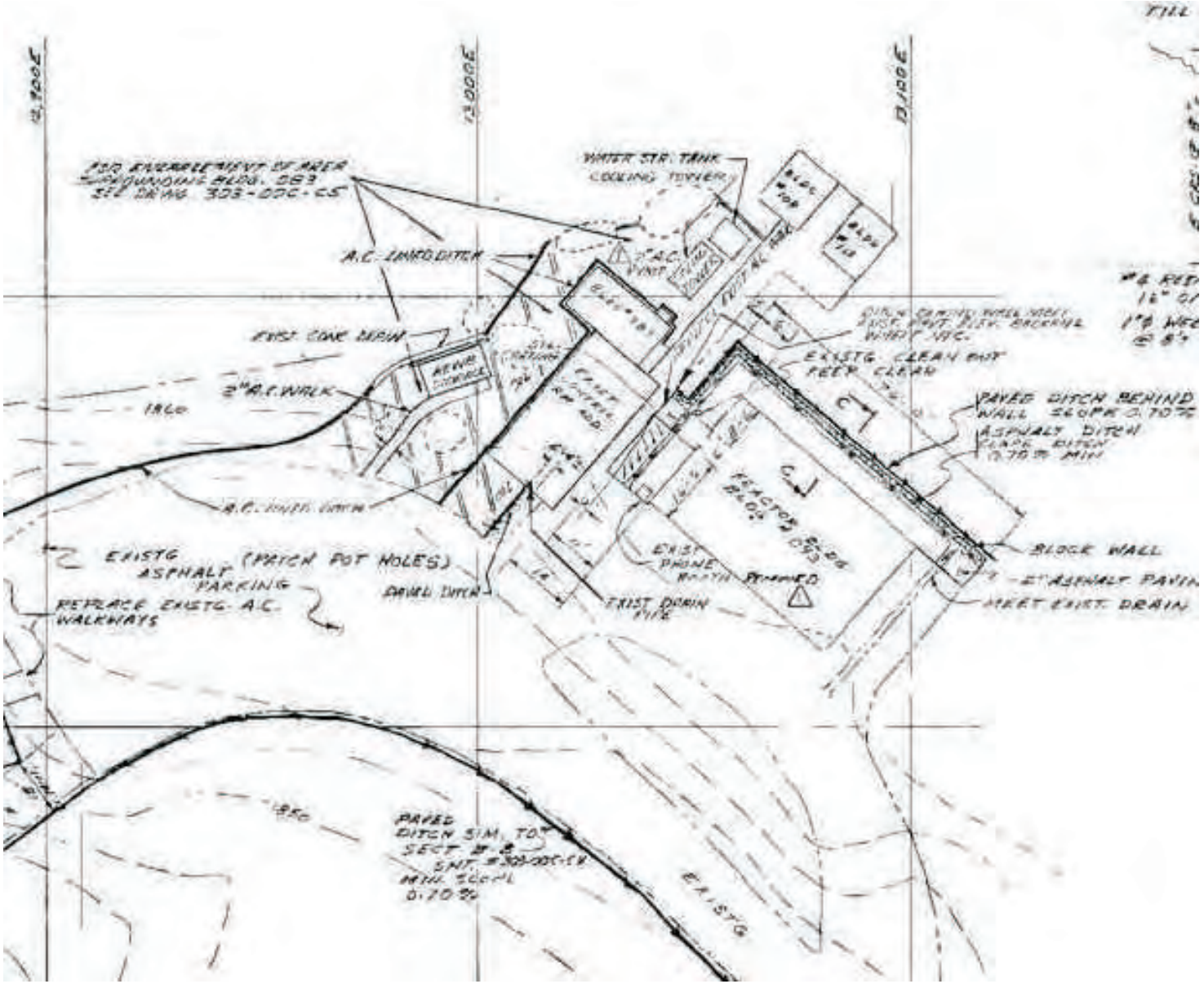
U.S. EPA Region 9

Figure 2.2.4c
Building 4093
Plot Plan

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-4d)bldg4093BP.cdr
Project:EP9038
Revised: 10/05/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.4d
Building 4093
1960 Building Photograph



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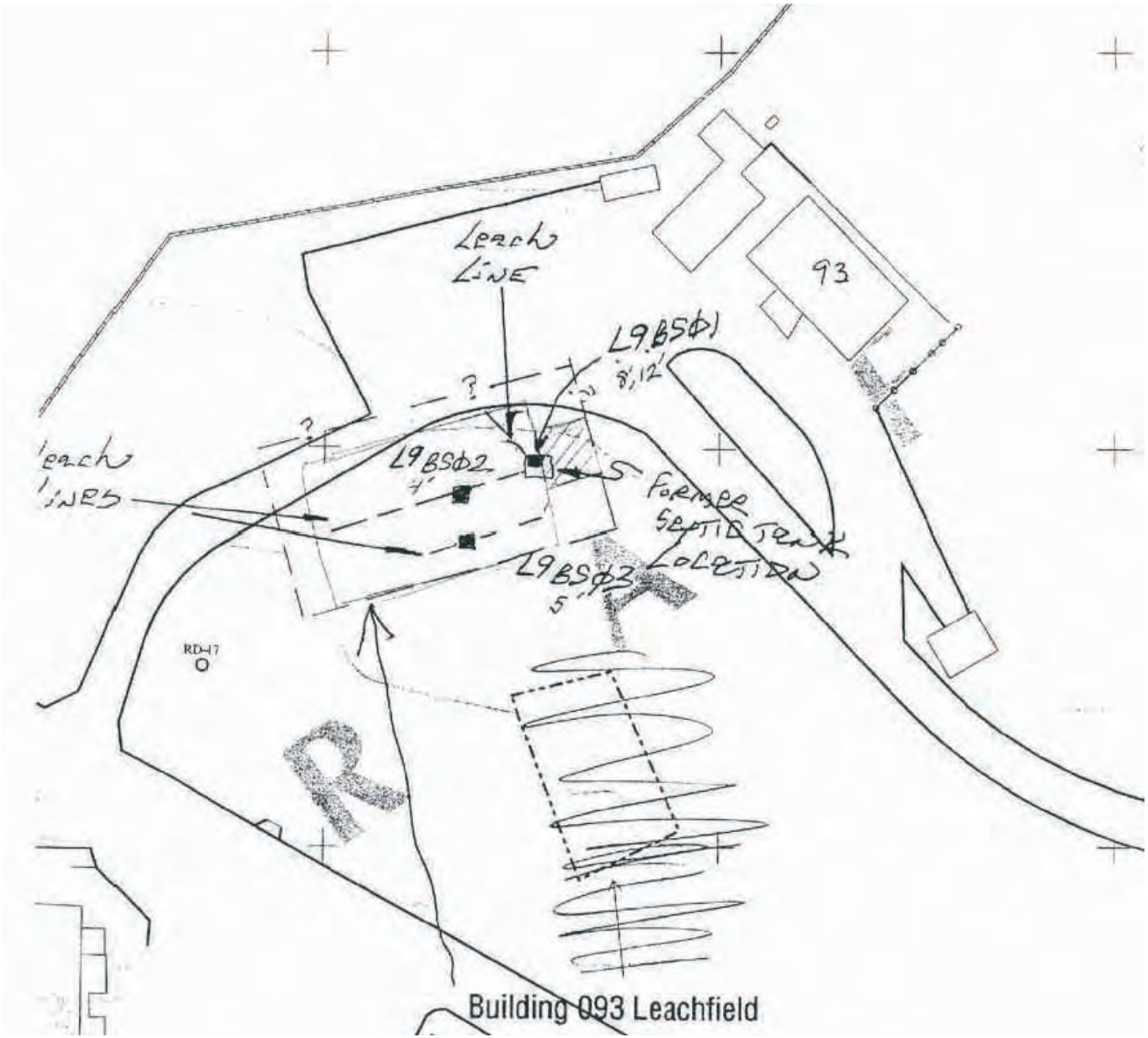
Revised: 10/05/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.4e
Building 4093
Drainage
Improvement



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Project:EP9038
Revised: 10/05/2010 TJ
Source: Boeing Company, 2008

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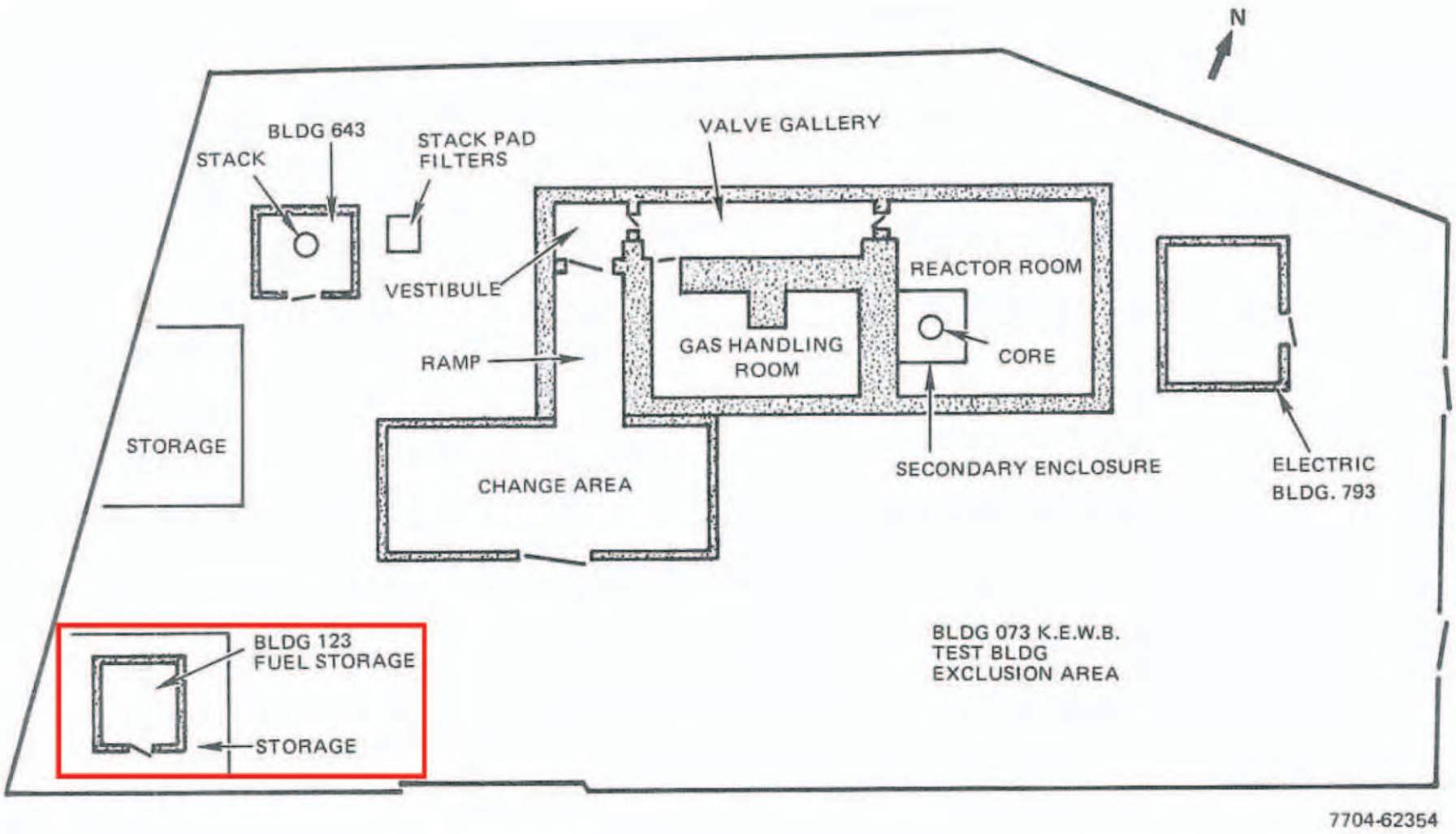
Figure 2.2.4f
Building 4093
Leachfield
Location

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-5a)bldg4123AP.cdr
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.5a
Building 4123
Site Photograph



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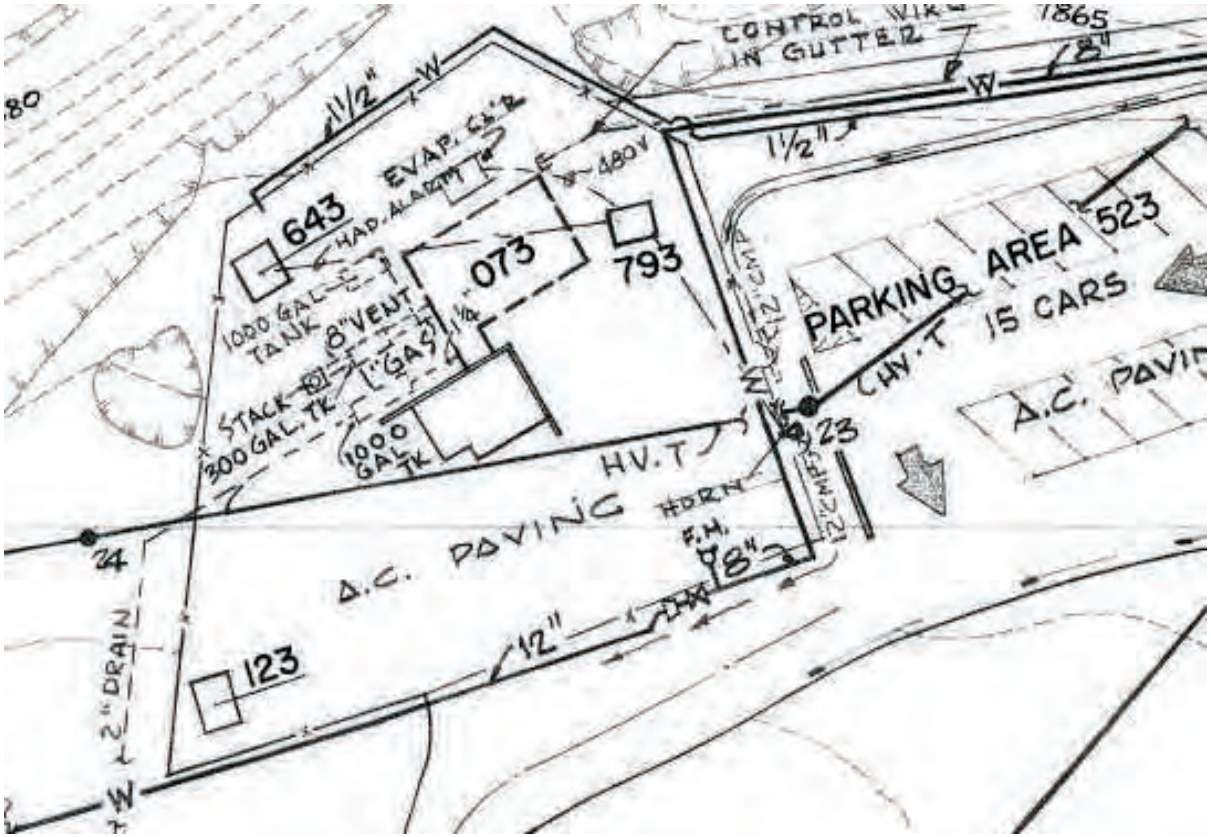
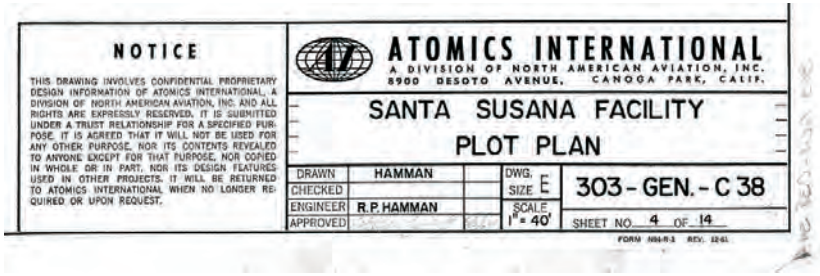
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.5b
Building 4123
Floor Plan





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Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.5c
Building 4123
Plot Plan

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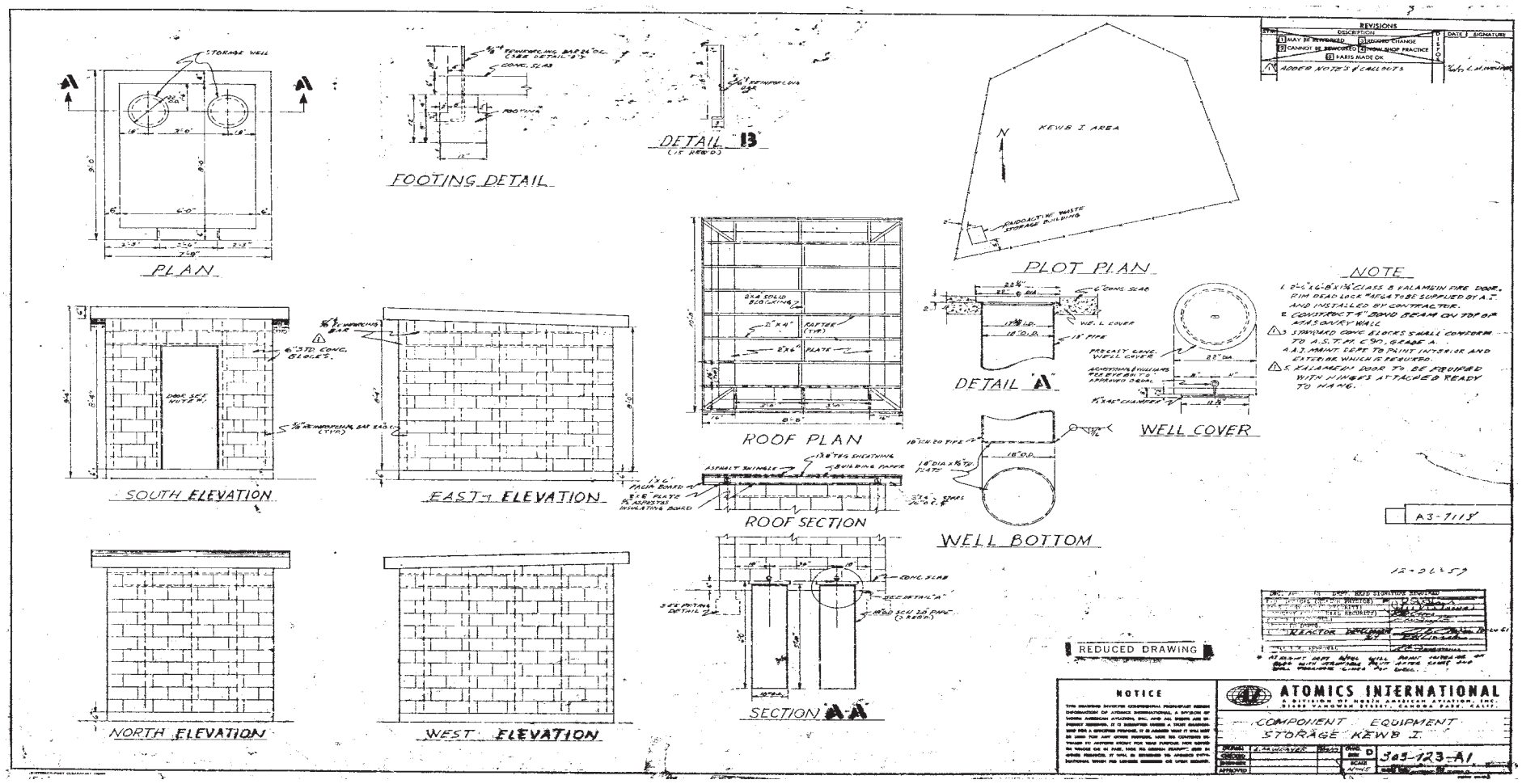
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.5d
Building 4123
Demolition
Photograph



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Project:EP9038
Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

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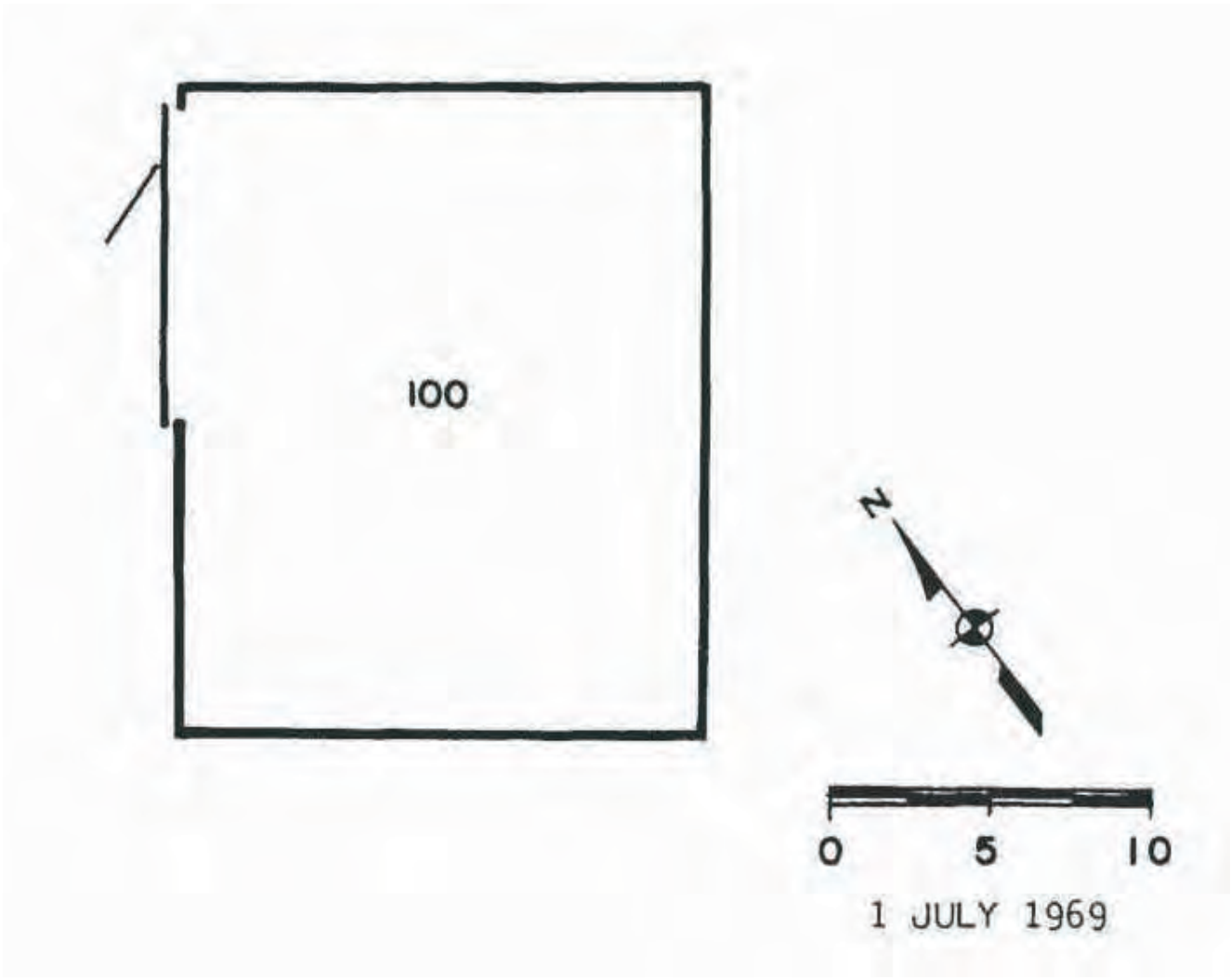
Figure 2.2.5e
Building 4123
Building Layout

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-6a)bldg4453AP.cdr
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.6a
Building 4453
Site Photograph



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Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

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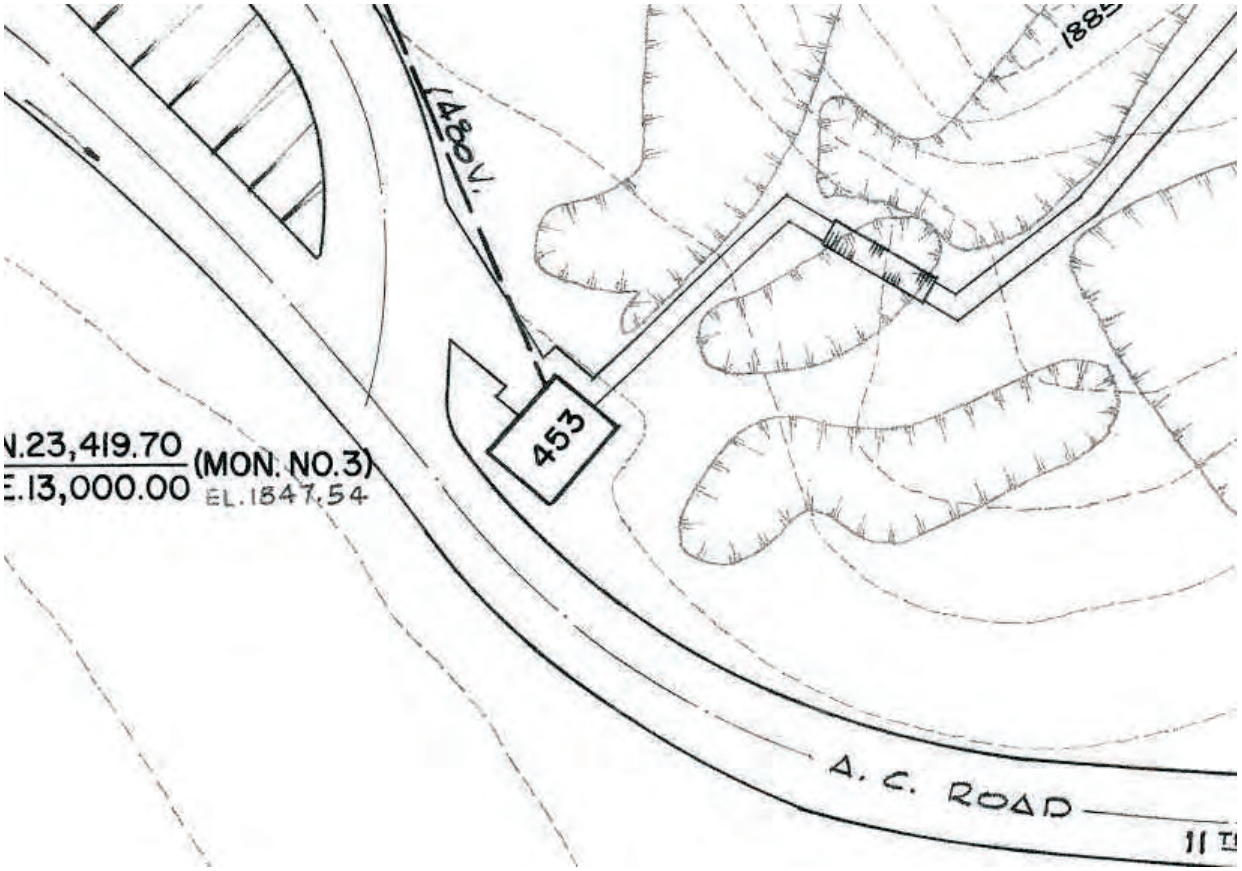
Figure 2.2.6b
Building 4453
Floor Plan



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SANTA SUSANA FACILITY
PLOT PLAN

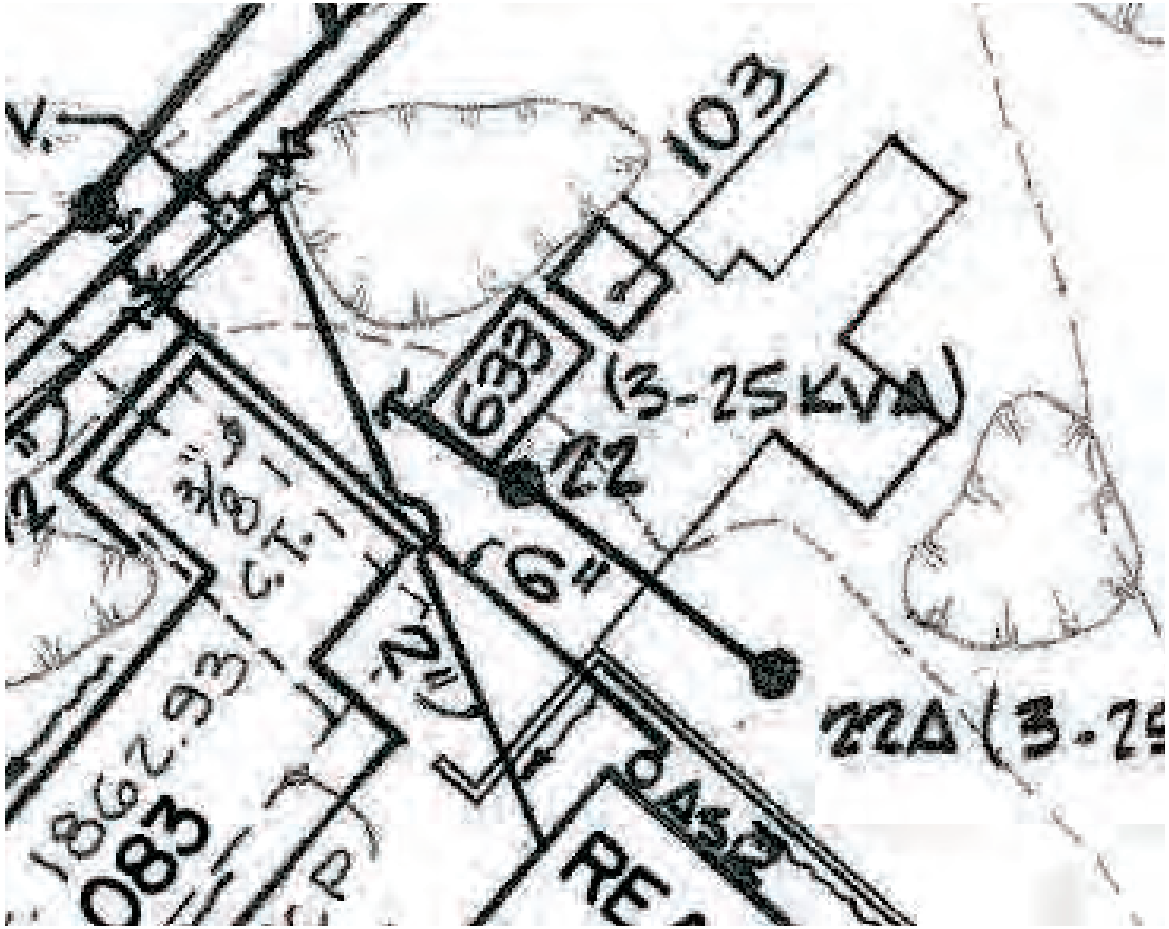
DRAWN	HAMMAN		DWG. SIZE E	303 - GEN. - C 38
CHECKED				
ENGINEER	R.P. HAMMAN		SCALE 1" = 40'	SHEET NO. 4 OF 14
APPROVED				

FORM N91-R-3 REV. 12-61

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-6c)bldg4453PP.cdr
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.6c
Building 4453
Plot Plan



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Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

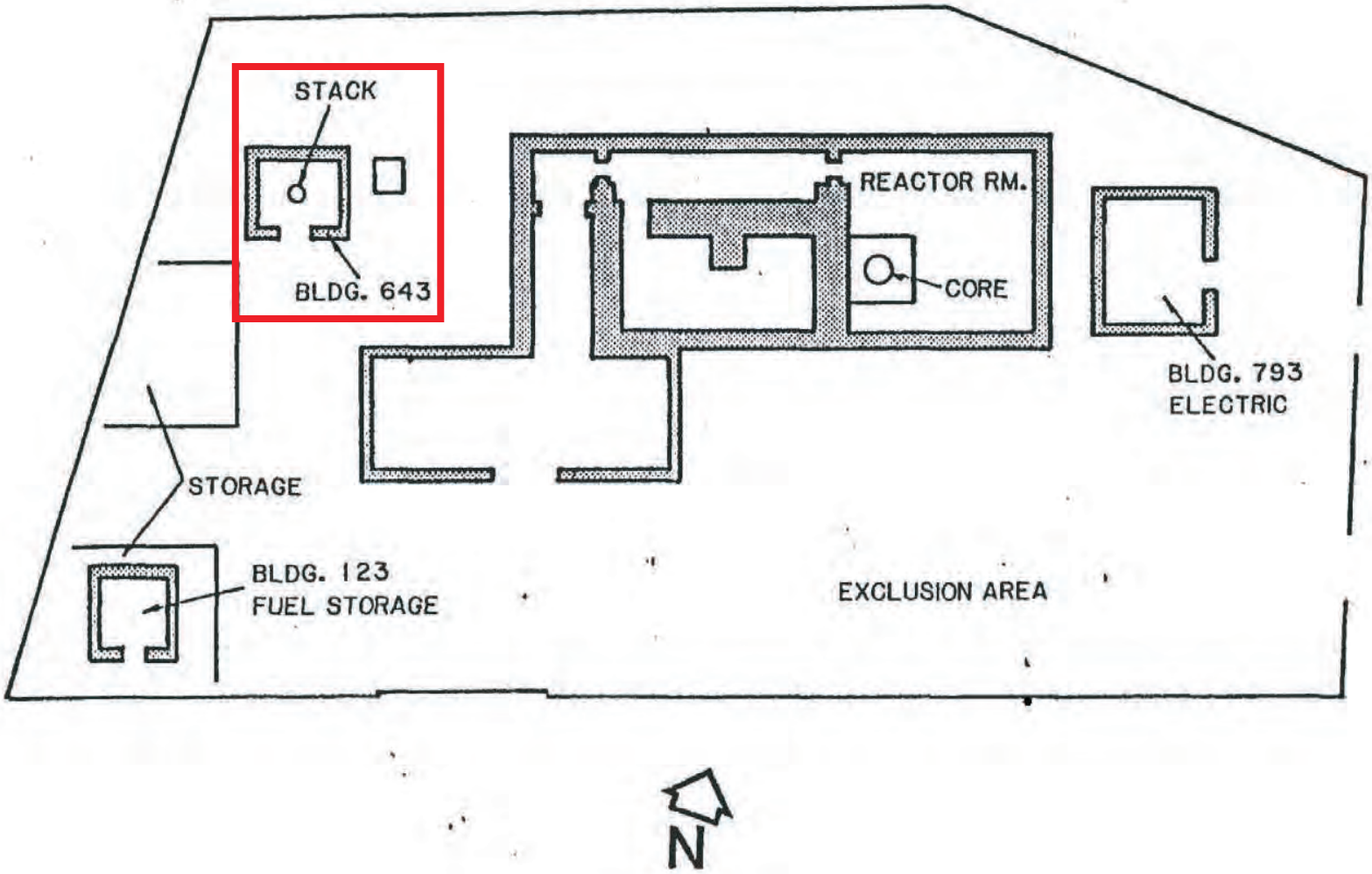
U.S. EPA Region 9

Figure 2.2.7a
Site 4633
Plot Plan

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-8a)bldg4643AP.cdr
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.8a
Building 4643
Site Photograph



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Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

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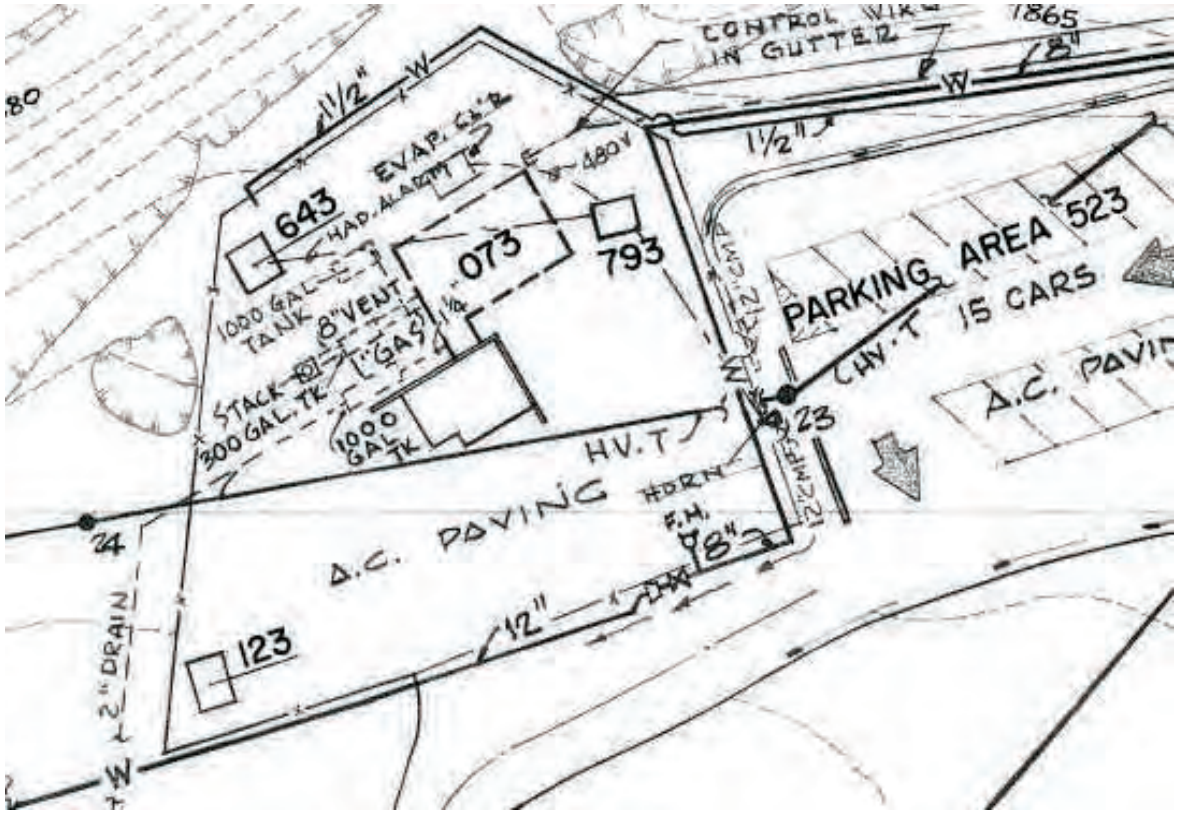
Figure 2.2.8b
Building 4453
Floor Plan



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Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

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Figure 2.2.8c
Building 4643
Plot Plan

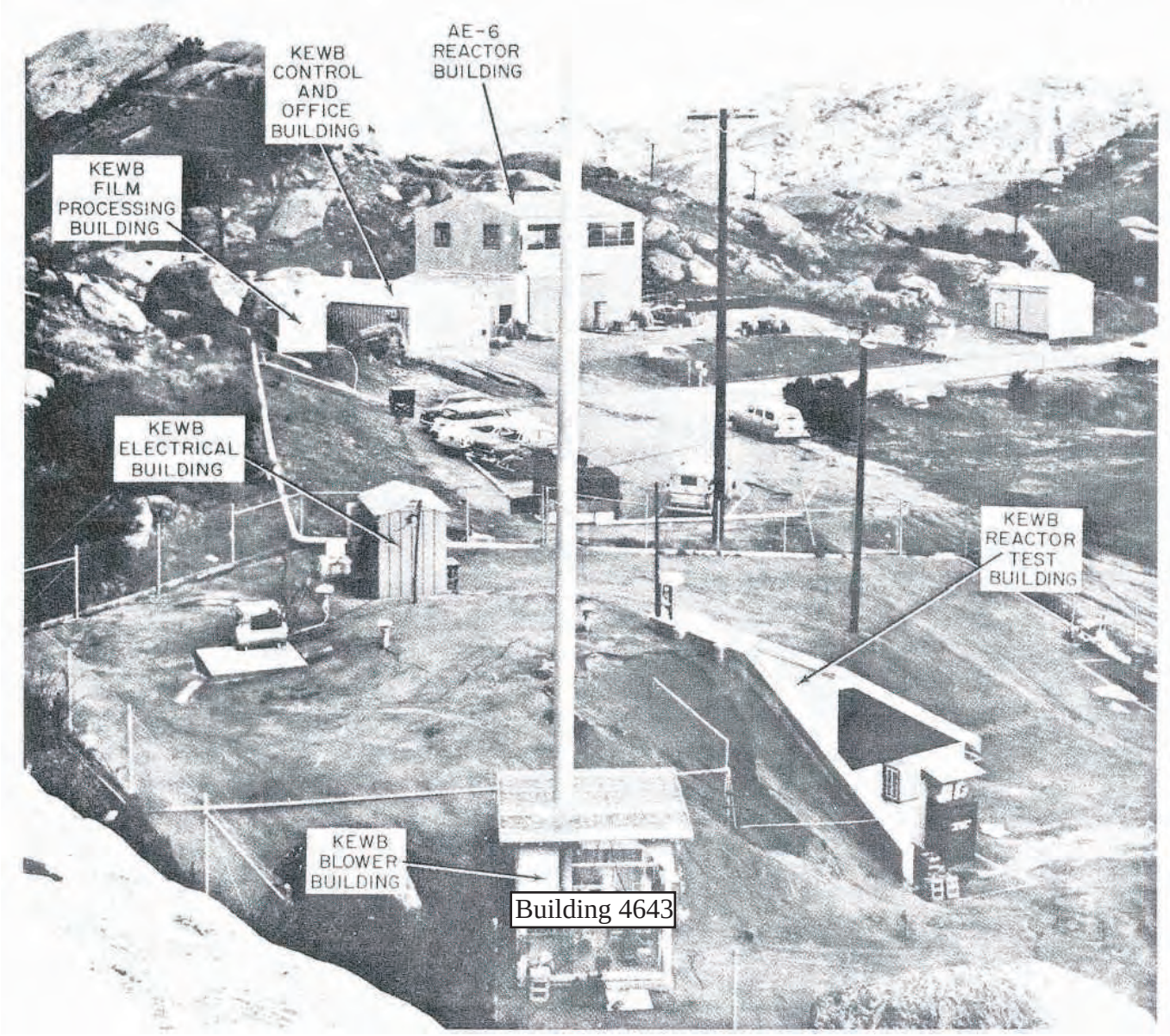

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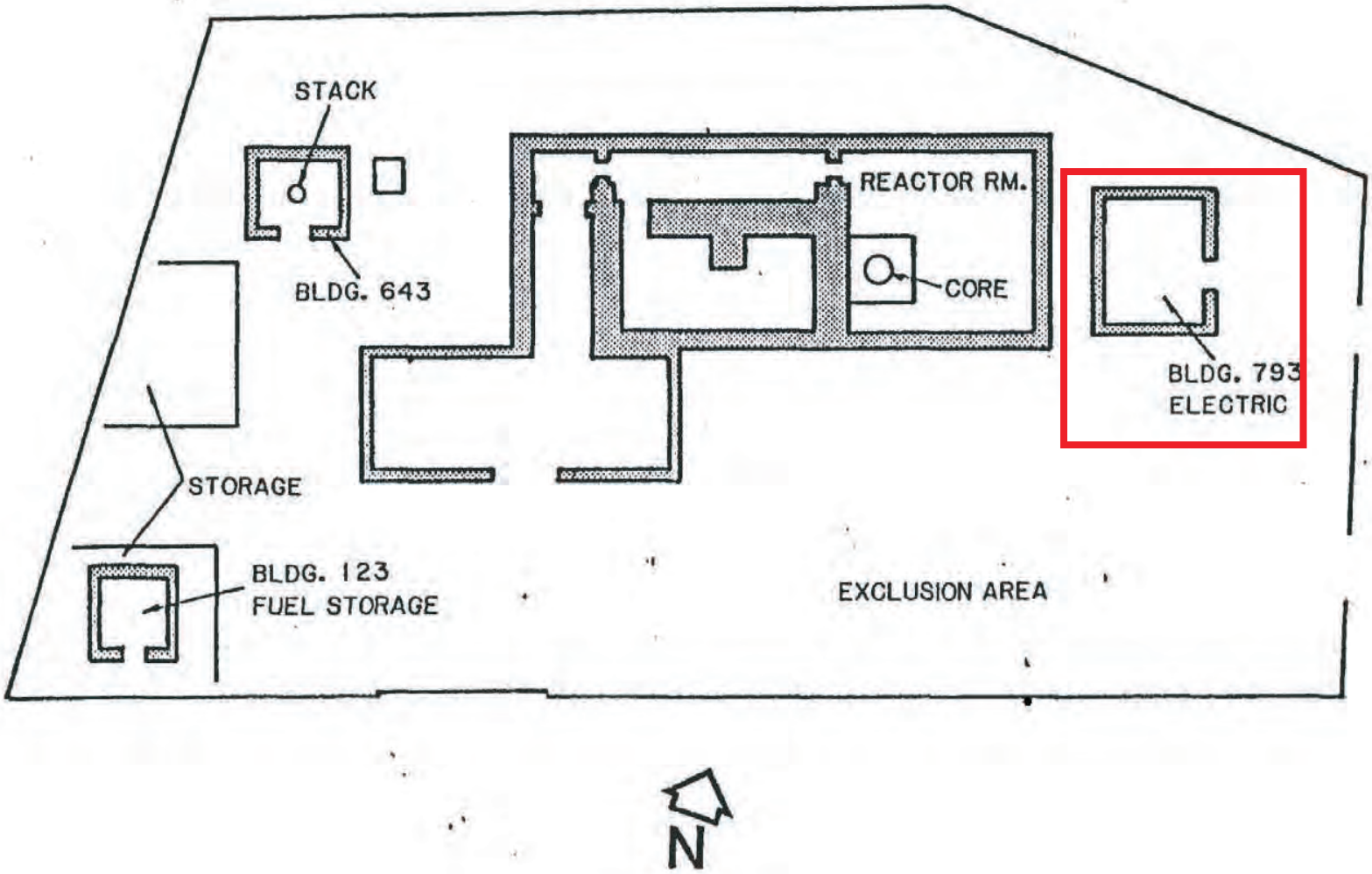
Figure 2.2.8d
Building 4643
KEWB Reactor Facilities Photograph

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-2-9a)bldg4793AP.cdr
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.9a
Building 4793
Site Photograph



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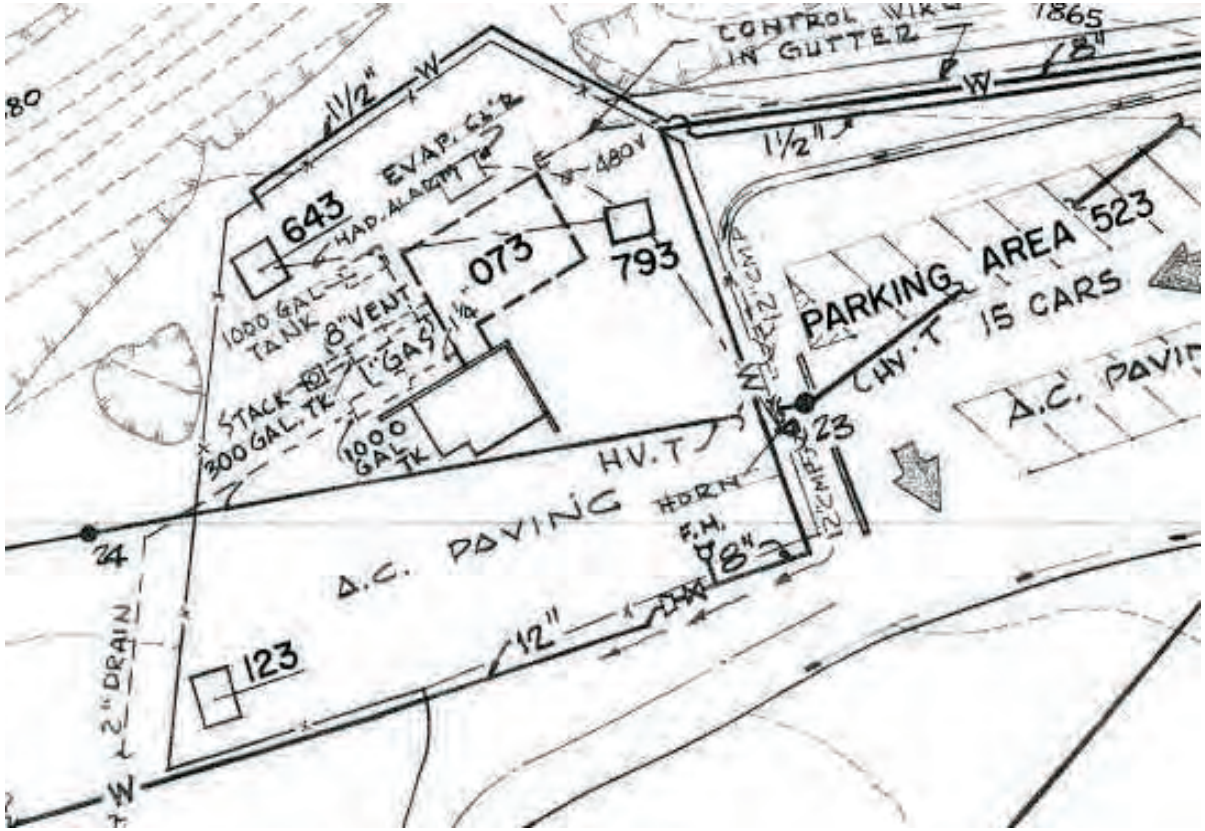
Project:EP9038
Revised: 10/19/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.9b
Building 4793
Floor Plan



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SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN		DWG. SIZE E	303 - GEN. - C 38
CHECKED				
ENGINEER	R.P. HAMMAN		SCALE 1" = 40'	
APPROVED				SHEET NO. 4 OF 14

FORM N94-R-3 REV. 12-61

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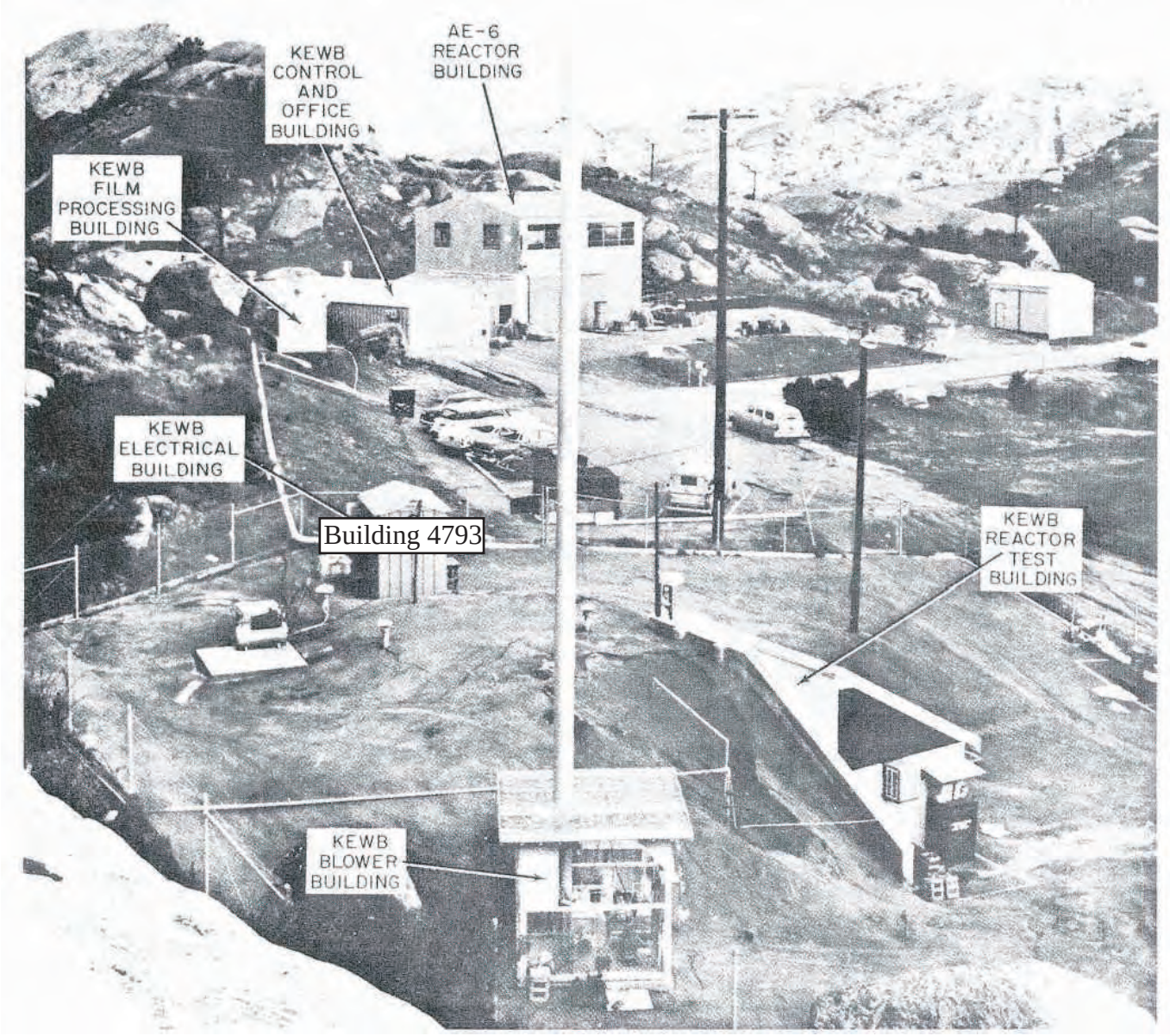
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.2.9c
Building 4793
Plot Plan



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Project:EP9038
Revised: 08/23/2010 TJ
Source: Boeing Company, 2008

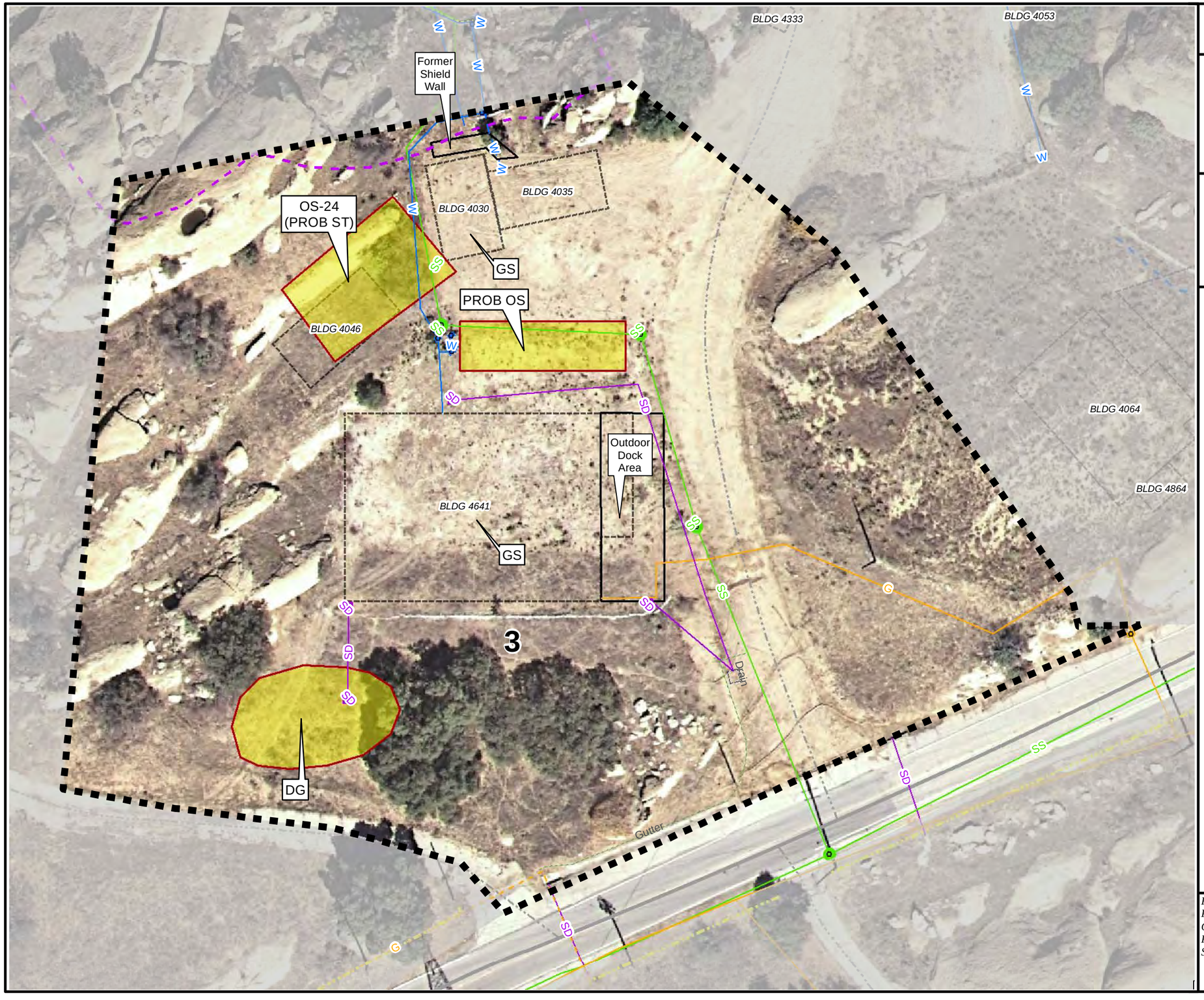
U.S. EPA Region 9

Figure 2.2.9d
Building 4793
KEWB Reactor Facilities Photograph

Historical Site Assessment
Final Technical Memorandum - HSA-5A

Figure 2.3
Area IV Subarea 5A-3
Santa Susana Field Laboratory

U.S. EPA Region 9



Legend

- Subarea 5A-3 Boundary
- Primary Roads
- Secondary Roads
- Underground Storage Tank
- Unknown Tank Type
- Sump
- Dry Well
- Tank Footprint
- Above ground Storage Tank
- Demolished Bldg.
- Existing Bldg.
- Parking Lots
- Drainage
- Drain
- Well

Aerial Photo Features
- Aerial Photography Features
- Leach Field
- Other

Surface Water
- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel
- French Drain
- Drainage
- Leach Field
- Septic System

Utilities
- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well
- Gas
- Storm Drain
- Sanitary Sewer
- Water

B	Building
CONT	Container
CR	Crates
DB	Debris
DG	Disturbed Ground
DTM	Dark Tone Material
EX	Excavation
FA	Fill Area
GS	Ground Scar
HT	Horizontal Tank
IM	Impoundment
MTMM	Medium Toned Mounded Material
OS	Open Storage
PA	Processing Area
PL	Parking Lot
POSS	Possible
PROB	Probable
S-T	Storage Tank
SS	Smoke Stack
ST	Storage
UO	Unidentified Object
VT	Vertical Tank
WDA	Waste Disposal Area

N

0 25 50 100
Scale In Feet

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Project: EP9038
Created: TJansen
Revised: 10/19/2010 TJ
Sorce: Boeing Company, 2008
CIRGIS, 2007

HydroGeoLogic, Inc

Redacted

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Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

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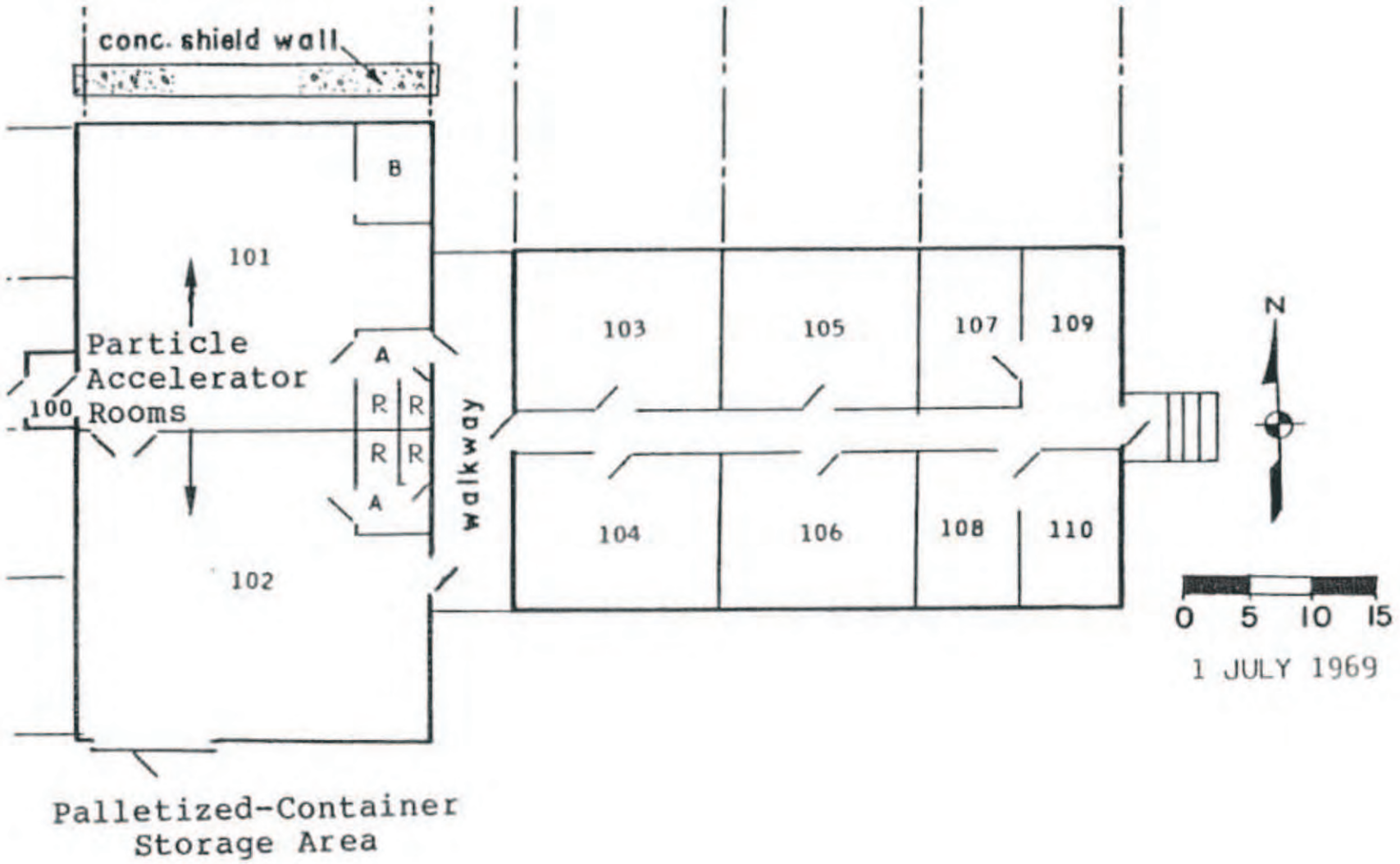
Figure 2.3.1a
Building 4030
Site Photograph



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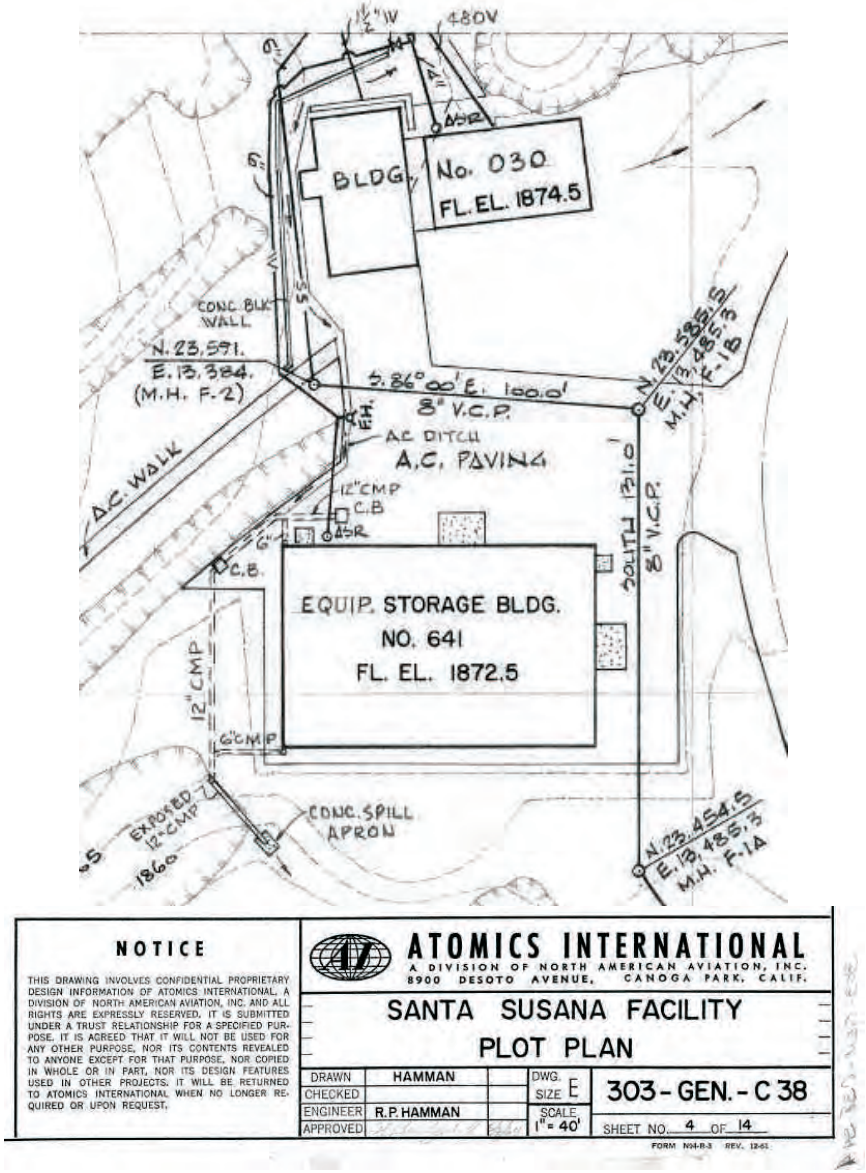
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.3.1b
Building 4030
Floor Plan



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Project:EP9038
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Figure 2.3.1c
Building 4030
Plot Plan

Pre-Demolition

Post-Demolition

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-3-1d)bldg4030PDP.cdr
Project:EP9038
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Figure 2.3.1d
Building 4030
Pre- and Post-Demolition Photograph

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Project:EP9038
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Source: Boeing Company, 2008

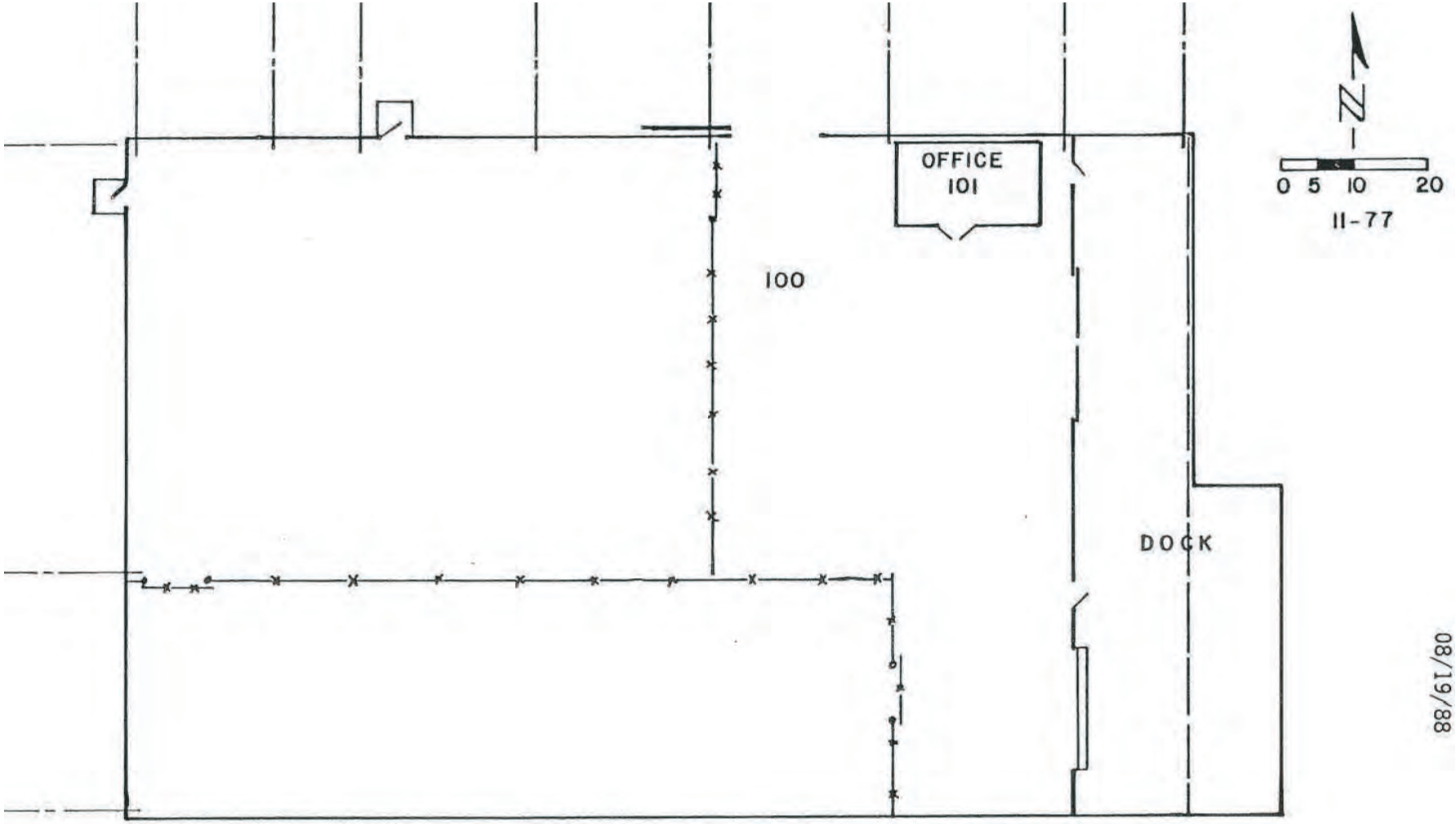
U.S. EPA Region 9

Figure 2.3.2a
Building 4046
Site Photograph

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-3-3a)bldg4641AP.cdr
Project:EP9038
Revised: 10/19/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.3.3a
Building 4641
Site Photograph



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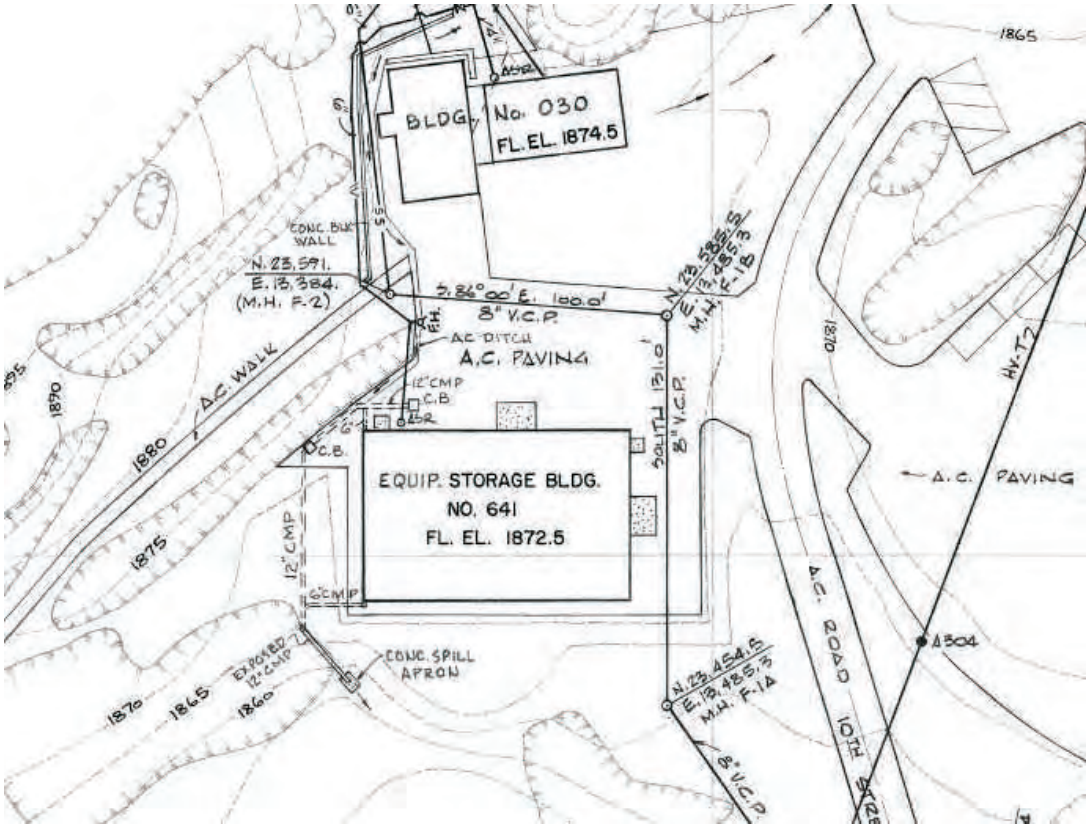
Project:EP9038
Revised: 10/19/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.3.3b
Building 4641
Floor Plan



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PLOT PLAN

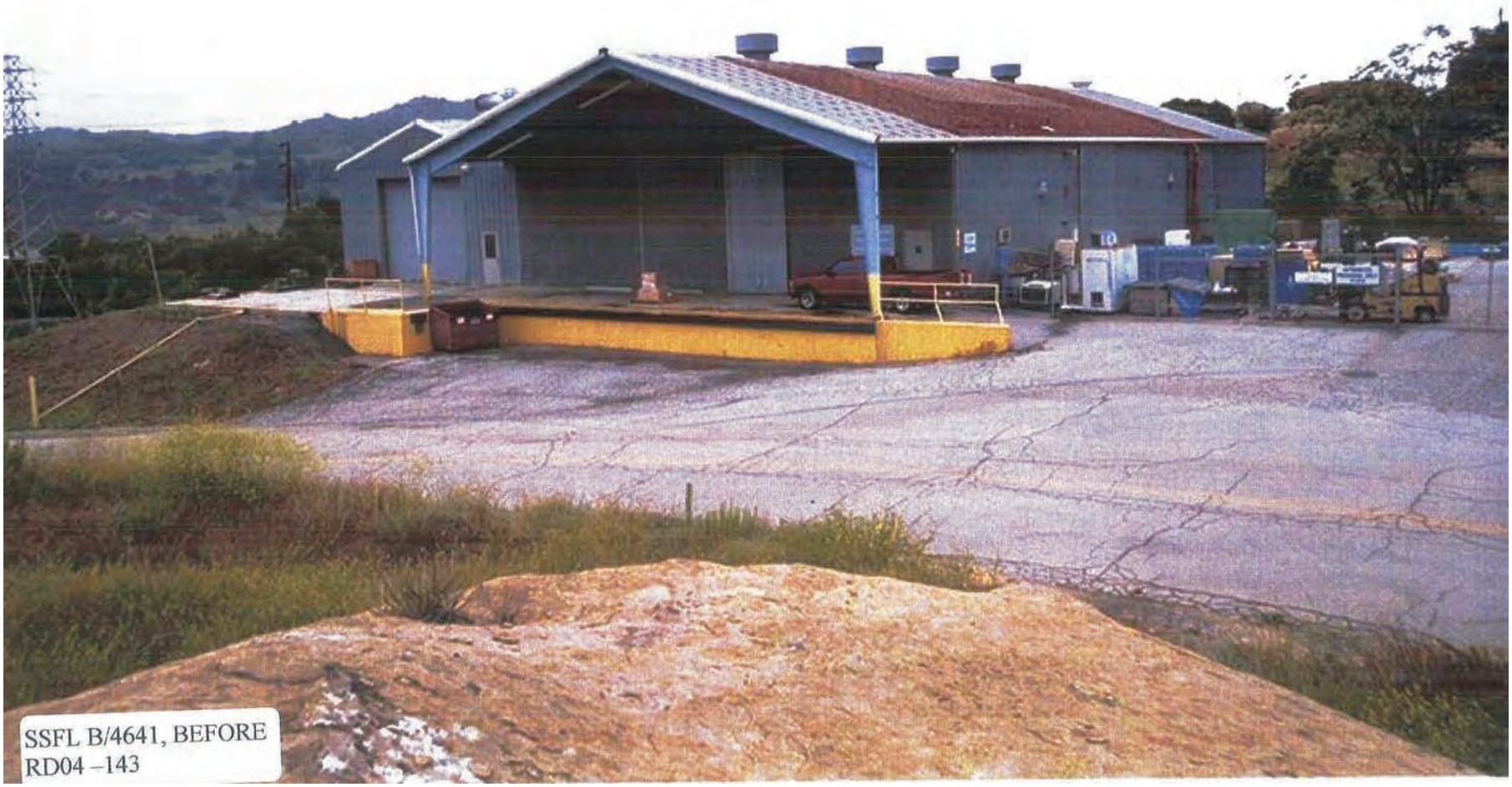
DRAWN	HAMMAN		DWG. SIZE E	303 - GEN. - C 38
CHECKED				
ENGINEER	R.P. HAMMAN		SCALE 1" = 40'	SHEET NO. 4 OF 14
APPROVED				

FORM N94-R-3 REV. 12-61

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-3-3c)bldg4641PP.cdr
Project:EP9038
Revised: 10/19/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.3.3c
Building 4641
Plot Plan



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Project:EP9038
Revised: 10/19/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.3.3d
Building 4641
Building Photograph

Historical Site Assessment
Final Technical Memorandum - HSA-5A

Figure 2.4
Area IV Subarea 5A-4
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

- Subarea 5A-4 Boundary
- Primary Roads
- Secondary Roads
- Underground Storage Tank
- Unknown Tank Type
- Sump
- Dry Well
- Tank Footprint
- Above ground Storage Tank
- Demolished Bldg.
- Existing Bldg.
- Parking Lots
- Drainage
- Drain
- Well

Aerial Photo Features

- Aerial Photography Features
- Leach Field
- Other

Surface Water

- Intermittent Stream
- Permanent Stream
- Surface Water
- Lined Channel
- French Drain
- Drainage
- Leach Field
- Septic System

Utilities

- Channel
- Drain
- Drain
- Drainage Divide
- Gutter
- Tank
- Tank
- Vault
- Well
- G – Gas
- SD – Storm Drain
- SS – Sanitary Sewer
- W – Water

B	Building
CONT	Container
CR	Crates
DB	Debris
DG	Disturbed Ground
DTM	Dark Tone Material
EX	Excavation
FA	Fill Area
GS	Ground Scar
HT	Horizontal Tank
IM	Impoundment
MTMM	Medium Toned Mounded Material
OS	Open Storage
PA	Processing Area
PL	Parking Lot
POSS	Possible
PROB	Probable
S-T	Storage Tank
SS	Smoke Stack
ST	Storage
UO	Unidentified Object
VT	Vertical Tank
WDA	Waste Disposal Area

N

0 25 50 100
Scale In Feet

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Created: TJansen
Revised: 10/19/2010 TJ
Sorce: Boeing Company, 2008
CIRGIS, 2007

HGL HydroGeoLogic, Inc.

Redacted

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-4-1a)bldg4005AP.cdr
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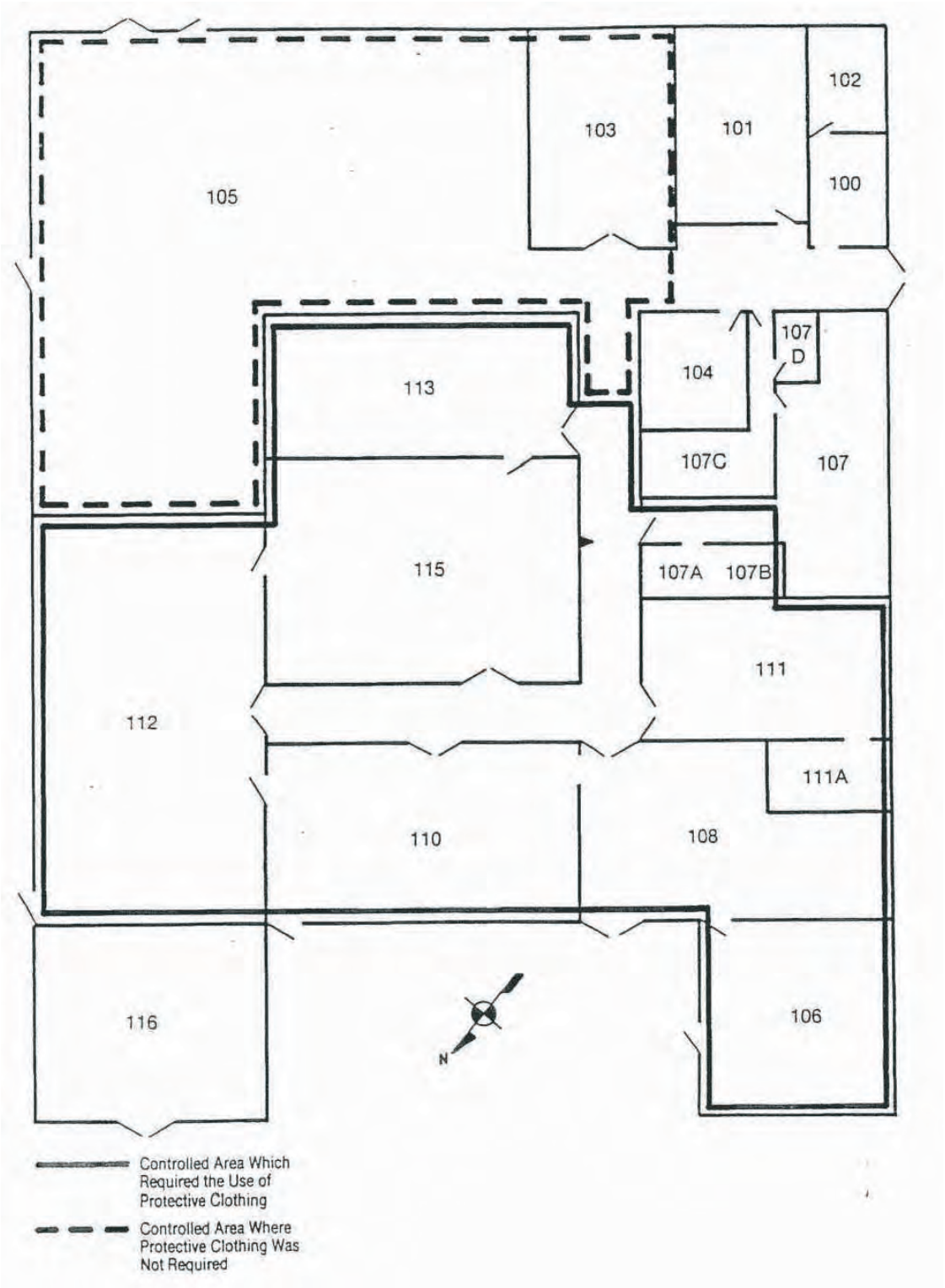
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.1a
Building 4005
Site Photograph



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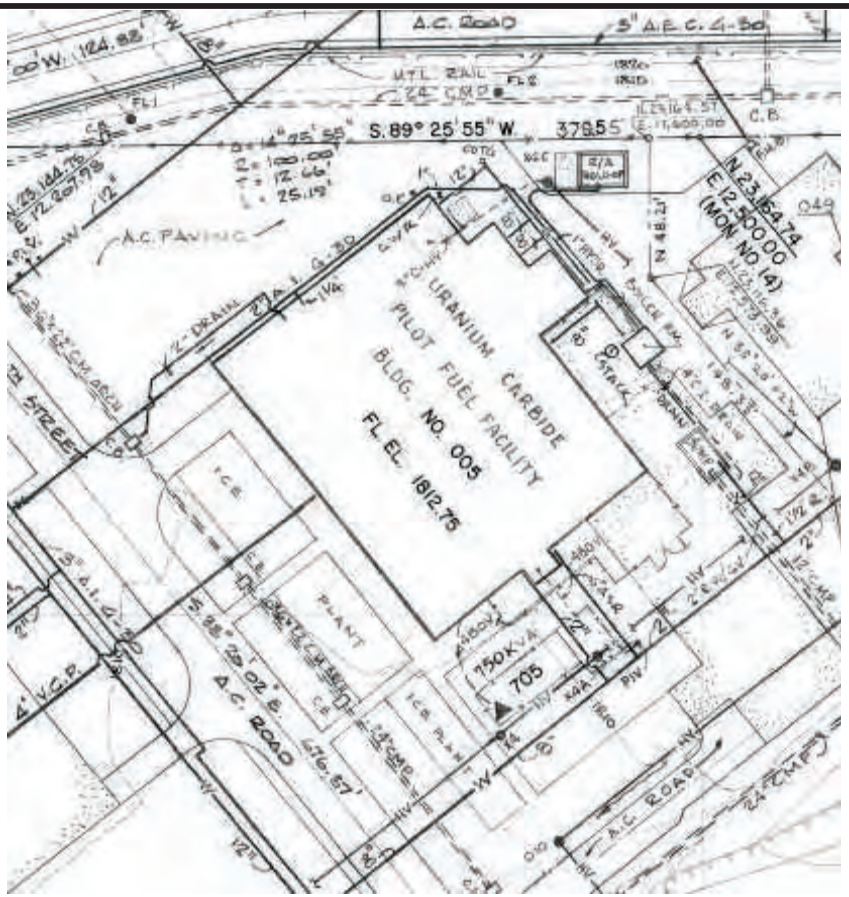
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.1b
Building 4005
Floor Plan



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SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN	DWG. SIZE E	303-GEN.-C 40
CHECKED			
ENGINEER	R PHAMMAN	SCALE 1"=40'	SHEET NO. 6 OF 14
APPROVED			

FORM NSA-F-2 REV. 12-61

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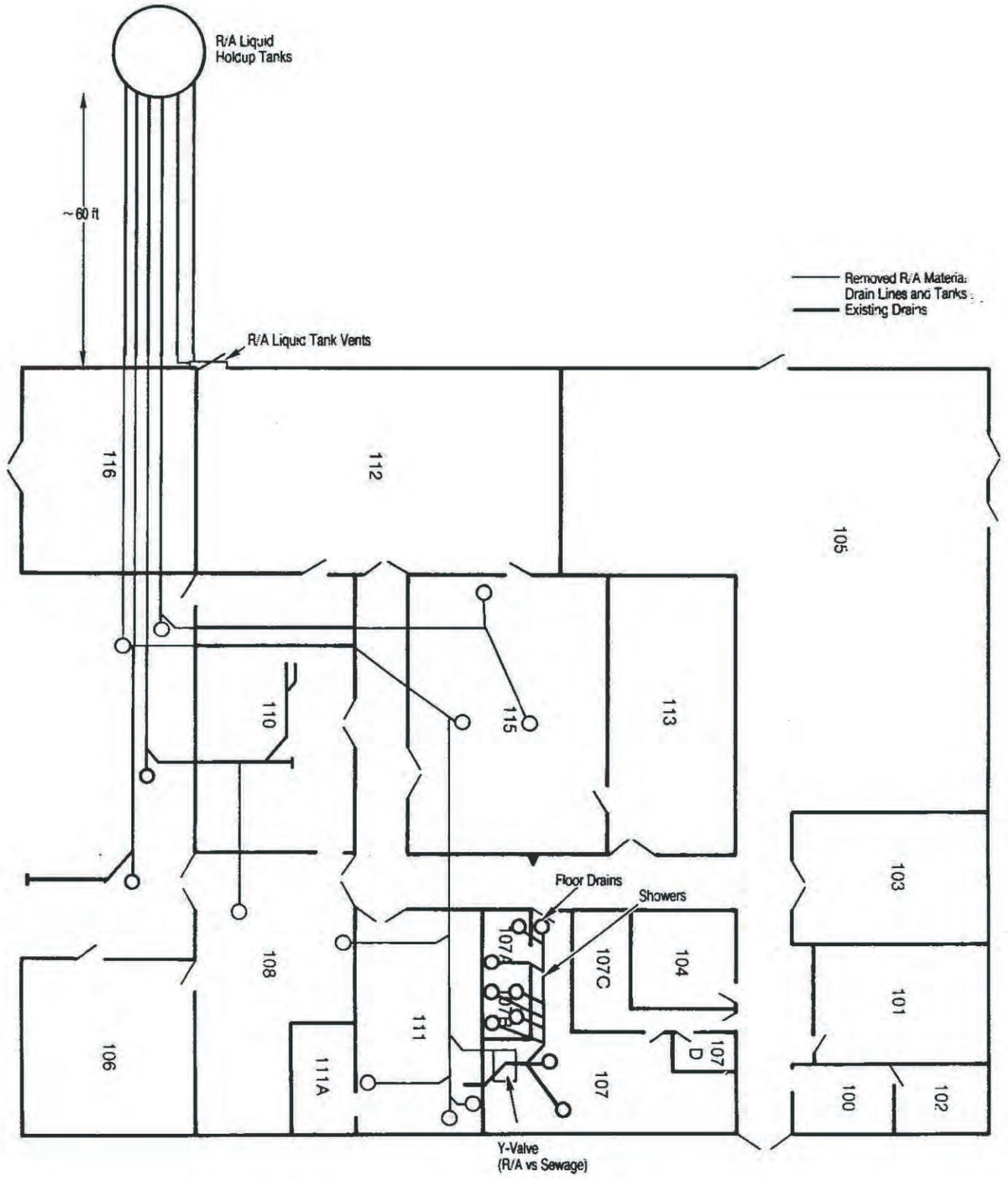
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.1c
Building 4005
Plot Plan



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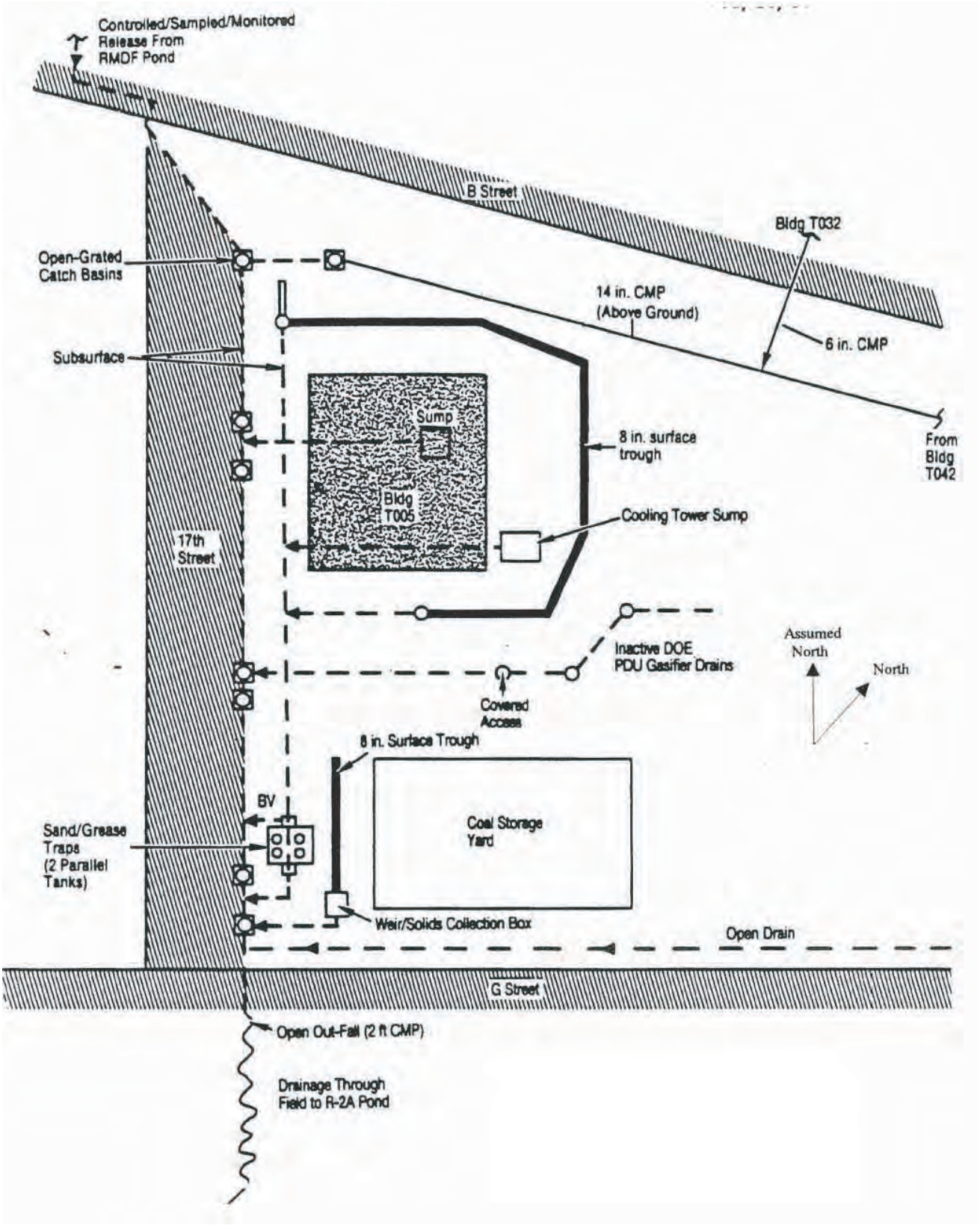
Revised: 08/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.1d
Building 4005
Radioactive Liquid Drain System



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Revised: 08/23/2010 TJ
Source: Boeing Company, 2008

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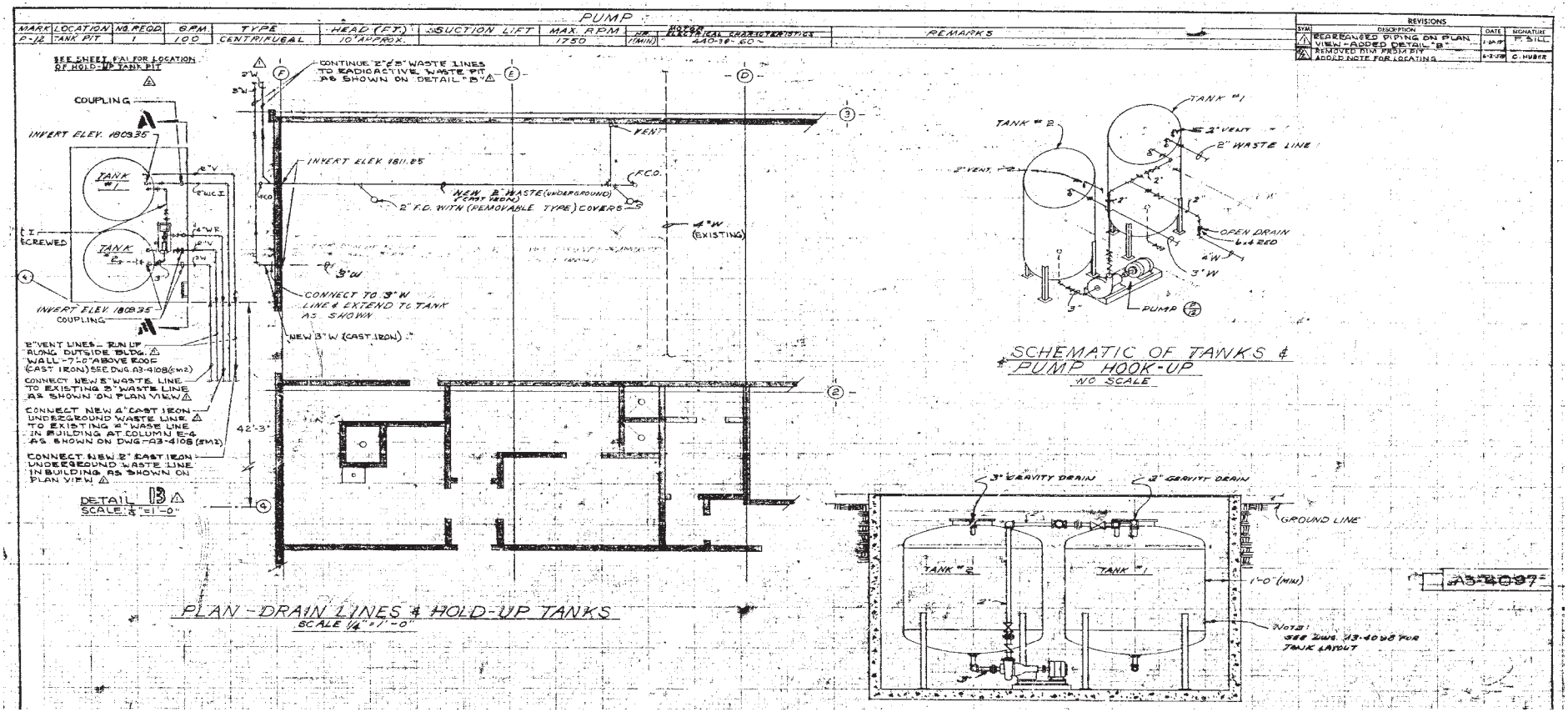
BV: Bypass Valve
CMP: Convoluted Metal Pipe
DOE: Dept. of Energy
PDU: Process Demonstration Unit
RMDF: Radioactive Materials Disposal Facility

Figure 2.4.1e
Building 4005
Surface Drainage



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Project:EP9038
Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

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Figure 2.4.1f
Building 4005
Drain Lines and
Hold-Up Tanks

REDACTED

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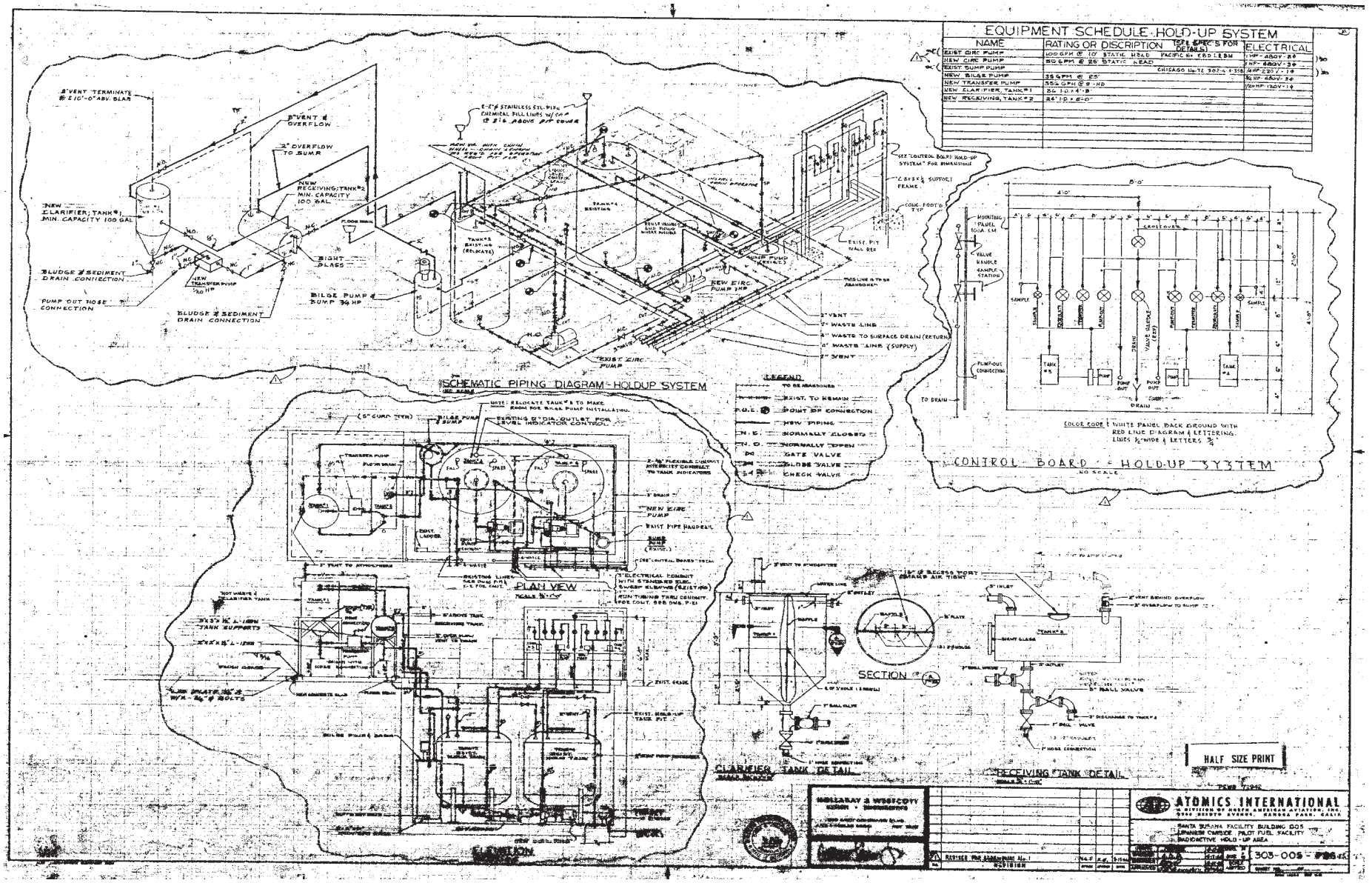
Project:EP9038
Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.1g
Building 4005
Uranium Carbide
Pilot Fuel Facility
Floor Plan



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Revised: 10/18/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.1h
Building 4005
Uranium Carbide
Pilot Fuel Facility
Radioactive Hold-Up Area

Redacted

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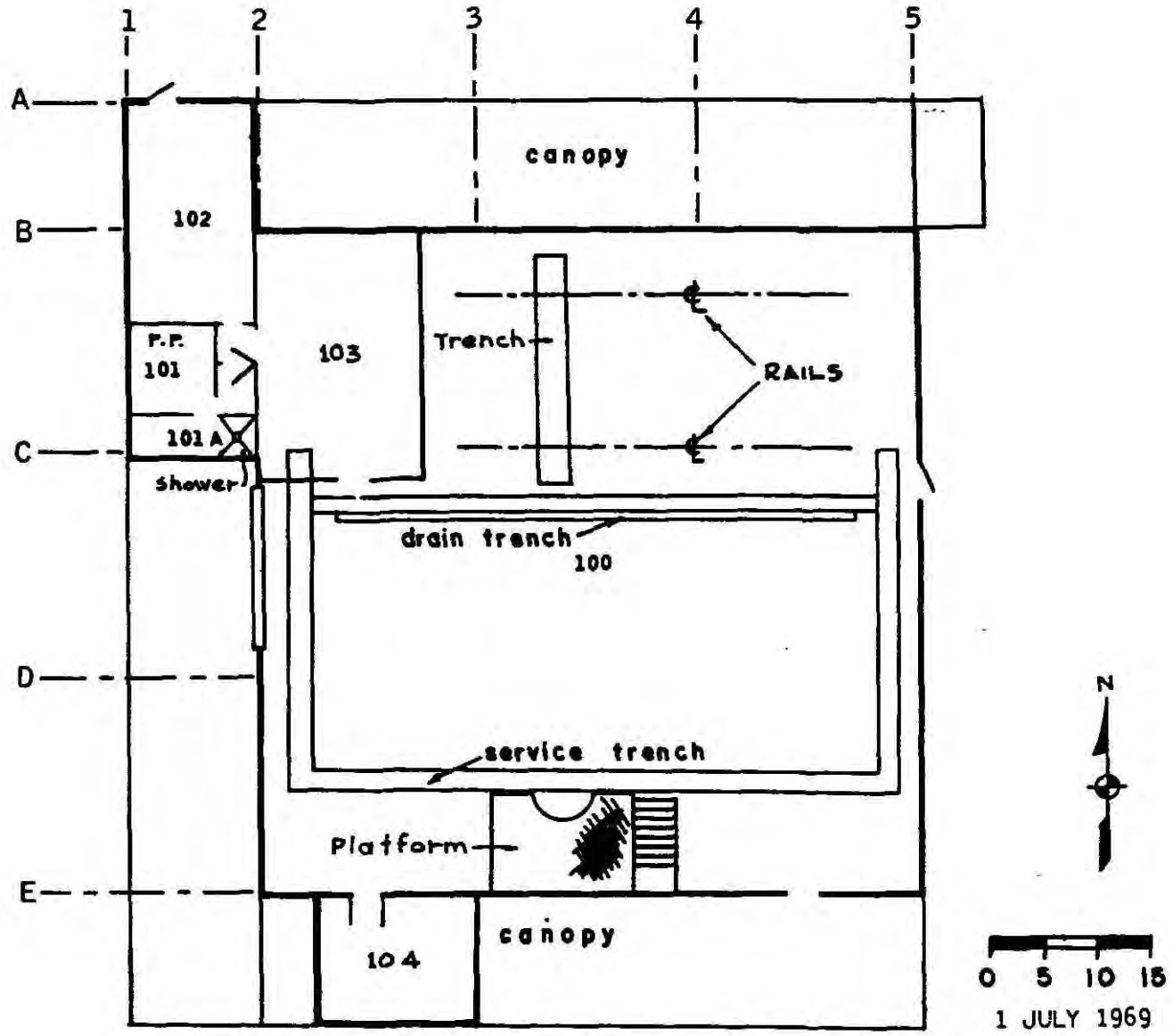
Project:EP9038
Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.2a
Building 4042
Site Photograph



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Revised: 10/19/2010 TJ
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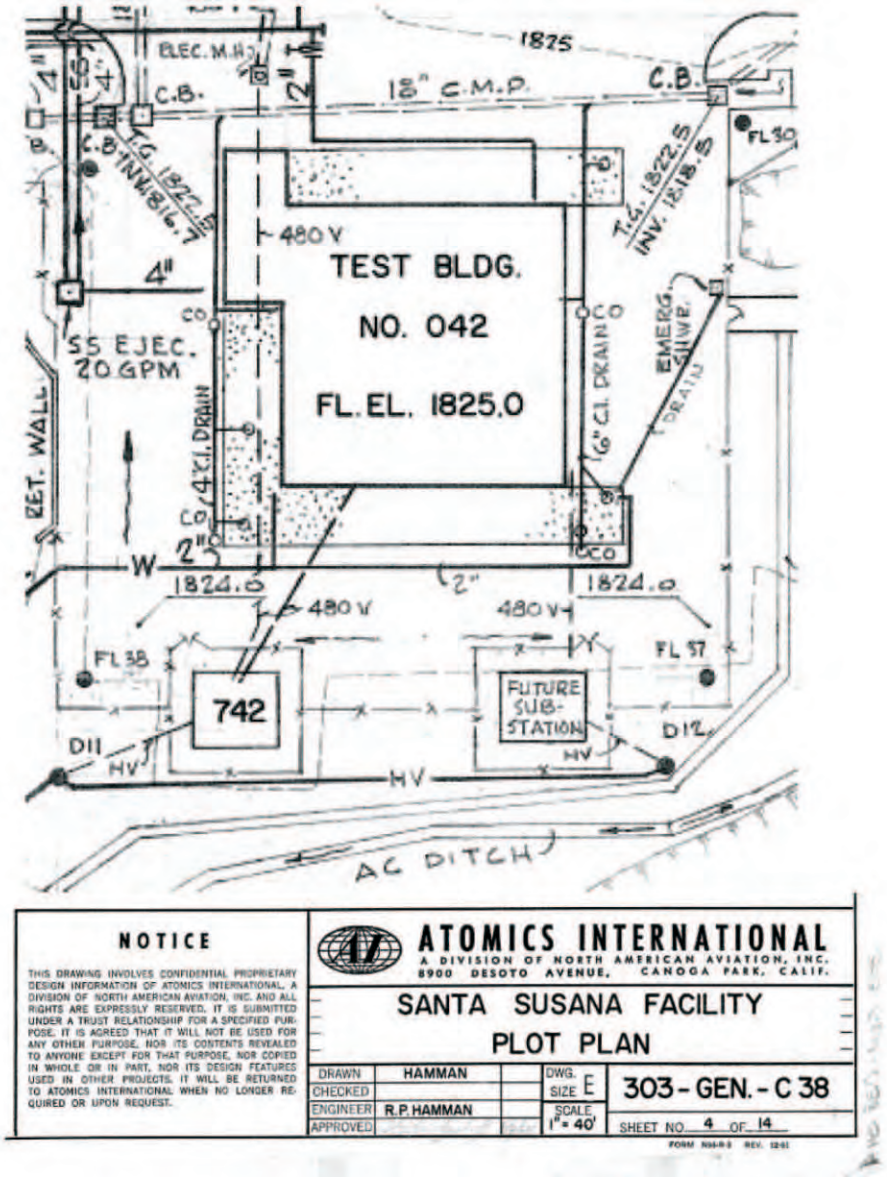
U.S. EPA Region 9

Figure 2.4.2b
Building 4042
Floor Plan



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Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.2c
Building 4042
Plot Plan

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Source: Boeing Company, 2008

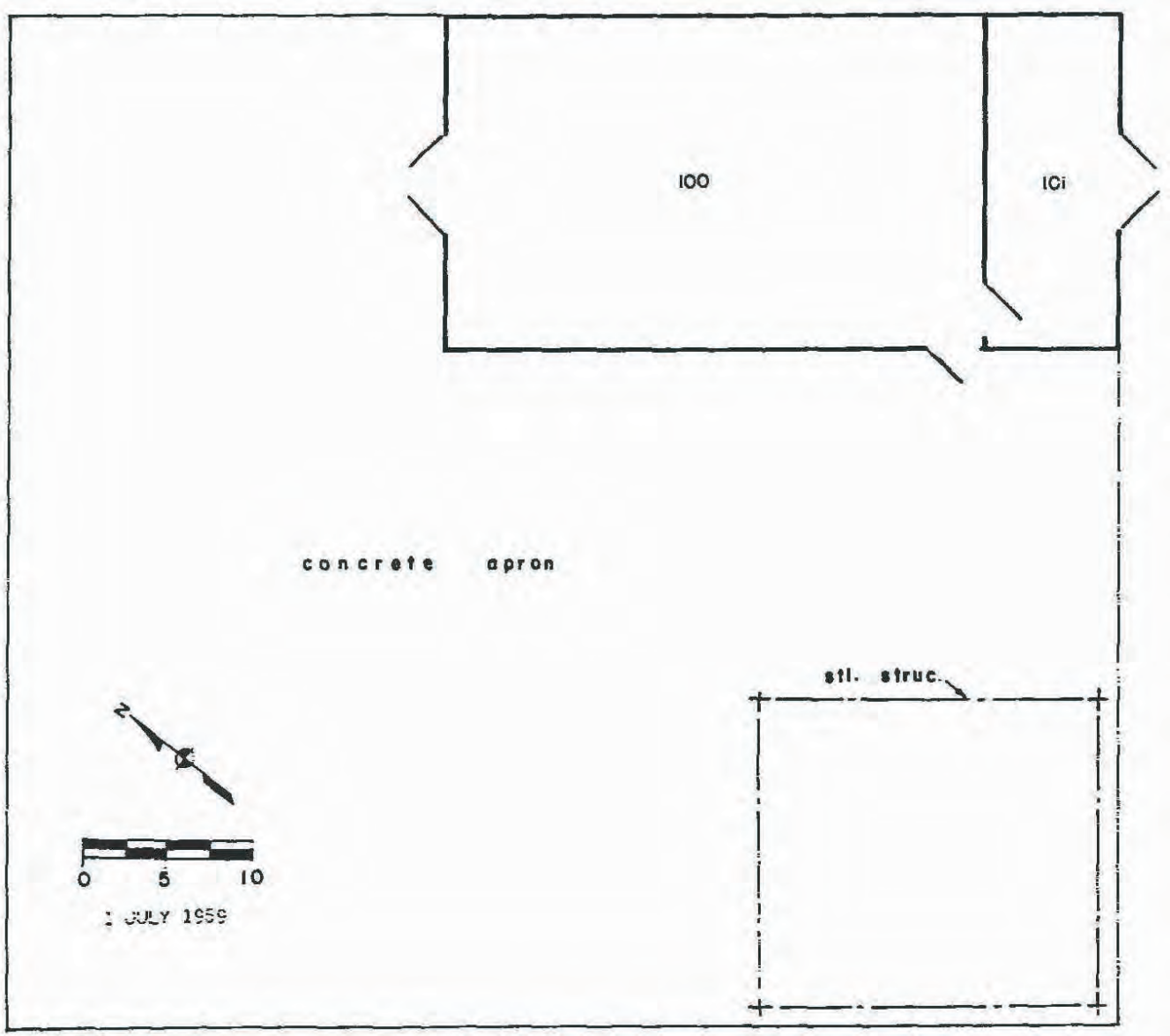
U.S. EPA Region 9

Figure 2.4.3a
Building 4048
Site Photograph

Y:/Santa_Susana/EP9038/TM/HSA_5A (2-4-4a)bldg4049AP.cdr
Project:EP9038
Revised: 10/19/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.4a
Building 4049
Site Photograph



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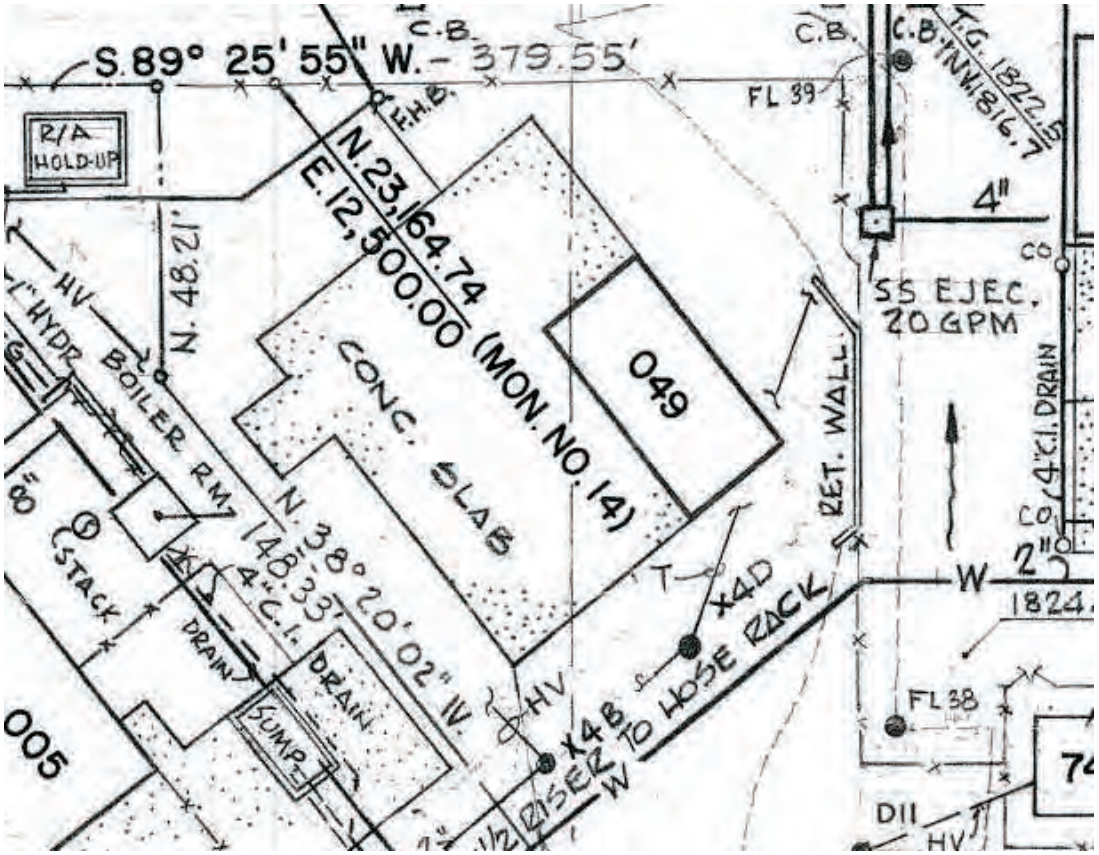
Revised: 10/19/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.4b
Building 4049
Floor Plan



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SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN		DWG. SIZE E	303 - GEN. - C 38
CHECKED				
ENGINEER	R.P. HAMMAN		SCALE 1" = 40'	SHEET NO. 4 OF 14
APPROVED				

FORM N94-R-3 REV. 12-61

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Project:EP9038
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U.S. EPA Region 9

Figure 2.4.4c
Building 4049
Plot Plan

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Revised: 10/06/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.5a
Building 4185
Site Photograph

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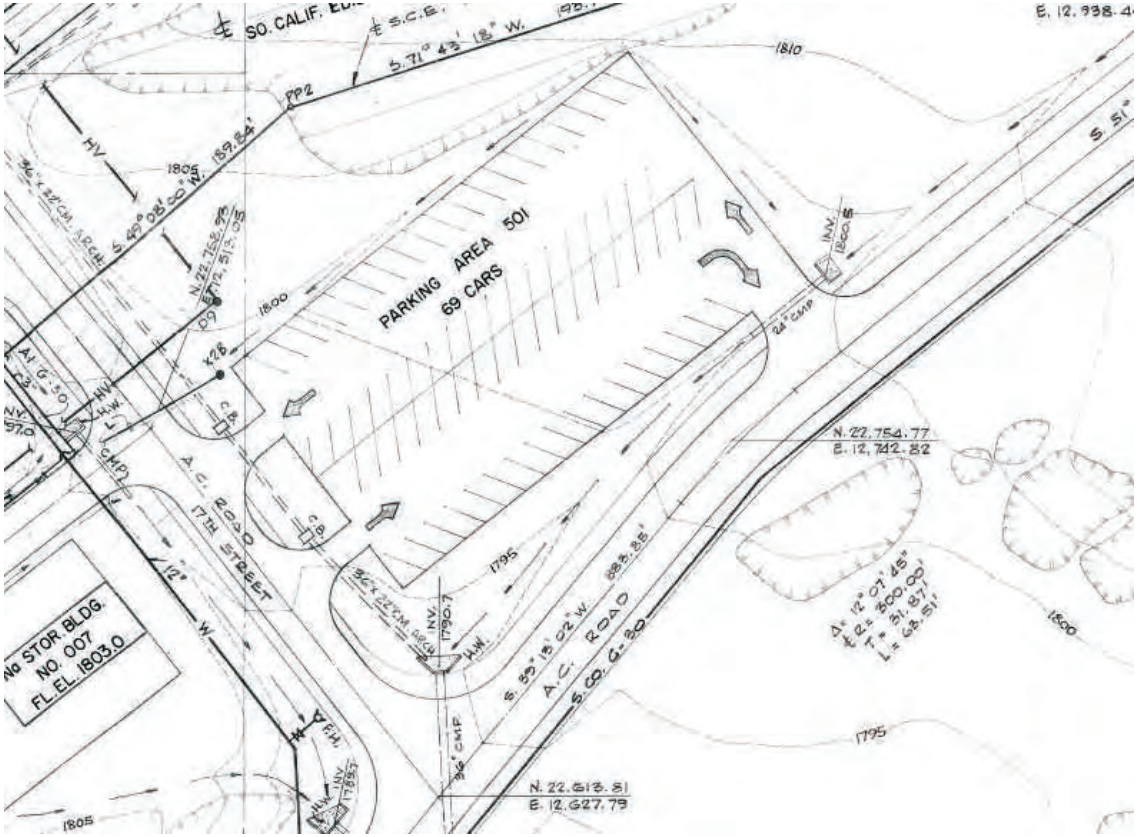
Revised: 10/06/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.6a
Parking Lot 4501
Site Photograph



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SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN	DWG. SIZE E	303 - GEN. - C 38
CHECKED			
ENGINEER	R.P. HAMMAN	SCALE 1" = 40'	SHEET NO. 4 OF 14
APPROVED			

FORM N91-R-3 REV. 12-61

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Revised: 09/23/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.6c
Parking Lot 4501
Plot Plan

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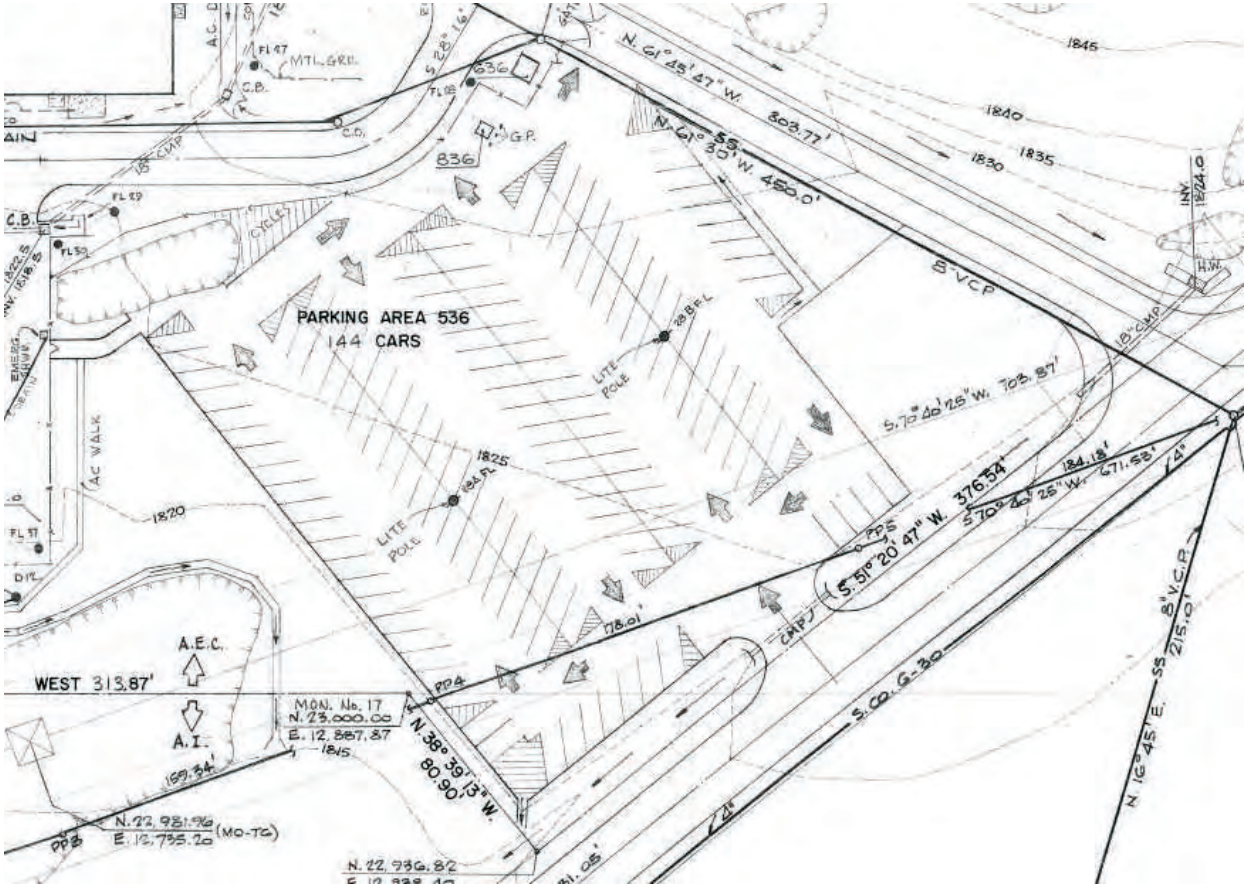
Project:EP9038
Revised: 10/19/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.7a
Parking Lot 4536
Site Photograph



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8900 DESOTO AVENUE, CANOGA PARK, CALIF.

SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN	DWG. SIZE	E
CHECKED			
ENGINEER	R.P. HAMMAN	SCALE	1" = 40'
APPROVED			

303 - GEN. - C 38

SHEET NO. 4 OF 14

FORM N94-R-3 REV. 12-61

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Revised: 10/19/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.4.7c
Parking Lot 4536
Plot Plan

Historical Site Assessment
Final Technical Memorandum - HSA-5A

Figure 2.5
Area IV Subarea 5A-5
Santa Susana Field Laboratory

U.S. EPA Region 9

Legend

- Subarea 5A-5 Boundary
- Primary Roads
- Secondary Roads
- Underground Storage Tank
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- Tank Footprint
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- Aerial Photography Features
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SS	Smoke Stack
ST	Storage
UO	Unidentified Object
VT	Vertical Tank
WDA	Waste Disposal Area

0 25 50 100
Scale In Feet

N

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HGL HydroGeoLogic, Inc

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Figure 2.5.1a
Building 4029
Site Photograph

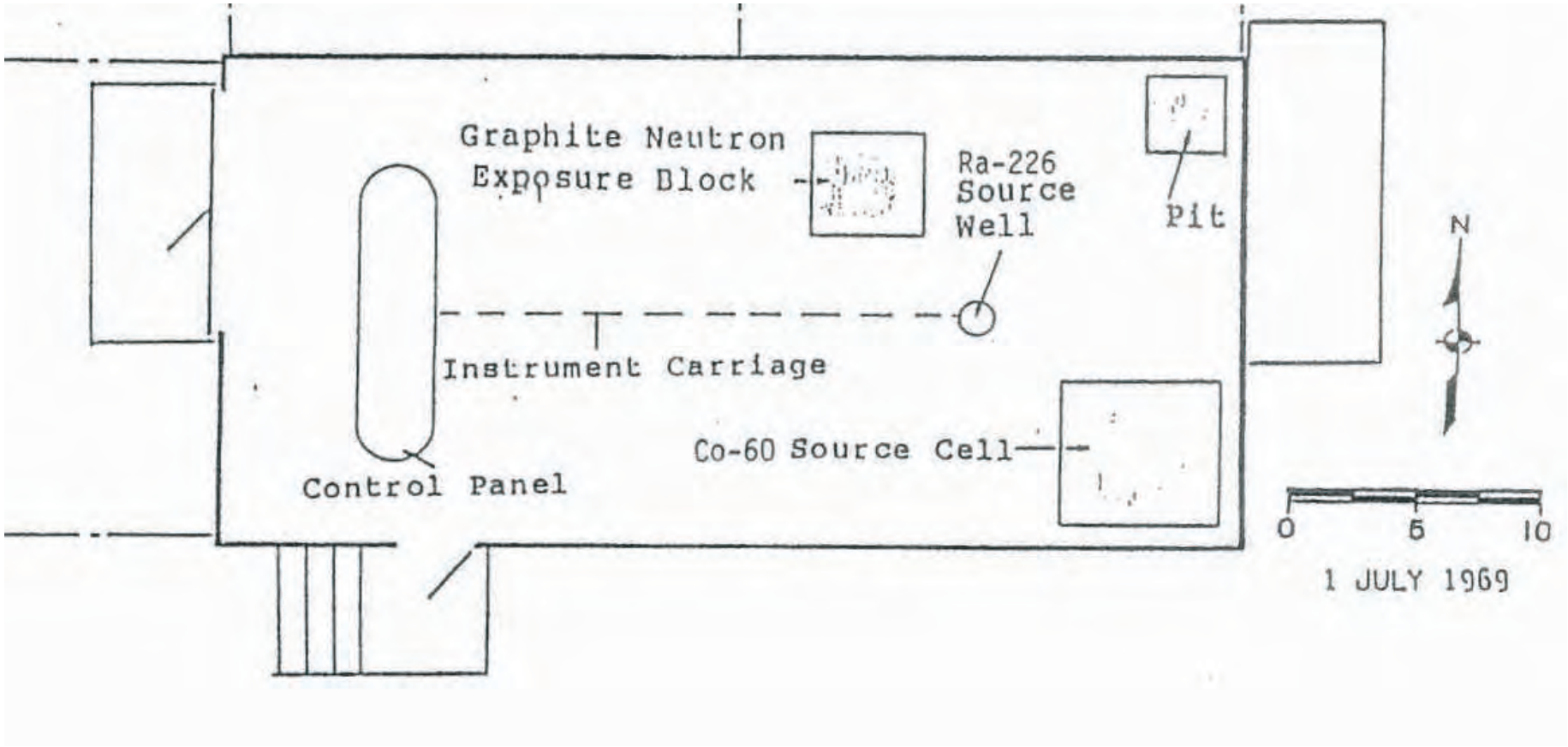

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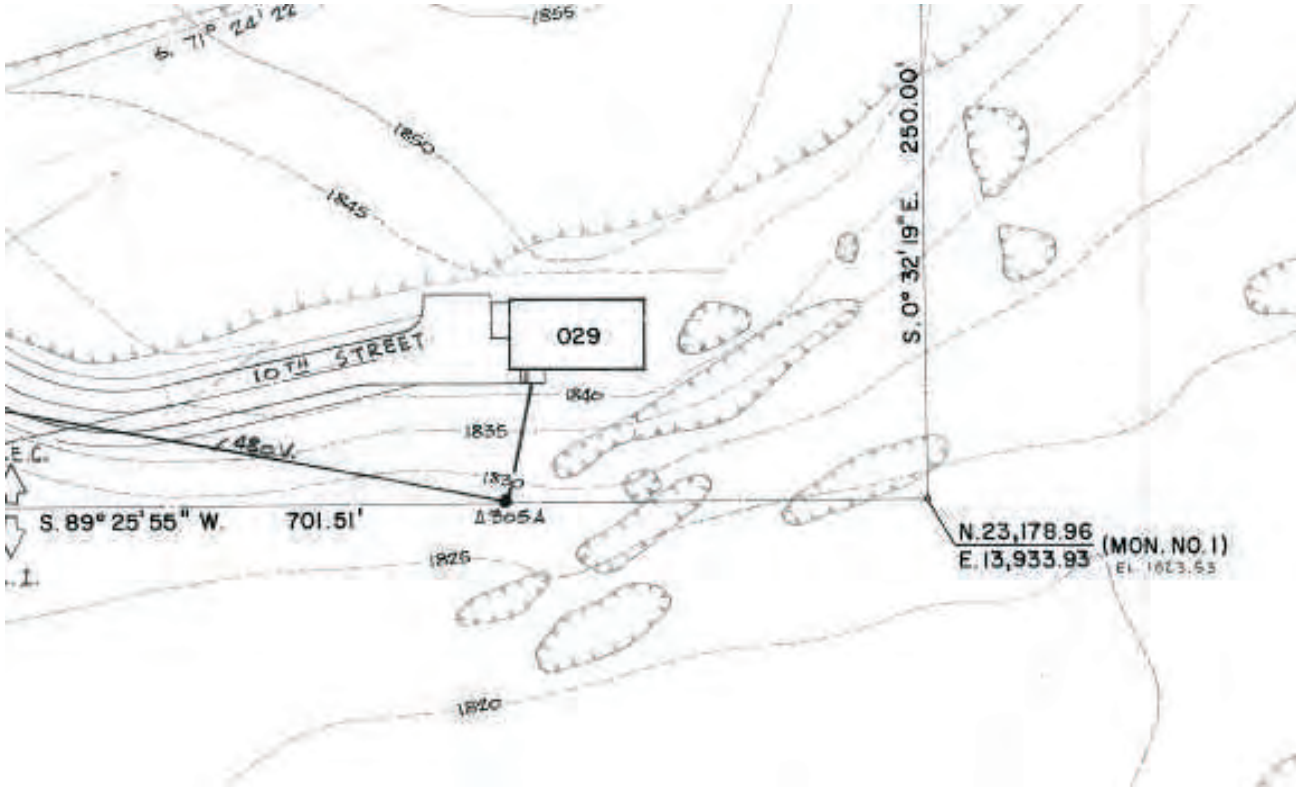
Figure 2.5.1b
Building 4029
Floor Plan



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SANTA SUSANA FACILITY
PLOT PLAN

DRAWN	HAMMAN	DWG. SIZE E	303-GEN. C-36
CHECKED			
ENGINEER	R.P. HAMMAN	SCALE 1"=40'	SHEET NO. 2 OF 14
APPROVED			

FORM NAA-R-2 REV. 12-61

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Revised: 09/23/2010 TJ
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Figure 2.5.1c
Building 4029
Plot Plan

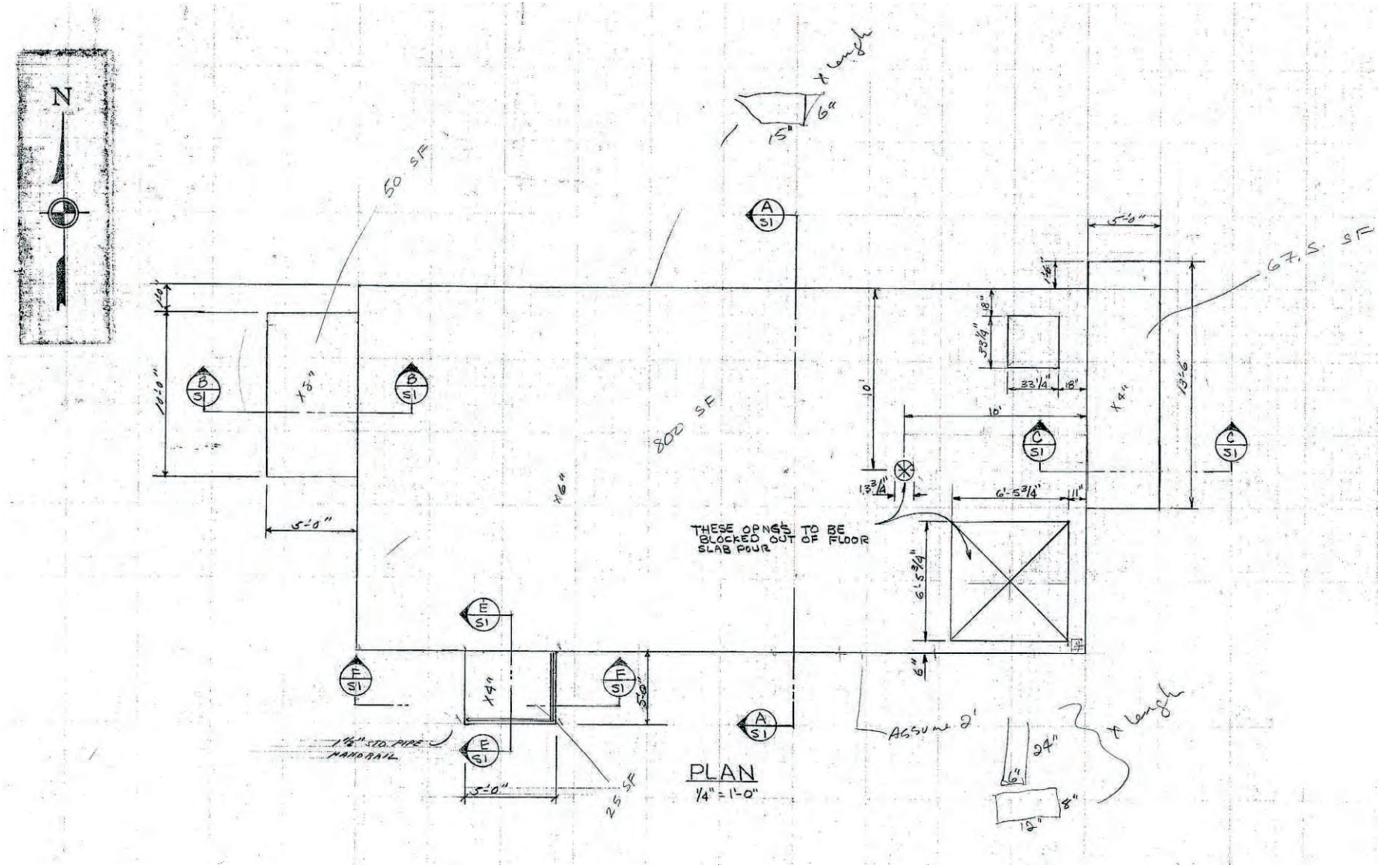

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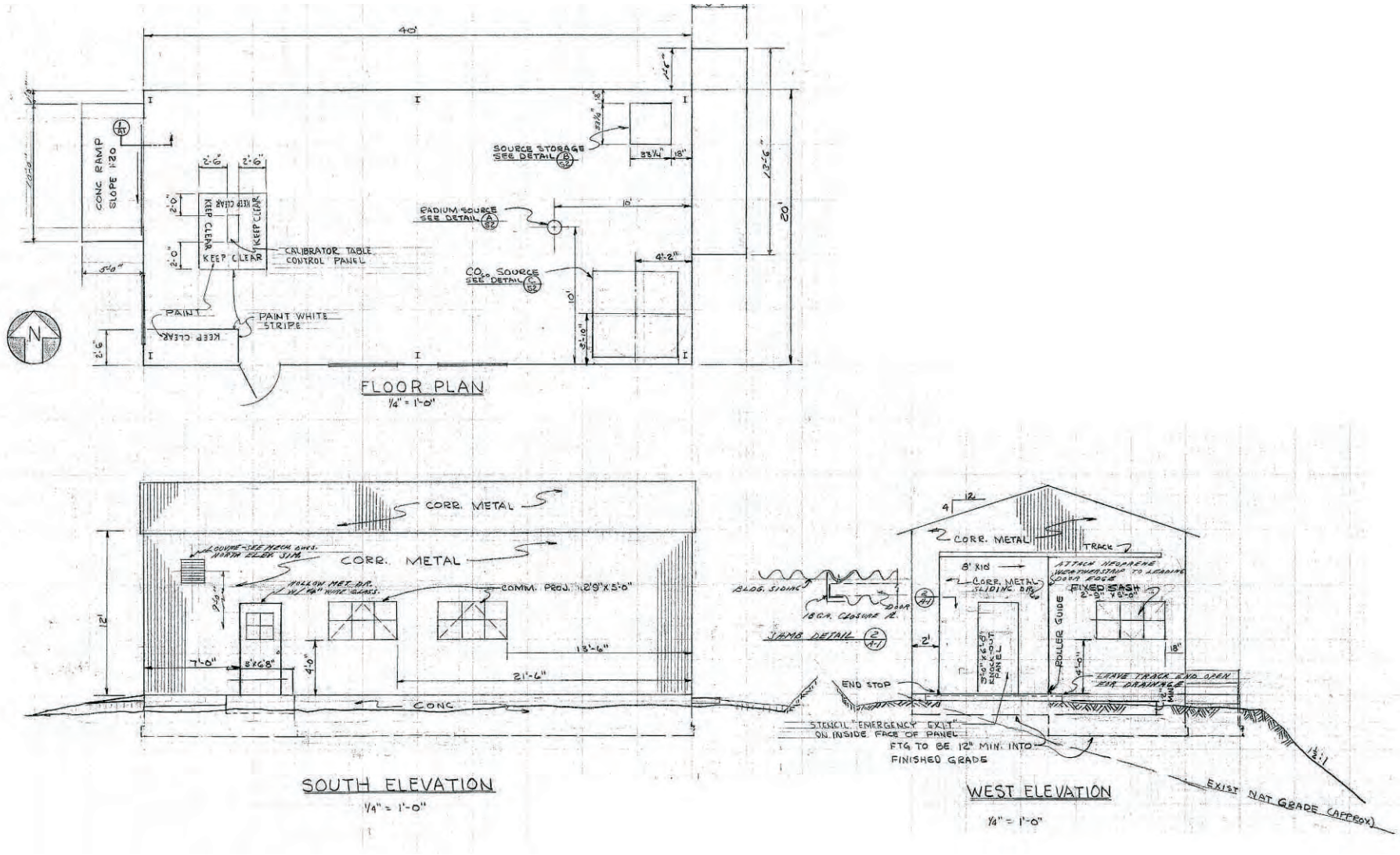
Figure 2.5.1d
Building 4029
Foundation Plan



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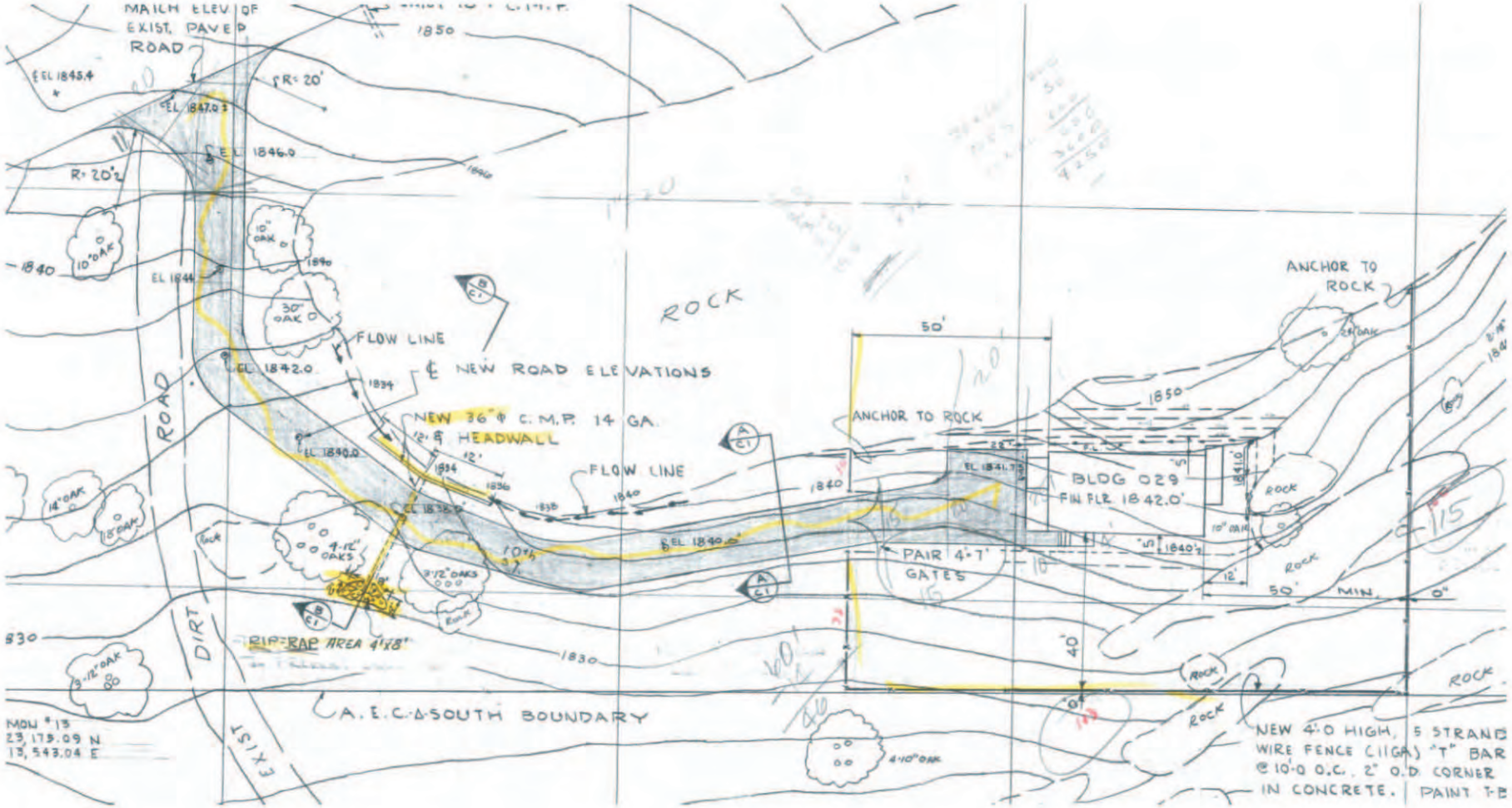
U.S. EPA Region 9

Figure 2.5.1e
Building 4029
Building Elevation Plan



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U.S. EPA Region 9

Figure 2.5.1f
Building 4029
1959 Site and Grading Plan

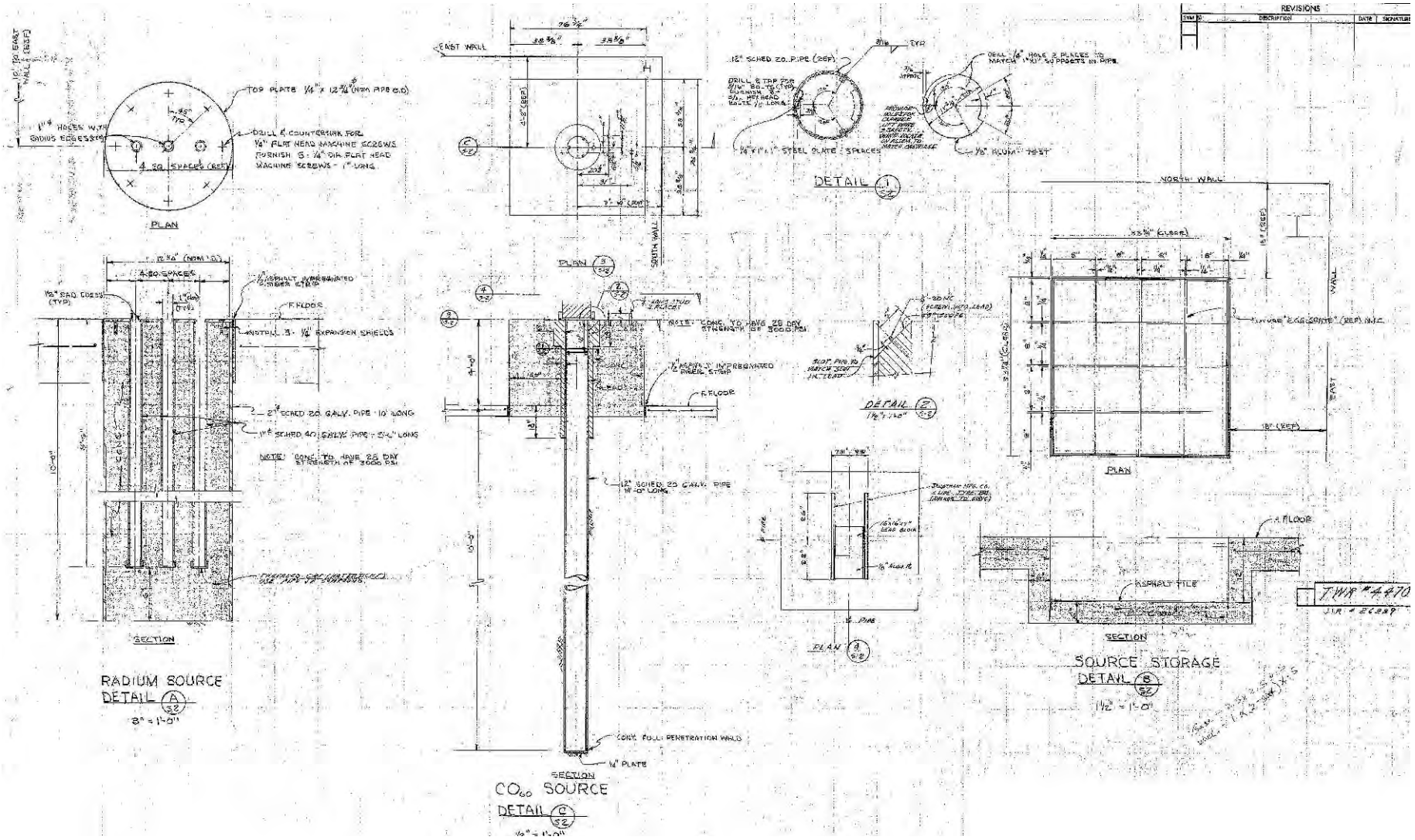

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Figure 2.5.1g
Building 4029
Source Storage
Details

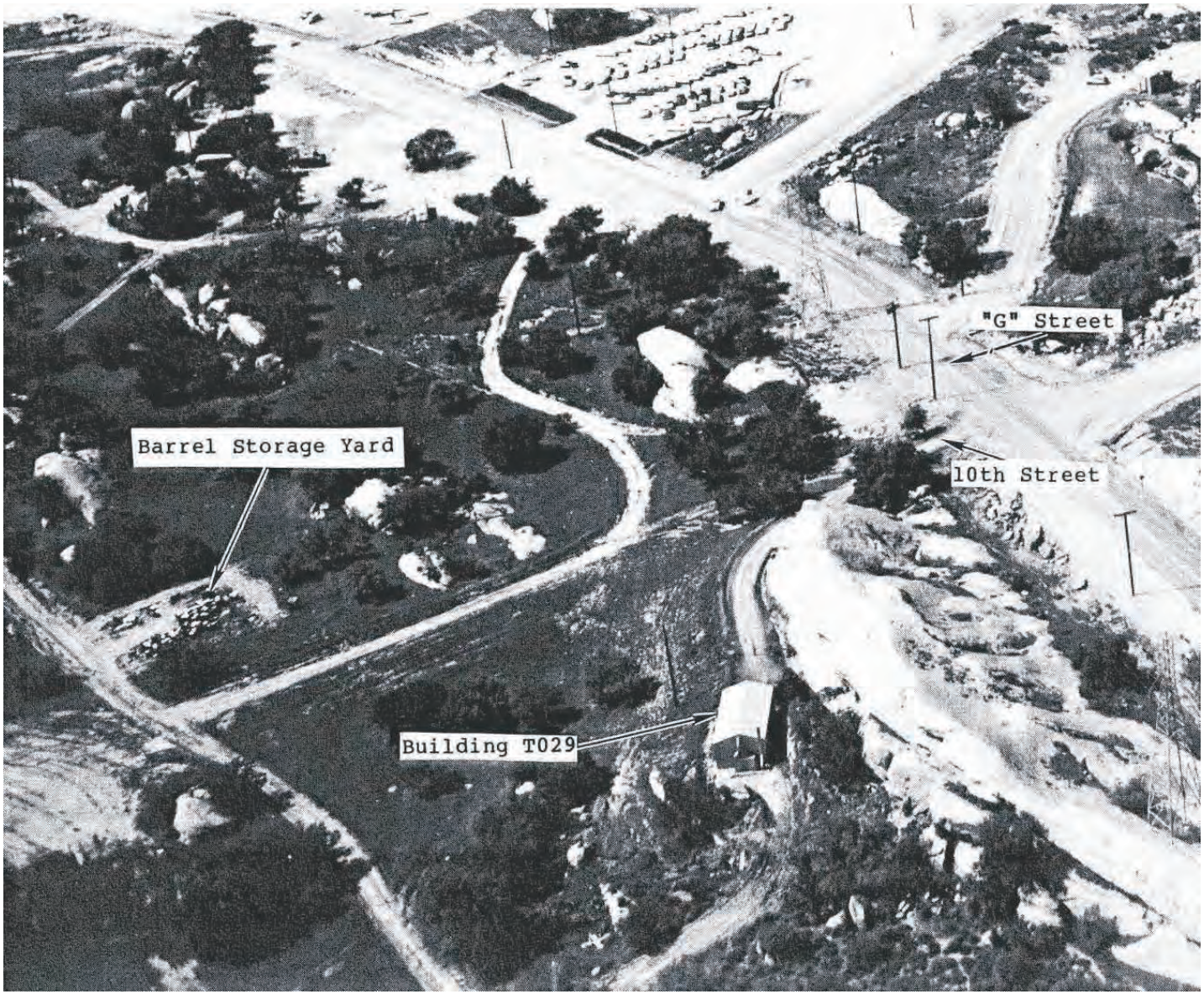

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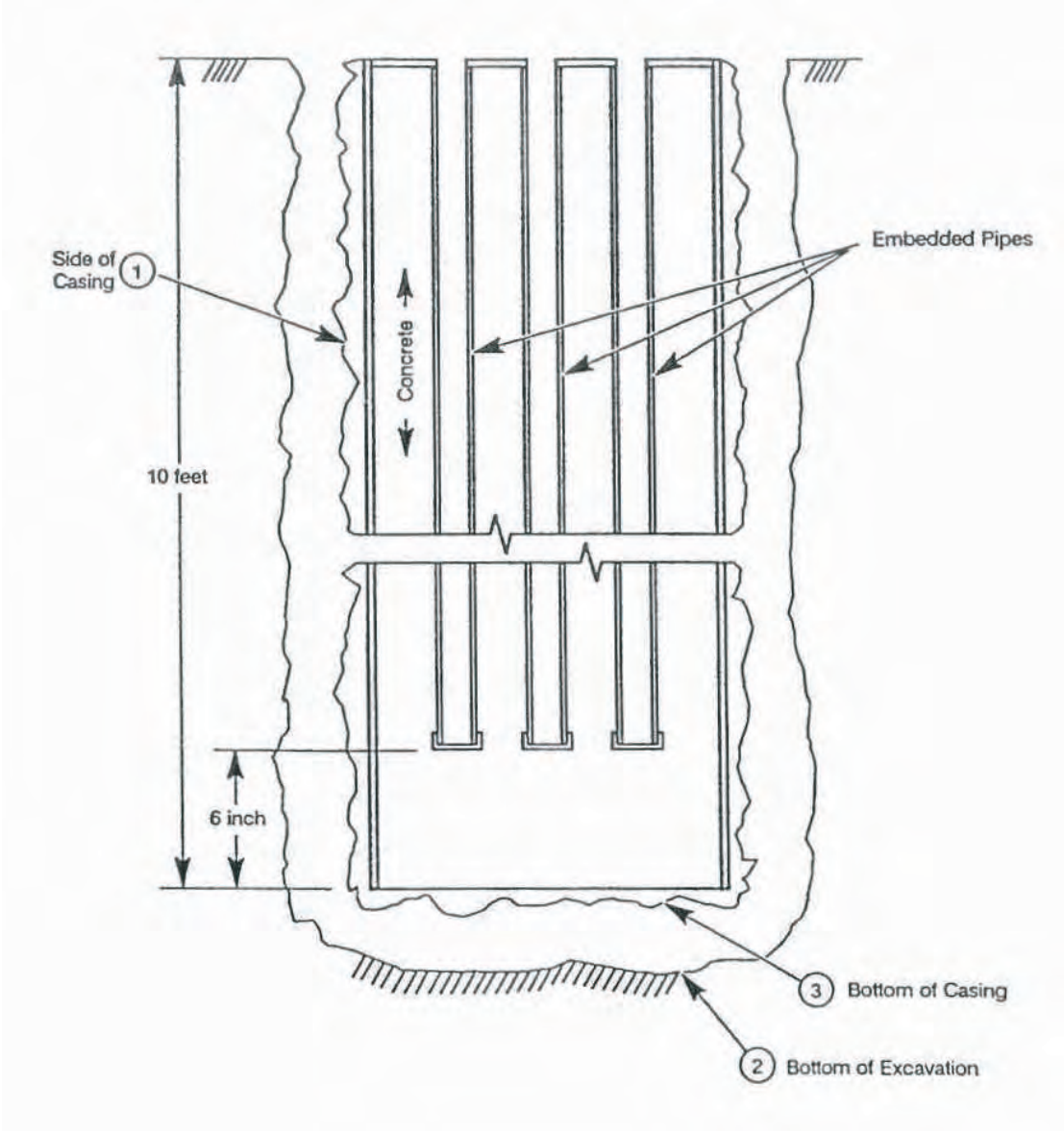
Figure 2.5.1h
Building 4029
Barrel Storage Yard



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Project:EP9038
Revised: 10/19/2010 TJ
Source: Boeing Company, 2008

U.S. EPA Region 9

Figure 2.5.1i
Building 4029
Radium Source
Storage Excavation