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Nuclear Facility Historical Site Assessment for the Separations Process Research Unit (SPRU) Disposition Project

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1.0 ACRONYMS AND GLOSSARY

UNITS OF MEASURE

centi	hundred, or hundredth part
Ci	Curie
Ci/ml	Curie per milliliter
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
cpm corr	corrected counts per minute
CW	closed window
dpm	disintegrations per minute
F	Fahrenheit
ft	foot, feet
ft^2	square feet
ft^3	cubic feet
g	gram
gal	gallon, gallons
gpm	gallons per minute
HP	horsepower
hr	hour
in	inch(es)
in^2	square inch(es)
kg	kilogram
kilo	thousand
l	liter
MDA	minimum detectible activity
micro	millionth
milli	thousandth
min	minute
ml	milliliter
mR	milliRoentgen
mrad	millirad
mRem	milliRem
mRep	milliRoentgen equivalent physical
nano	thousand millionth
pCi	picoCurie
pico	one trillionth (10^{-12}) part
ppm	parts per million
psig	pounds per square inch gauge
R	Roentgen
rad	radiation absorbed dose
Rem	Roentgen equivalent man
Rep	Roentgen equivalent physical
sq ft	square feet (foot)
µCi	microCurie
µCi/cc	microCurie per cubic centimeter
µCi/ml	microCurie per milliliter
µg	microgram

ACRONYMS

Ag	silver
Al	aluminum
Am	americium
App.	appendix
B	boron
Ba	barium
BCE	batch count extraction
Be	beryllium
Bi	bismuth
BKC	Blaw-Knox Company
C	carbon
C-(six digit number)	correspondence referenced
Ca	calcium
CCTF	Corrosion Coolant Test Facilities
Cd	cadmium
Ce	cerium
CFR	Code of Federal Regulations
Cl	chlorine
Co	cobalt

corr	corrected [cpm]
Cr	chromium
Cs	cesium
Cu	copper
CW	closed window
DAC	derived air concentration
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
Eu	europium
F	fluorine
Fe	iron
FPCE	Full Core Physics Experiment
FY	fiscal year
GE	General Electric
GM	Geiger-Mueller (detector)
H	hydrogen
HEPA	high efficiency particulate air (filter)
Hg	mercury
HP	horsepower
HSA	historical site assessment
I	iodine
I-(six digit number)	interview referenced
K	potassium
KAPL	Knolls Atomic Power Laboratory
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
Mg	magnesium
Mn	manganese
MPC	Maximum Permissible Concentration
MPC_a	Maximum Permissible Concentration for air
N	nitrogen
Na	sodium
Nb	niobium
Ni	nickel
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
NYSDEC	New York State Department of Environmental Conservation
OW	open window
P	phosphorous
p.	page
Pa	protactinium
Pb	lead
PCB	polychlorinated biphenyls
pp.	pages
Pr	praseodymium
Pu	plutonium
PUREX	plutonium uranium extraction
R-(six digit number)	report reference
Ra	radium
radiac	radioactive detection, identification, and computation
RCRA	Resource Conservation and Recovery Act
REDOX	reduction-oxidation
RML	Radioactive Materials Laboratory
RMP	radiation work permit
Rn	radon
Ru	ruthenium
RWP	radiological work permit
S	sulfur
Si	silicon
S&M	surveillance and maintenance
SPRU	Separations Process Research Unit
Sr	strontium
SWMU	solid waste management unit
TBP	tributyl phosphate
Th	thorium
Ti	titanium
TRU	transuranic
U	uranium
USGS	United States Geological Survey
V-(six digit number)	videotape reference
WBS	work breakdown structure
Y	yttrium
Zn	zinc
Zr	zirconium

GLOSSARY

actinide(s). A group of elements that are very dense, radioactive metals. The elements are actinium, thorium, protactinium, uranium, neptunium, plutonium, americium, curium, berkelium, californium, einsteinium, fermium, mendelevium, nobelium, and lawrencium.

accessible. In this historical site assessment, the term accessible is used to describe areas in Buildings G2, H2, and the pipe tunnels that can be entered without dosimetry, protective clothing, respirators, or supplied clean air. See also "inaccessible."

alpha. A particle emitted from the nucleus of an atom that contains two protons and two neutrons.

aquiclude. A subsurface rock, soil, or sediment unit that does not yield useful quantities of water.

background radiation. Radiation from: (1) naturally occurring radioactive materials which have not been technologically enhanced; (2) cosmic sources; (3) global fallout as it exists in the environment (such as from the testing of nuclear explosive devices); (4) radon and its progeny in concentrations or levels existing in buildings or the environment which have not been elevated as a result of current or prior activities; and (5) consumer products containing nominal amounts of radioactive material or producing nominal amounts of radiation (DOE-STD-1098-99, *Radiological Control* [Change Notice No. 1, June 2004]). Background radiation is typically less than 10 microrad per hour.

beta. A beta is a high-speed particle, identical to an electron, that is emitted from the nucleus of an atom.

cell. A shielded enclosure within a structure where hazardous processes can be remotely controlled and carried out. Cells are typically constructed of thick concrete walls to isolate radioactive materials, and fission products that have high gamma radiation emissions.

closed window (CW). The position that the "sleeve" of a Geiger-Mueller (GM) detector must be in to cover the detector and filter out beta radiation, allowing only gamma and x-ray radiation to be measured.

contamination area. One type of radiologically contaminated area. Others are "radiation area," "high radiation area," "very high radiation area," or "high contamination area." Entry into these areas requires workers to have special training, protective clothing, and a radiological work permit. A contamination area is an area where removable contamination levels (disintegrations per minute/100 cm^2) exceed or are likely to exceed the listed values in Table 2-2 of DOE-STD-1098-99, *Radiological Control* (Change Notice No. 1, June 2004), but less than or equal to 100 times the Table 2-2 values.

corrected counts per minute (cpm corr or ccpm). Counts per minute measured less the average background radiation count. Counts per minute may also be corrected for decay.

crud. A buildup of radiological precipitates in piping or other fluid system components in bends, elbows, tanks, etc.

Curie. A Curie is a measure of radioactivity based on the observed decay rate of approximately 1 gram of radium. The Curie was named in honor of Pierre and Marie Curie, pioneers in the study of radiation. One Curie of radioactive material has 37 billion atomic transformations (disintegrations) in 1 second. It is defined as the number of nuclear transformations occurring per minute. One Curie = 2.22×10^{12} disintegrations per minute.

decommissioning. The process of closing and securing a nuclear facility or nuclear materials storage facility to provide adequate protection from radiation exposure and to isolate radioactive contamination from the human environment.

decontamination. The removal of a chemical, biological, or radiological contaminant from, or neutralizing its potential effect on, a person, object or environment by washing, chemical action,

mechanical cleaning, or other techniques. Decontamination may also include treatment and disposal of wastes generated during decontamination efforts.

derived air concentration (DAC). For the radionuclides listed in Appendix A of 10 CFR 835, the airborne concentration that equals the annual limit on intake (ALI) divided by the volume of air breathed by an average worker for a working year of 2000 hours (assuming a breathing volume of 2,400 cubic meters). For radionuclides listed in Appendix C of 10 CFR 835, the air immersion DACs were calculated for a continuous, non-shielded exposure via immersion in a semi-infinite atmospheric cloud. The values are based upon the derived airborne concentration found in Table 1 of the *U. S. Environmental Protection Agency's Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion*, published September 1988 (DOE-STD-1098-99, *Radiological Control* [Change Notice No. 1, June 2004]).

exponential notation. The following exponential notations are examples of those used in this document.

$1 \times 10^{4} = 10{,}000$
$1 \times 10^{2} = 100$
$1 \times 10^{0} = 1$
$1 \times 10^{-2} = 0.01$
$1 \times 10^{-4} = 0.0001$

facilon. A durable fiberglass reinforced plastic sheeting material commonly used in radiological contamination controls.

fission product. A usually radioactive isotope produced as a result of the fission of a massive atom such as U-235. The REDOX and PUREX runs for the separation of plutonium and uranium from fission products by solvent extraction were tested in the SPRU Building G2.

fixed contamination. Radioactivity remaining on a surface after repeated decontamination attempts fail to significantly reduce the contamination level.

gamma. Gamma rays are electromagnetic waves or photons emitted from the nucleus (center) of an atom.

high-level radioactive waste. During the years of SPRU research (and for the purposes of this historical site assessment) high-level radioactive waste referred to the liquid waste produced in the G2 process pilot plant that measured 0.05 microCuries or greater per liter. Low-level radioactive waste (less than 0.05 microCuries per liter) included contaminated waste from the laundry and incinerator scrubber. The chemistry laboratories also produced primarily low-level radioactive liquid waste. These high- and low-level waste definitions were used to distinguish waste streams at the time of SPRU operations and do not correspond to present DOE definitions of high- and low-level waste (R-001949, p. 36).

high radiation area. One type of radiologically contaminated area. Others include “radiation area,” “very high radiation area,” “contamination area,” or “high contamination area.” Entry into these areas requires workers to have special training, protective clothing, and a radiological work permit. A high radiation area is an area with dose rates greater than 100 milliRems in one hour 30 centimeters from the source or from any surface through which the ionizing radiation penetrates. Areas at licensee facilities must be posted as “high radiation areas,” and access into these areas is maintained under strict control (DOE-STD-1098-99, *Radiological Control* [Change Notice No. 1, June 2004]).

inaccessible. In this historical site assessment, the term inaccessible is used to describe areas in Buildings G2, H2, and the Pipe Tunnels that cannot be entered without dosimetry, protective clothing, and in some cases, respirators or supplied clean air. See also “accessible.”

interceptor. An interceptor is a plumbing trap that collects particulates and solids in a piping system.

low-level radioactive waste. During the years of SPRU research (and for the purposes of this historical site assessment) low-level radioactive waste (less than 0.05 microCuries per liter) included contaminated waste from the laundry and incinerator scrubber. The chemistry laboratories also produced primarily low-level radioactive liquid waste. High-level radioactive waste refers to the liquid waste produced in the G2 process pilot plant that was 0.05 microCuries or greater per liter. These high- and low-level waste definitions were used to distinguish waste streams at the time of SPRU operations and do not correspond to present DOE definitions of high- and low-level waste (R-001949, p. 36). (See definition of ***radioactive waste***.)

MPCa (Maximum permissible concentration for air)**.** MPCa is the concentration of a radioisotope in air that would lead to an annual dose of 5 Rem due to inhalation of that isotope. This unit was replaced by the derived air concentration (DAC).

non-process areas (versus process areas). Non-process areas are the areas in G2 that were not used to chemically separate plutonium from uranium. The non-process areas are currently accessible.

open window (OW). The position that the "sleeve" of a GM detector must be in to expose the detector. Beta, gamma, and x-ray radiation are measured with an "open window."

picoCurie. A picoCurie is one one-trillionth (1/1,000,000,000,000) of a Curie.

plenum. An air-filled space in a structure that receives air from a blower for distribution (as in a ventilation system).

process areas (versus non-process areas). The SPRU process area (about 7,500 square feet [R-001949, p. 64]) is inaccessible and includes Cells Nos. 1, 2, 3, 4, and 5; Cell Access Corridor, Process and Hot Tunnels, Upper and Lower Sampling Aisles, and the Pipe and Motor Generator Room. These areas were used to chemically separate plutonium from uranium.

protective storage mode. Protection storage mode is a non-operating status with continuing surveillance and monitoring.

PUREX. PUREX is a uranium and plutonium extraction process using a solvent, tributyl phosphate (TBP). SPRU was a PUREX pilot plant.

rad, radiation absorbed dose. The rad is a unit for measuring energy absorbed in any material. Absorbed dose results from energy being deposited by the radiation. It is defined for any material and applies to all types of radiation. It is a measurement of absorbed dose but does not take into account the potential biological effects that different types of radiation have on the human body. Greater than 100 rad must be imparted in a short period over a substantial portion of the body before most individuals will show significant clinical symptoms.

radiac (radioactive detection, identification, and computation)**.** The term refers to the detection and measurement of the intensity of emitted nuclear radiation.

radiation. Radiation is energy in transit in the form of high-speed particles and electromagnetic waves. Electromagnetic waves make up visible light, radio and television waves, ultraviolet, and microwaves, with a large spectrum of energies. These examples of electromagnetic waves do not cause ionizations of atoms because they do not carry enough energy to separate molecules or remove electrons from atoms.

radiation area. One type of radiologically contaminated area. Others include "high radiation area," "very high radiation area," "contamination area," or "high contamination area." Entry into these areas requires workers to have special training, protective clothing, and a radiological work permit. A radiation area is any area with radiation levels greater than 5 milliRems in one hour at 30 centimeters from the source or from any surface through which the radiation penetrates (DOE-STD-1098-99, *Radiological Control* [Change Notice No. 1, June 2004]).

radioactive waste. During SPRU operations, high-level radioactive liquid waste was defined as 0.05 microCuries or more per liter and low-level radioactive waste was defined as less than 0.05 microCuries per liter. Note: These are not current DOE definitions of high and low-level radioactive waste. Per DOE Manual 435.1-1, *Radioactive Waste Management Manual,* (July 9, 1999), high-level waste is the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations, and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation. Low-level radioactive waste is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material, or naturally occurring radioactive material.

radiological work permit (RWP). Permit that identifies radiological conditions, establishes worker protection and monitoring requirements, and contains specific approvals for radiological work activities. The radiological work permit is an administrative process for planning and controlling radiological work and informing workers of the radiological conditions (DOE-STD-1098-99, CN1, June 2004).

REDOX (reduction-oxidation). REDOX was a chemical extraction process for separating uranium and plutonium from mixed fission products. SPRU was a REDOX pilot plant. A full-scale REDOX plant was built at the Hanford site in Richland, Washington.

Rem, Roentgen equivalent man. The Rem is a unit for measuring the biological effects of radiation on the human body. It is the most commonly used unit for dose reporting. The Rem takes into account the absorbed dose and the biological effects of different types of radiation. It is a measurement of biological dose equivalence. This unit applies to both internal and external doses.

removable contamination. Radioactivity that can be transferred from a surface to an absorbent material, such as filter paper or cotton swabs, by rubbing with moderate pressure and swabbing an area of at least 100 square centimeters.

Rep, Roentgen equivalent physical. The Rep is an obsolete unit of absorbed radiation dose equal to the absorption of 93 ergs of energy per gram. This is equivalent to 0.93 rad. The definition was made because a dose of 1 rep of beta rays was considered biologically equivalent to a dose of 1 Roentgen of x-rays.

Roentgen. The Roentgen is a unit for measuring ionization caused by gamma/x-rays in air. Therefore, it does not relate to the biological effects of radiation on the human body. It is a measurement of exposure.

SI prefixes. SI stands for "Système International d'Unités," or the international system of units. SI prefixes refer to the way many units are broken down into smaller units or expressed as multiples, using standard metric prefixes. Examples include a millirad (mrad) is 10^{-3} rad, a microRem (μRem) is 10^{-6} Rem, a nanogram is 10^{-9} grams, and a picoCurie is 10^{-12} Curies.

slug. A slug is a lump, disk, or cylinder of metal. During SPRU pilot tests, metal slugs (smaller than 6 inches in diameter) containing uranium and encased in aluminum were separated into plutonium and uranium.

surficial. Surficial means of or pertaining to a surface, especially the land surface: a surficial geologic deposit.

surveillance and maintenance. Periodic inspections and maintenance of structures, systems, and equipment necessary for the satisfactory containment of contamination to protect workers, the public, and the environment.

TBP/diluent. Solvent extraction is a process to recover, purify, or separate metals during liquid extraction. Solvent extraction refers to a process that transfers one or more components between two immiscible (or nearly immiscible) liquid phases. Many solvents can extract uranium, plutonium, or

thorium from acid solutions. One of these solvents is tri-n-butyl phosphate (TBP). The TBP is always diluted in an organic matrix, or diluent, to improve the physical characteristics of the organic phase.

Transuranic (TRU). Transuranics are elements heavier than uranium (e.g., plutonium) with half-lives greater than 20 years and concentrations of more than 100 nanoCuries per gram of waste. All transuranics are man-made alpha-emitters. SPRU operations involved TRU elements.

work breakdown structure (WBS). A deliverable-oriented grouping of project elements that organizes and defines the total scope of the project. Each descending level represents an increasingly detailed definition of a project component. Project components may be products or services. The WBS reflects the way in which project costs and data will be summarized and eventually reported.

2 EXECUTIVE SUMMARY

The *Nuclear Facility Historical Site Assessment for the Separations Process Research Unit (SPRU) Disposition Project* documents the identification, collection, organization, cataloguing, review, and analysis of available information for the SPRU Disposition Project. The SPRU facilities occupy approximately 5 acres on the Knolls Atomic Power Laboratory (KAPL) property in Niskayuna, New York. KAPL is owned by the U.S. government and operated by the U.S. Department of Energy (DOE) Office of Naval Reactors, Schenectady Naval Reactors, and their contractor, KAPL, Inc., a Lockheed Martin Company.

The SPRU Disposition Project includes both the SPRU nuclear facilities and land areas. The land areas are addressed in a separate historical site assessment.

The SPRU facilities were constructed to research the separation of plutonium and uranium from radioactive material encased in aluminum, known as slugs. SPRU operated between February 1950 and October 1953, when research activities ceased following successful development of the reduction oxidation (REDOX) and plutonium uranium extraction (PUREX) processes subsequently used by Hanford and the Savannah River Sites. The research was performed on a laboratory scale; SPRU was never a production plant. Decommissioning of SPRU began in October 1953 and continued through the 1990s. All SPRU facilities are under surveillance and maintenance.

This report organizes and compiles information for the following SPRU facilities:

- Building G2 – contains laboratories, hot cells, separations process testing equipment, and the pipe tunnels in G2
- Building H2 – contains equipment and tanks for liquid waste processing and includes the H2 Pipe Tunnel and H1 Cooling Towers
- Tunnels – contain piping, utilities, and equipment in each building and also connect Buildings G2 and H2 and Buildings G1 and E1
- Tank Farm – contains subsurface tank vaults and tanks along the eastern side of Building H2 for storing liquid waste.

In addition to summarizing the historical documentation, this historical site assessment addresses whether areas are impacted or not impacted by radioactive contamination, the contamination sources, the likelihood of contamination migration, threats to human health, and further characterization needs.

Impacted versus Non-impacted

The SPRU facilities are considered impacted by radioactive contamination above background levels. H2 and G2 have high to very high radiation and contamination areas based on survey data, guidance, and definitions provided in DOE-STD-1098-99, *Radiological Control*, as well as low radiation and contamination areas. The Tunnels and Tank Farm are both considered high radiation and contamination areas.

Sources of Contamination

SPRU processes were a contributor to the contamination in each of the facilities. The SPRU facility decontamination and decommissioning events through at least 1966 also generated radioactive waste. However, non-SPRU KAPL activities in G2, H2, the Tunnels, and the Tank Farm after SPRU decommissioning continued to contaminate these areas. Building H2 was used for waste management at least until 2001, when a new waste management facility at E11 became operational. The Tunnel piping is still used to transport liquid waste.

Likelihood of Contamination Migration

The Tank Farm vaults pose the highest potential for contamination migration relative to the other SPRU facilities. Contaminated water from unknown sources around H2 is collected in the H2 footer drains and treated in the Hillside Drain System. Buildings G2 and H2 are concrete structures with contaminated concrete and abandoned equipment and no evidence of migration from inside the buildings. If the facilities are demolished, a risk of releases to the air and soil exists. There is evidence of prior water seepage into the G2-H2 Tunnel as well as radioactive sludge in the north tunnel sump. There is no evidence that other SPRU areas are probable contamination pathways to the environment.

Natural events such as earthquakes, flooding, fire, or human accident scenarios have the possibility of altering the physical conditions reported in this historical site assessment, including the likelihood of contamination migrating to the environment.

Threat to Human Health

The SPRU facilities are identified and managed as radiological control areas with specific area access restricted as appropriate. Human health risk to the public and current workers is as low as reasonable achievable and is considered negligible. The greatest risk to human health is estimated to be for workers should demolition of the facilities occur, although the risk is considered manageable.

Further Characterization Needs

The Tunnels and the piping in the Tunnels potentially require additional characterization prior to demolition activities. There is little information regarding contamination in the Tunnels and piping. There were interview references to pipes being nearly full of sludge and other references indicating the pipes were flushed to remove residual sludge. Two H2 areas recommended for further characterization include the Hopper Cells and the Pipe Tunnel. The accessible areas of Building G2 were surveyed in 2004, and the Tank Farm tanks and vaults were characterized during the 1989 and 1998 surveys.

The conditions summarized above are based on historical site assessment information and assessments and are relevant only for the near future. Under current conditions and surveillance and maintenance activities, SPRU-related contamination is contained within the facilities, equipment, tanks, piping, and managed in the Hillside Drain System.

3 HISTORICAL SITE ASSESSMENT PURPOSE

The purpose of a historical site assessment is to determine and document the status of a site or facility following the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* guidance that resulted from U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and U.S. Nuclear Regulatory Commission (NRC) concurrence on an approach to conducting radiation surveys and investigations at potentially contaminated sites. This historical site assessment documents an investigation to collect existing information describing the Separations Process Research Unit (SPRU) facility history from the start of site activities to the present.

The SPRU Disposition Project is being implemented under DOE Manual 413.3-1, *Project Management for the Acquisition of Capital Assets*. The DOE Manual 413.3-1 applies to all DOE projects with an expected budget in excess of $5 million, and establishes a capital acquisition management system that organizes projects into four phases with associated "Critical Decisions." Information in the historical site assessment will provide input into the Critical Decision-1 package titled "Approve Alternative Selection and Cost Range." An Integrated Project Team of individuals with diverse backgrounds will provide input to and review of key decisions throughout all phases of the SPRU Disposition Project.

3.1 Historical Site Assessment Scope

The following SPRU facilities are addressed in this historical site assessment, and are shown in Figure 3-1. SPRU facilities addressed in this historical site assessment and the associated work breakdown structure (WBS) designation are listed and described in Table 3-1.

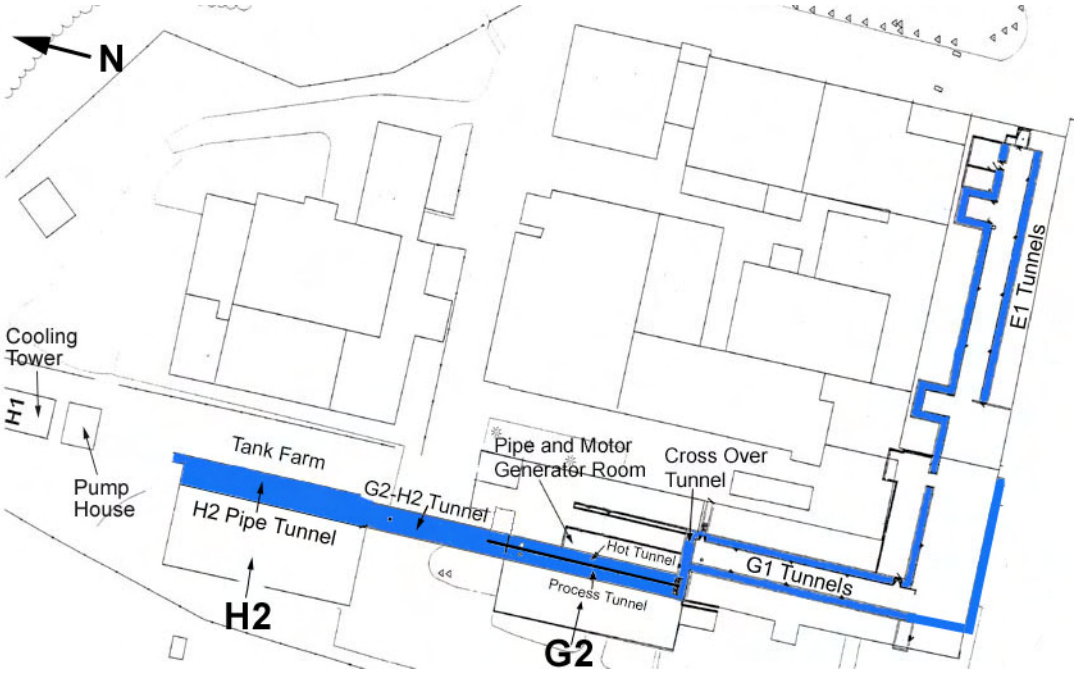


Figure 3-1. Structures in the Historical Site Assessment Scope (2004)

Table 3-1. SPRU Areas within the Scope of the Historical Site Assessment and Associated WBS

Historical Site Assessment Section and Scope	SPRU Facility and WBS	Areas Included in WBS
Section 7, G2 and G2 Pipe Tunnels Current Conditions Scope: G2 –laboratories, hot cells, separations process testing equipment, and the G2 Tunnels	G2 and G2 Pipe Tunnels WBS 1.4.8.10.2.2	G2 structure and contents; pipes; processing tanks Soil immediately adjacent to and below building Soil contaminated by discharges from building Stack and foundation G3 facility remnants
Section 8, H2, H1, and H2 Pipe Tunnel Current Conditions Scope: H2 - used for liquid and solid waste processing, H1 Cooling Tower, the Pipe Tunnel inside H2, and the Tank Enclosures * (but not the tanks)	H2 and Tank Enclosures WBS 1.4.8.10.2.3	H2 structure and contents; pipes; processing tanks; and Tank Enclosures H2 Pipe Tunnel Soil immediately adjacent to and below building Soil contaminated by building discharges including the hillside Stack and foundation Demolition of decontaminated Tank Enclosures H1 Cooling Tower Cooling Tower Pump House
Section 9, Tunnels Current Conditions Scope: Tunnels in and connecting G2 and H2 and between G2 and KAPL buildings G1 and E1	Tunnel Cleanout WBS 1.4.8.10.2.4	Pipes that are in G1 and E1 Tunnels Pipes that are in the G2-H2 Tunnel Decontamination of E1 and G1 Tunnels
Section 10, Tank Farm Current Conditions Scope: Tank Farm - a subsurface concrete-enclosed series of tanks along the east side of H2 used for storing liquid waste	Tank Enclosure Cleanout WBS 1.4.8.10.2.5	Six 10,000-gallon waste tanks and one 5,000-gallon waste tank adjacent to H2 Tank contents (tank heels, sludge, liquids, etc.) Piping (and contents) connecting the tanks with H2 Soil above and below the Tank Enclosures Decontamination of Tank Enclosures

* Tank Enclosures is the WBS term for Tank Vaults

The following areas in the proximity of the SPRU facilities are not included in this historical site assessment and are addressed in the *Land Areas Historical Site Assessment for the SPRU Disposition Project.*

- Upper Level Land Area
  - Soils and groundwater underlying and surrounding the SPRU Facility Area
- North Field Land Area
  - Former Slurry Drum Storage Area
- Lower Level Land Area
  - Lower Level Parking Lot
  - Railroad Staging Area
  - K4 and Laundry Lines
  - K5 Retention Basin
  - K6 and K7 Storage Pads (demolished and removed)
  - J3 Cold Incinerator
  - J4 and J5 Sand Filter Bed Area

3.2 SPRU Background

The SPRU nuclear facilities are located on the Knolls Atomic Power Laboratory (KAPL) site in Niskayuna, New York, and managed by the DOE Office of Environmental Management. KAPL is owned by the U.S. government and operated by the U.S. DOE Office of Naval Reactors, Schenectady Naval Reactors, and their contractor, KAPL, Inc., a Lockheed Martin Company. The KAPL mission is envisioned to continue past the 2014 time frame estimated for SPRU cleanup. Therefore, the anticipated SPRU future land use, or end state, is consistent with DOE's continued mission.

Construction began in 1947 under a contract between the General Electric Company (GE) and the Atomic Energy Commission. Originally, the site mission had a dual purpose: design and development of nuclear-powered reactors and conduct of pilot tests on chemical processes to separate plutonium and uranium from radioactive material encased in aluminum. The SPRU facilities were constructed to address the latter mission on a laboratory scale; SPRU was never a production plant (R-001546)[1].

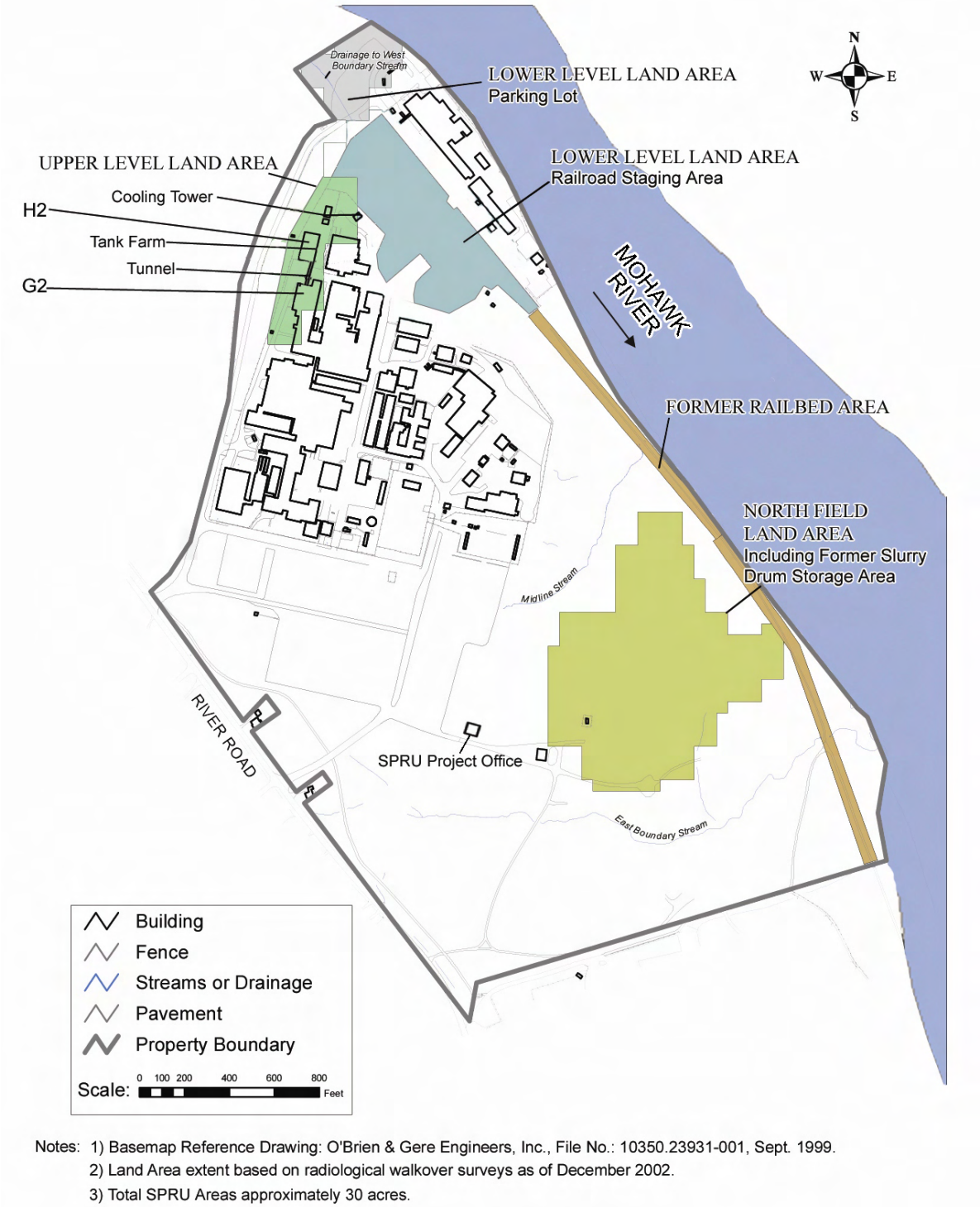
SPRU operated between February 1950 and October 1953, when research activities ceased following successful development of the reduction oxidation (REDOX) and plutonium uranium extraction (PUREX) processes subsequently used by Hanford and the Savannah River Site (R-000255). Decommissioning of SPRU continued through the 1990s; storage tanks were drained and flushed and steam, gas, and electrical services were shut down. The high efficiency particulate air (HEPA)-filtered exhaust system remained operational to maintain the buildings at a constant negative pressure. From the mid-1950s to the early 1990s, portions of Building G2 were modified and used by KAPL office workers and laboratory personnel (R-000255). Building H2 and the Tank Farm were partially shut down, but some areas remained in use for SPRU decommissioning activities and other KAPL waste management functions.

Section 6, SPRU Facility History, provides a comprehensive history.

[1] References in this historical site assessment are noted with parenthetical numbers that are listed in Appendix A, References.

4 PROPERTY IDENTIFICATION

The SPRU Disposition Project nuclear facilities are on the KAPL site in eastern New York State, approximately 2 miles east of the City of Schenectady. KAPL is located along River Road, on the south bank of the Mohawk River. The SPRU facilities are shown in Figure 4-1 and listed in Table 4-1.



Notes: 1) Basemap Reference Drawing: O'Brien & Gere Engineers, Inc., File No.: 10350.23931-001, Sept. 1999.
2) Land Area extent based on radiological walkover surveys as of December 2002.
3) Total SPRU Areas approximately 30 acres.

Figure 4-1. SPRU Disposition Project Areas

Table 4-1. SPRU Disposition Project Areas

Nuclear Facility Historical Site Assessment for the SPRU Disposition Project Scope
Building G2 *Building H2* *H2 Tank Farm* *Pipe Tunnels* *Hi Cooling Tower* *Cooling Tower Pump House*
Land Areas Historical Site Assessment for the SPRU Disposition Project Scope
Upper Level Land Area - Soils and groundwater underlying and surrounding the SPRU Facilities *North Field Land Area* - Former Slurry Drum Storage Area *Lower Level Land Area* - Lower Level Parking Lot - Railroad Staging Area - K4 and Laundry Lines - K5 Retention Basin - K6 and K7 Storage Pads (demolished and removed) - J3 Cold Incinerator - J4 and J5 Sand Filter Bed Areas

Neither the KAPL site nor the SPRU Disposition Project areas are on EPA's National Priorities List (C-000536, C-000537). In 1998, the New York State Department of Environmental Conservation (NYSDEC) completed a *Resource Conservation and Recovery Act* (*RCRA) Facility Assessment, Preliminary Review – Visual Site Inspection Report of KAPL*, and included SPRU Disposition Project areas (R-001546).

The solid waste management units (SWMUs) listed in Table 4-2 are within the scope of the *Nuclear Facility Historical Site Assessment for the SPRU Disposition Project.* The SWMUs were formerly listed in the KAPL Part 373 NYSDEC Permit #4-4224-00024/00001, and are now included in the *U.S. DOE SPRU RCRA Hazardous Waste Part A Permit Application*, dated February 1, 2004. The SPRU site EPA ID number is NYR 000 096 859. Soil and groundwater near these SWMUs are being characterized in accordance with work plans approved by NYSDEC.

Table 4-2. SPRU Facility Solid Waste Management Units

Name	SWMU Number	Description	Notes
H2 Tank Farm	SWMU-031	One 5,000-gallon and six 10,000-gallon stainless steel storage tanks in seven underground concrete vaults on the east side of H2	
SPRU Tank 527	SWMU-058	200-gallon stainless steel tank in G2 Cell 3	No further action per KAPL Site Permit.
SPRU Tank 531	SWMU-059	500-gallon stainless steel tank in the East Bay of G2 Cell No. 5	No further action per KAPL Site Permit.
SPRU Tank 532	SWMU-060	400-gallon stainless steel tank in the East Bay of G2 Cell No. 5	No further action per KAPL Site Permit.
SPRU Tank 534	SWMU-061	750-gallon stainless steel tank in the East Bay of G2 Cell No. 5	No further action per KAPL Site Permit.
SPRU Tank 551	SWMU-062	75-gallon stainless steel tank in the East Bay of G2 Cell No. 5	No further action per KAPL Site Permit.
SPRU Tank 536	SWMU-063	100-gallon stainless steel tank in the East Bay of G2 Cell No. 5	No further action per KAPL Site Permit.
SPRU Tank 316	SWMU-064	1,000-gallon stainless steel tank in the south end of G2 Cell No. 5	No further action per KAPL Site Permit.
Pipe Tunnels	SWMU-057	Tunnels located in and connecting the basement of G2 and H2	Inactive
H2 Processing Facility	SWMU-030	Waste Treatment Facility	Inactive

Source: U.S. DOE SPRU RCRA Hazardous Waste Part A Permit Application, dated February 1, 2004. EPA ID number is NYR 000 096 859.

4.1 Physical Characteristics

SPRU-related areas occupy approximately 30 acres of the 170-acre KAPL site. The SPRU facilities described in this historical site assessment occupy approximately 5 acres. The remaining 25 acres consist of the Lower Level and North Field Land Areas, which will be addressed in a *Land Areas Historical Site Assessment for the SPRU Disposition Project*.

Figure 4-2 shows the location of KAPL relative to its regional setting. The SPRU Project Office is located at 2425 River Road, Niskayuna, New York, 12309. The KAPL site and SPRU facilities are located on a bluff overlooking the southern bank of the Mohawk River. Surface elevations at the site range between approximately 330 feet above mean sea level at the top of the bluff to 230 feet on the lower portions of the site along the river. Figure 4-3 shows the KAPL property relative to its location in the Niskayuna area.

4.2 Environmental Setting

In the eastern portion of New York State near SPRU, the Mohawk River flows from west to east toward its confluence with the Hudson River approximately 15 miles downstream. The Mohawk River drains the southern portion of the Adirondack Mountains to the northwest and portions of the Catskill Mountains to the south. Median monthly discharge from the Mohawk River ranges between 2,000 and 10,000 cubic feet per second (USGS, 1996). Average annual precipitation near the site is 38 inches per year and average runoff is 18 inches per year. Surface water from the KAPL property drains to the northeast into the Mohawk River by way of three ephemeral streams: the East and West Boundary streams and the Midline Stream.

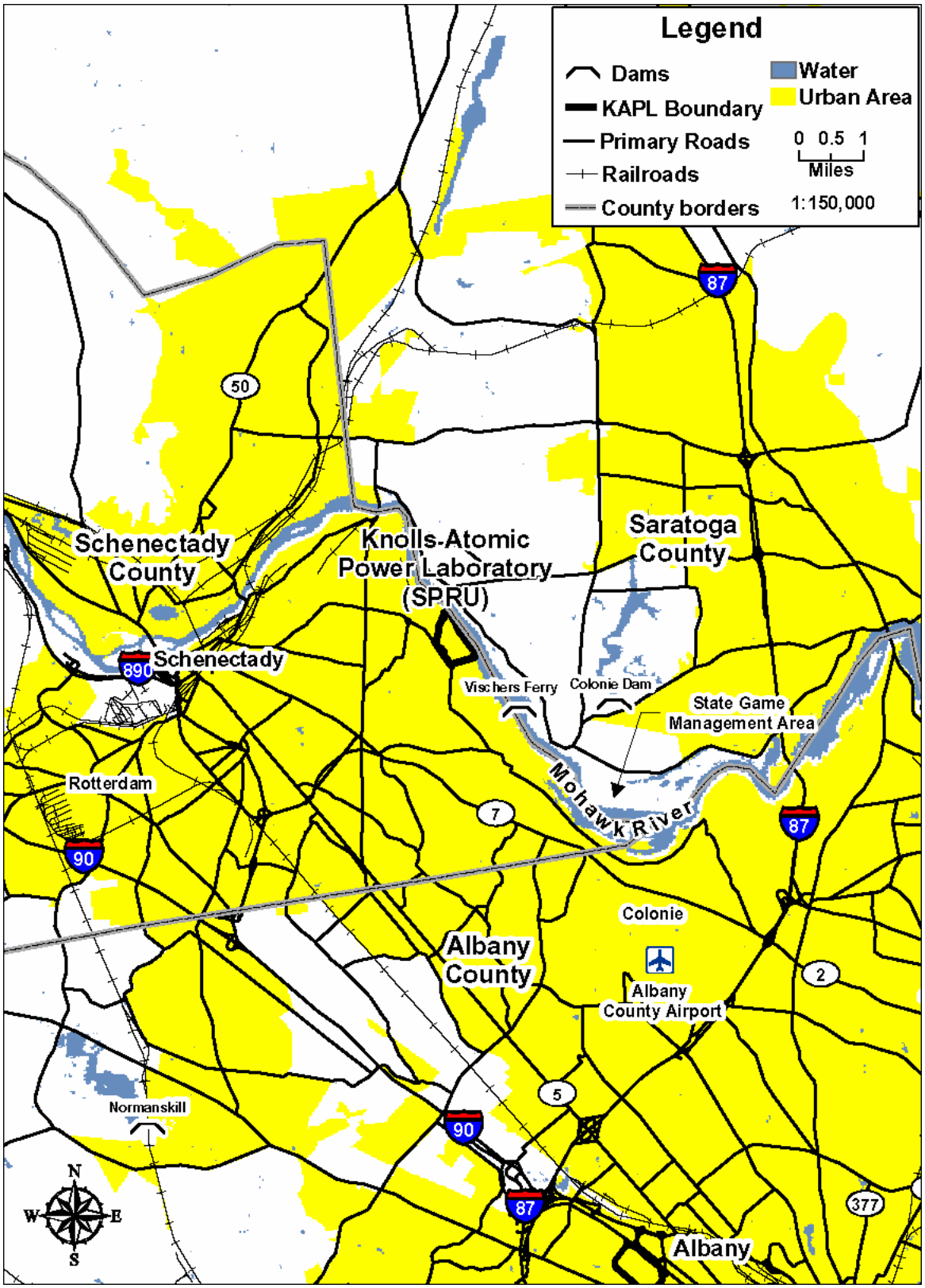


Figure 4-2. SPRU Area Map (2004)

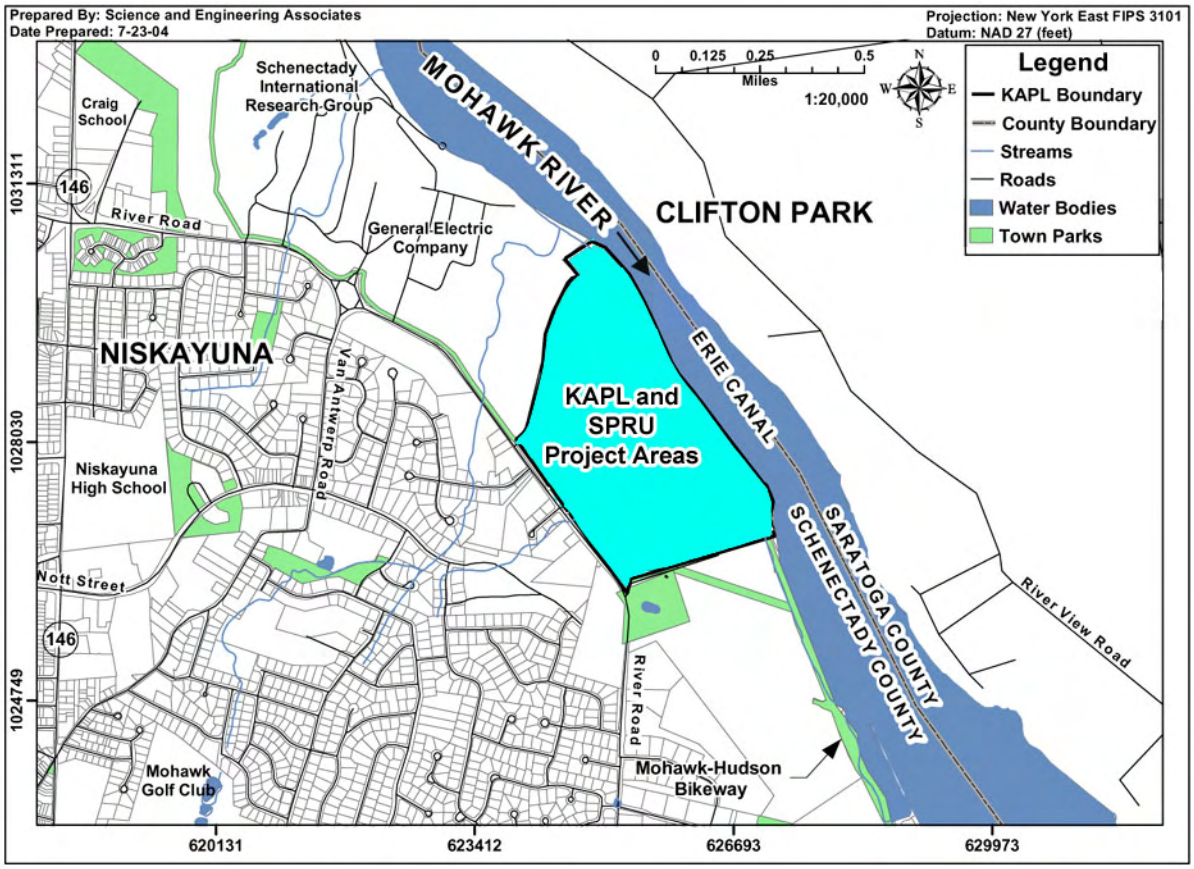


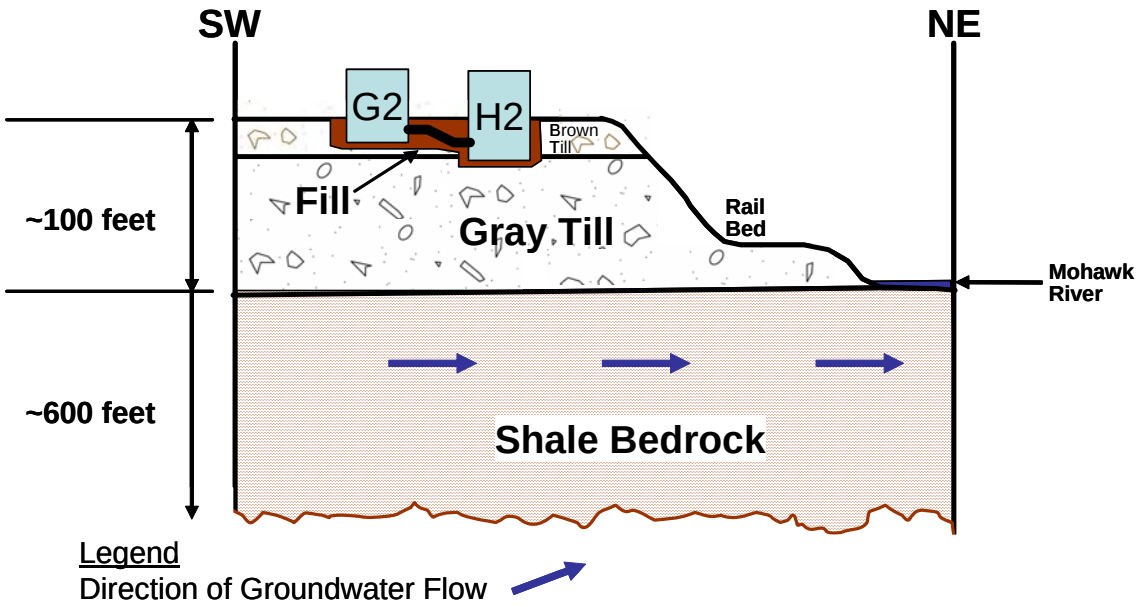
Figure 4-3. SPRU Vicinity Map (2004)

Surficial deposits at KAPL consist of tightly compacted glacial till up to 70 feet thick that acts as an aquiclude, minimizing the downward infiltration of water. The till thins toward the Mohawk River, where it is absent or up to a maximum of 10 feet thick. Glacial lake deposits of silt and fine sand are present at the surface in isolated areas on the KAPL site (R-000159, pp. 4-8). The surficial glacial deposits are underlain by bedrock consisting predominantly of Ordovician Schenectady Formation shale, with some interbedded siltstone that is up to 600 feet thick. The bedrock typically has low porosity and impermeability (R-000159, pp. 4-6).

Shallow, perched groundwater is encountered intermittently in the glacial till and lake deposits and, when found, is not laterally continuous. Where present, it is encountered between 5 and 10 feet below grade, with a general flow direction to the north or northeast (R-000159). Groundwater within the underlying bedrock is found locally within fractures and bedding planes and is not laterally continuous. Where encountered, the water table in the shale bedrock is approximately 70 feet below grade, and groundwater flow is generally to the north or northeast toward the Mohawk River (R-000159), moving at less than 5 to 10 feet per year (R-002032, p. 8). There are no aquifers suitable for development under the site because of the dense glacial till and low-permeability shale bedrock (R-002032).

Locally, shallow north and northeasterly perched groundwater flow patterns are perturbed at the KAPL site by streams, topography, and artificial fill for building and piping around G2, H2, and the tunnels (Figure 4-4) (R-000431). The G2 and H2 foundations extend to depths of 12 and 30 feet below grade, respectively. Shallow groundwater flows preferentially through the more permeable backfill around the tunnels, piping corridors, and buildings.

Shallow, perched groundwater flow is also locally affected by footing drains that were installed along the exterior of the H2 foundation. Between 1983 and 2001, an average of 79,000 gallons of water per year discharged from the footing drains to a hillside collection sump west of the building (R-000432, pp. 10, 11). Water continues to discharge to the hillside sump and it is actively collected, monitored, and treated before being released to the storm water system (C-002100).



Schematic Stratigraphic Cross Section
(Not to Scale)

R-000159, based on information from ERM-Northeast, 1992, *Final Report – Hydrogeologic Evaluation of the Knolls Atomic Power Laboratory – Knolls Site*, July 8, 1992.

Figure 4-4. SPRU Groundwater Schematic (2004)

4.3 Adjacent Land Use

Figure 4-5 shows land use in the areas adjacent to SPRU. SPRU is located within KAPL property, which occupies a strip of land along the southern bank of the Mohawk River. The area has been used for research and development since the late 1940s. GE continues to operate a research and development facility northwest of KAPL, and the Schenectady International Research Group is located further to the northwest along the river.

To the southeast of the SPRU facilities, on the KAPL property, is a research and development facility dedicated to support of the United States Naval Nuclear Propulsion Program. KAPL facilities include administrative offices; chemistry, physics, radioactive materials laboratories; engineering offices; computer facilities; machine shops; a sewage pumping station; a boiler house; oil storage facilities; cooling tower; and RCRA-permitted hazardous and mixed waste storage and treatment facilities.

Outside the KAPL boundaries, to the southwest, land use consists of medium- to high-density residential housing in Niskayuna, New York. To the southeast is the closed municipal landfill and Niskayuna recreational land consisting of hiking trails and a bike path. To the northeast, the Mohawk River is under the jurisdiction of the Canal Corporation. Across the Mohawk River is low-density residential housing in the Town of Clifton Park.

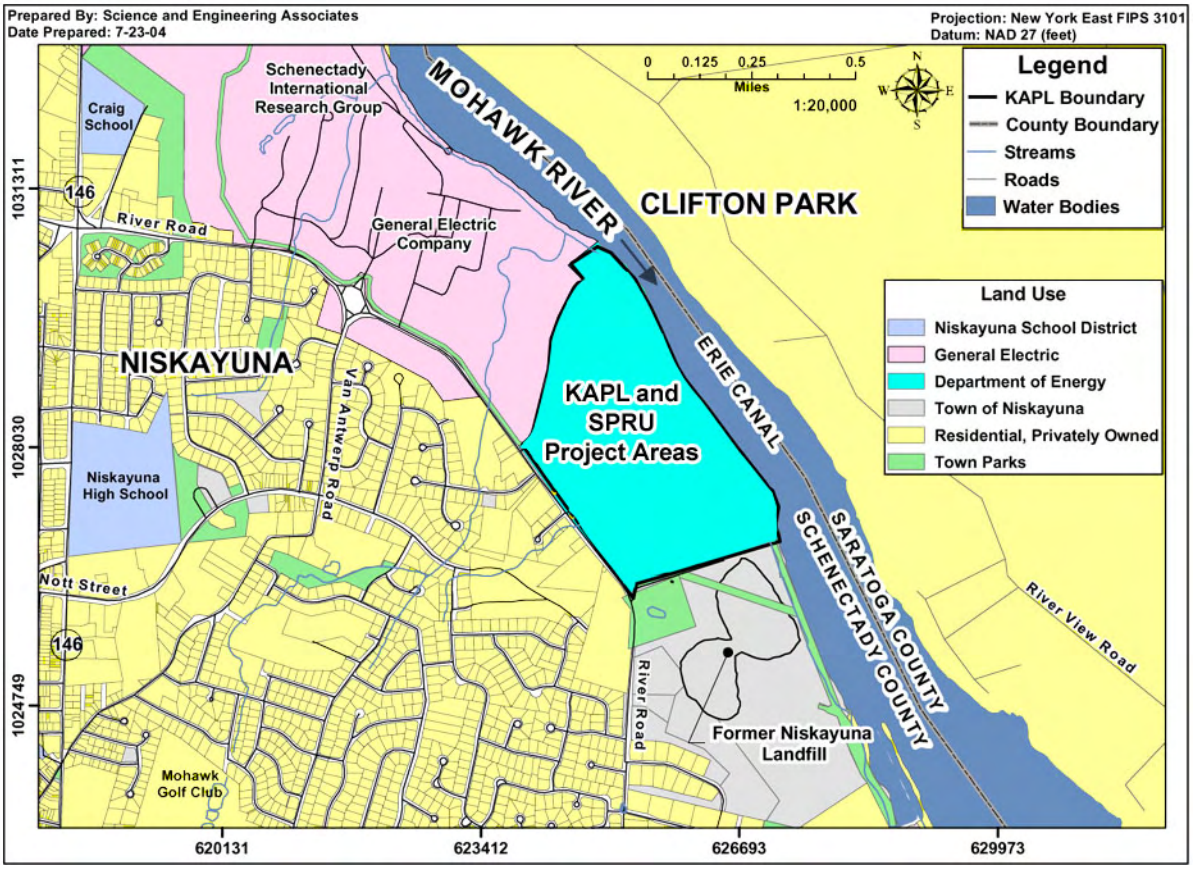


Figure 4-5. SPRU Disposition Project Surrounding Area Land Use (2004)

5 HISTORICAL SITE ASSESSMENT METHODOLOGY

Information for the *Nuclear Facility Historical Site Assessment for the SPRU Disposition Project* was compiled and reviewed following the methodology presented in the DOE Statement of Work dated September 12, 2003, and the approach outlined in MARSSIM. A project team with expertise in nuclear engineering and health physics, civil and mechanical engineering, waste management facilities, environmental remediation, and historical site assessment development conducted the historical research and report preparation. Site visits were made to observe existing conditions in SPRU facilities and to interview knowledgeable people. The following types of information were reviewed:

- Historical documents including SPRU Disposition Project correspondence and operational records from KAPL, SPRU, and other DOE sites' libraries and files
- Radiological survey data
- Technical drawings
- Property assessments
- Photographs and video documentation of the building interiors
- Interviews with past and current employees.

5.1 Documents Reviewed

The project team screened a list of approximately 3,000 documents for potential relevance to the *Nuclear Facility Historical Site Assessment for the SPRU Disposition Project*. Of these, approximately 1000 documents were reviewed for information pertinent to the assessment; more than 160 documents were pertinent references for this document. In addition, 13 videotapes, more than 2,000 drawings or maps, and approximately 680 historical photographs were researched and reviewed for input into this document. Current photographs of the interior and exterior of Buildings G2 and H2 are included in this document.

Documents reviewed included correspondence, radiological surveys, sampling data, permits, authorizations, and SPRU facility records from the time of construction to the present. The videotapes recorded historical inspections and radiological surveys that occurred in the SPRU facilities during the 1989 inspections of Building H2, Building G2 process areas and tunnels, the G1 and G2-H2 unnels, and the 1998 Tank Farm inspection. The drawings and maps, specifically engineering drawings such as blueprints and site plats and plots, provided information concerning the chronology of construction, historical research activities, and post-closure modifications to the SPRU facilities. (Note: as-built drawings for the SPRU facilities do not exist.) Historical photographs provided documentation of the construction process and current building configurations.

5.2 Site Visits

Project team personnel toured the following SPRU-related areas of KAPL and interiors of Buildings G2 and H2 to observe, assess, and document conditions:

- Tour of Upper and Lower Areas, March 12, 2004
- Tour of the interior of G2, exterior of H2 and G2, March 19, 2004
- Tour of the interior of G2, exterior of H2 and G2, April 13, 2004
- Tour of the interior of G2, exterior of H2 and G2, April 14, 2004
- Tour of the interior of G2, exterior of H2 and G2, and Land Areas, April 26, 2004
- Tour of the interiors of G2 and H2, May 11, 2004.

5.3 Personal Interviews

Project team personnel conducted interviews with former and current KAPL employees. Interview notes are recorded and archived with SPRU reference documents.

5.4 Radiological Contamination

After compiling information and data from available sources, the project team analyzed the information to determine whether SPRU facility areas were impacted or non-impacted, the level and type of contamination, the potential for contamination releases to the environment, and additional characterization needs.

Current radiological conditions in SPRU facility areas are derived from the most recent radiological survey data available. However, past radiological surveys targeted specific areas and no single survey covered all the SPRU facility areas. The primary radiological surveys used to show current conditions are as follows:

- 1989 (most of G2, H2, Tank Farm Vaults and Tanks, and some Tunnel areas)
- 1998 (Tank Farm Vault inspection)
- 2004 (accessible areas).

Historical site assessment drawings showing current radiological conditions are provided in Sections 7, 8, 9, and 10. Tables in Sections 7, 8, 9, and 10 include data from other historical survey events as appropriate.

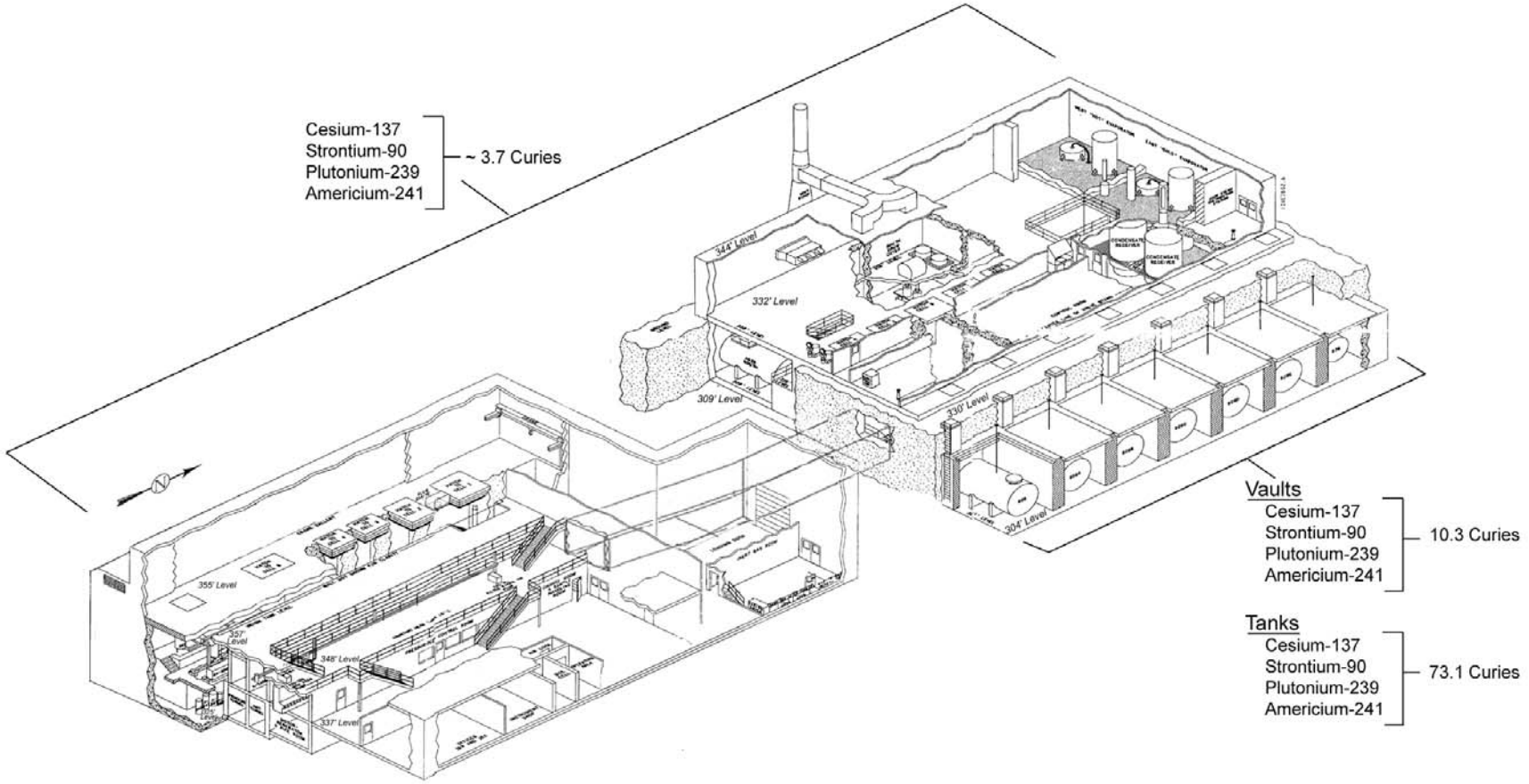
SPRU radionuclide distribution was calculated for the 1989 survey report, *Preliminary Evaluation of the Status of the Separations Process Research Unit* (R-001949), dated 1992. The estimated total residual SPRU radioactivity as presented on Figure 5-1 is 87 Curies (R-001949, Appendix C). It should be noted that there are inconsistencies and uncertainties identified in the *Preliminary Evaluation of the Status of the Separations Process Research Unit* report regarding the total amount and distribution of radioactivity in SPRU facilities.

For the Tank Farm tanks and vaults, "due to uncertainty in the calibration and actual locations of the detectors used for the radiation measurements, and in the density of the residue in the tanks, the uncertainty in the curie content (83.4) is estimated to be a factor of 2" (R-001949, p. C-3).

The Curie content of the rest of G2 and H2 Building complex is approximately 3.7 Curies. The values provided for the remainder of the G2 and H2 Building complex are very approximate values based on limited general area radiation level surveys which are not intended for Curie content estimates (R-001949, p. C-3).

The *Preliminary Evaluation of the Status of the Separations Process Research Unit* report further analyzes radiation amount and distribution as follows:

- "The quantities of radioactivity remaining are estimated to be in the range of 10 curies of plutonium and 80 curies of long-lived mixed fission products, principally strontium-90 and cesium-137; these estimates could vary by a factor of two (2)" (R-001949, p. 6).
- "The estimated total residual SPRU radioactivity is about 10 curies of plutonium and 77 curies of long-lived mixed fission products, principally strontium-90 and cesium-137; these estimates could vary by a factor of 2" (R-001949, p. 110).



Source: Preliminary Evaluation of the status of the Separations Process Research Unit (SPRU) October 1992, Appendix C (R-001949)

Note: Representation of building interior is not to scale.

Figure 5-1. SPRU Radiological Contamination Distribution (1992)

The DOE-STD-1098-99, *Radiological Control* (Change Notice No. 1, June 2004), provides criteria for defining radiation areas, contamination areas, and posting radiological controls. The project teams used this Standard as guidance for evaluating SPRU survey data and designating radiation and contamination areas on drawings showing current radiological conditions. Table 5-1 defines radiation areas and contamination areas according to the Standard.

Table 5-1. DOE-STD-1098-99 Criteria for Radiation and Contamination Areas

Area	Criteria	Required Posting	Posting and Protection
Radiation Area	Radiation levels could result in an individual receiving > 0.005 Rem in 1 hour at 30 cm	"CAUTION, RADIATION AREA" [see 835.603(a)]	"RWP[1] AND PERSONNEL DOSIMETER REQUIRED FOR ENTRY"
High Radiation Area	Radiation levels could result in an individual receiving > 0.1 Rem in 1 hour at 30 cm	"CAUTION" or "DANGER," "HIGH RADIATION AREA" [see 835.603(b)]	"PERSONNEL DOSIMETER, SUPPLEMENTAL DOSIMETER, AND RWP REQUIRED FOR ENTRY"*
Very High Radiation Area	Radiation levels could result in an individual receiving > 500 rad in 1 hour at 100 cm	"GRAVE DANGER, VERY HIGH RADIATION AREA" [see 835.603(c)]	"SPECIAL CONTROLS REQUIRED FOR ENTRY"*
Contamination Area	Removable contamination levels (dpm/100 cm^2) > Table 2-2 values[1] but less than or equal to 100 x Table 2-2 values	"CAUTION, CONTAMINATION AREA" [see 835.603(e)]	"RWP AND PROTECTIVE CLOTHING REQUIRED FOR ENTRY"
High Contamination Area	Removable contamination levels (dpm/100 cm^2) > 100 x Table 2-2 values[2]	"CAUTION" or "DANGER," "HIGH CONTAMINATION AREA" [see 835.603(f)]	"RWP AND PROTECTIVE CLOTHING REQUIRED FOR ENTRY"
Airborne Radioactivity Area	Airborne concentrations (µCi/ml) above background: 1) are > the applicable DAC[3] values[2]; or 2) could result in an individual (without respirator) receiving an intake > 12 DAC-hrs in a week	"CAUTION" or "DANGER," AIRBORNE RADIOACTIVITY AREA" [see 835.603(d)]	"RWP AND PROTECTIVE CLOTHING REQUIRED FOR ENTRY"

* Source: DOE-STD-1098-99, Radiological Control, June 2004. Table 2-2 refers to the Table 2-2 Summary of Surface Contamination Values [see 835 Appendix D] in DOE-STD-1098-99.

Notes: 1 RWP – radiological work permit
2 Levels exceed or are likely to exceed the listed values
3 DAC – derived air concentration

5.5 Chemical Analysis

Asbestos, polychlorinated biphenyls (PCBs), and other chemical surveys have not been performed in the SPRU facility areas. However, hazardous properties were common with the building materials, equipment, and other materials commonly used in the late 1940s and early 1950s. SPRU documentation does not include site characterization for these hazardous properties. The *Nuclear Facility Historical Site Assessment for the SPRU Disposition Project* recognizes the potential for chemical hazards but cannot identify current chemical conditions. If sample collection reveals concentrations of asbestos-containing building materials, PCBs, or heavy metals (e.g., lead, mercury, and copper) in excess of applicable regulatory thresholds, mitigation measures during decommissioning activities will be required.

The following is a partial list of potential asbestos-containing building materials, PCBs, and heavy metals associated with materials and equipment discussed in records reviewed and/or observed onsite:

- Asbestos-containing building materials are found in an estimated 3,000 product types manufactured primarily between 1940 and the present in the United States (www.epa.gov). Equipment and materials in SPRU associated with asbestos-containing building materials include fireproofing, ventilation materials, piping and other insulation, arc shields, steam flange gaskets, transite paneling, floor tile, exterior asbestos corrugated material, and mastic.
- PCBs are found in equipment, oil, and paint products manufactured primarily between 1929 and 1977 in the United States. More than 1.5 billion pounds were manufactured prior to cessation of production in 1977 (www.epa.gov). Remaining materials and equipment associated with SPRU research activities during this period include light ballasts, remnant oil products (e.g., ventilation system for dust control, spindle oil, electrical equipment), and painted surfaces.
- Heavy metals (e.g., mercury and lead) are found on painted surfaces and various equipment onsite. Electrical equipment remaining onsite include switches and relays and wiring. Other equipment onsite includes piping, meters, fluorescent lamps, and batteries. Lead shielding is abundant in the SPRU facilities.
- Unidentified sealants and plastic wall materials that may require special handling for removal (e.g., asbestos-containing materials, volatile organic compounds, etc.) were also used. For example, one reference described a sprayed, strippable film, which was applied to the internal surfaces to prevent adhesion of radioactive contamination to the building structure. The chemical constituents of this material were not revealed in documents reviewed (R-001949, p. 67).

6 SPRU FACILITY HISTORY

In May 1946, GE entered into a prime contract with the Atomic Energy Commission Production Division to operate the Hanford Engineering Works in Richland, Washington, and to build and operate a laboratory that would become KAPL. The Hanford program involved operating natural uranium-fueled reactors to produce plutonium, with KAPL providing Hanford technical and scientific support in designing and developing nuclear power reactors. In early 1947, the Atomic Energy Commission launched an urgent program to provide production facilities to recover plutonium and uranium from irradiated fuel. The Hanford fuel recovery plan was based on a solvent extraction process known as REDOX (reduction-oxidation) (R-000427). GE Hanford was requested to provide a full-scale REDOX plant at the Hanford site in Richland, Washington by late 1949, and in December 1947, requested a REDOX pilot plant to research the process.

SPRU Buildings G2 and H2, the connecting tunnels, and adjacent Tank Farm were constructed between 1947 and 1949 to perform pilot-scale tests on chemical separation processes (R-000255). Radioactive REDOX processing commenced in June 1950. In October 1950, the Atomic Energy Commission requested that SPRU be used to support DuPont in developing a fuel recovery plant at the Savannah River Plant in South Carolina, and by December, SPRU terminated REDOX testing and started modifications to support PUREX research. PUREX work at SPRU was terminated in June 1953. The SPRU plant decommissioning began in October 1953 (R-000427). Table 6-1 provides a chronological overview of events associated with SPRU.

Table 6-1. SPRU Timeline

Date	Noteworthy Event
May 1946	Atomic Energy Commission awarded General Electric the prime contract.
August 1947	Construction commenced.
December 1947	REDOX pilot plant construction requested by General Electric Hanford.
February 1948	Blaw-Knox (subcontractor) hired to design pilot plant.
June 1948	Pilot plant was named Separations Process Research Unit (SPRU).
July 1949	Pre-operational testing began.
February 1950	Non-radioactive REDOX runs initiated.
June 1950	Radioactive REDOX runs initiated.
October 1950	Atomic Energy Commission SPRU pilot plant supports DuPont in developing the PUREX process.
December 1950	REDOX testing terminated and PUREX modifications began. Between June and December 1950, 54 REDOX separation process runs were performed.
February 1951	First PUREX run initiated.
June 1953	PUREX work terminated.
October 1953	SPRU decommissioning activities began to close and secure the SPRU research facilities to provide adequate protection from radiation exposure and to isolate radioactive contamination from the human environment. Decontamination, deactivation, and decommissioning activities included: • Flushing out all tanks with nitric acid and water • Steam, gas, and electrical services shut down • Fuses removed from electrical disconnect switches • Inlet air dampers to the cell areas were closed • HEPA-filtered exhaust ventilation left operational to maintain facility at negative pressure to control airflow into these areas and to monitor discharges. (R-001949, p. 5)

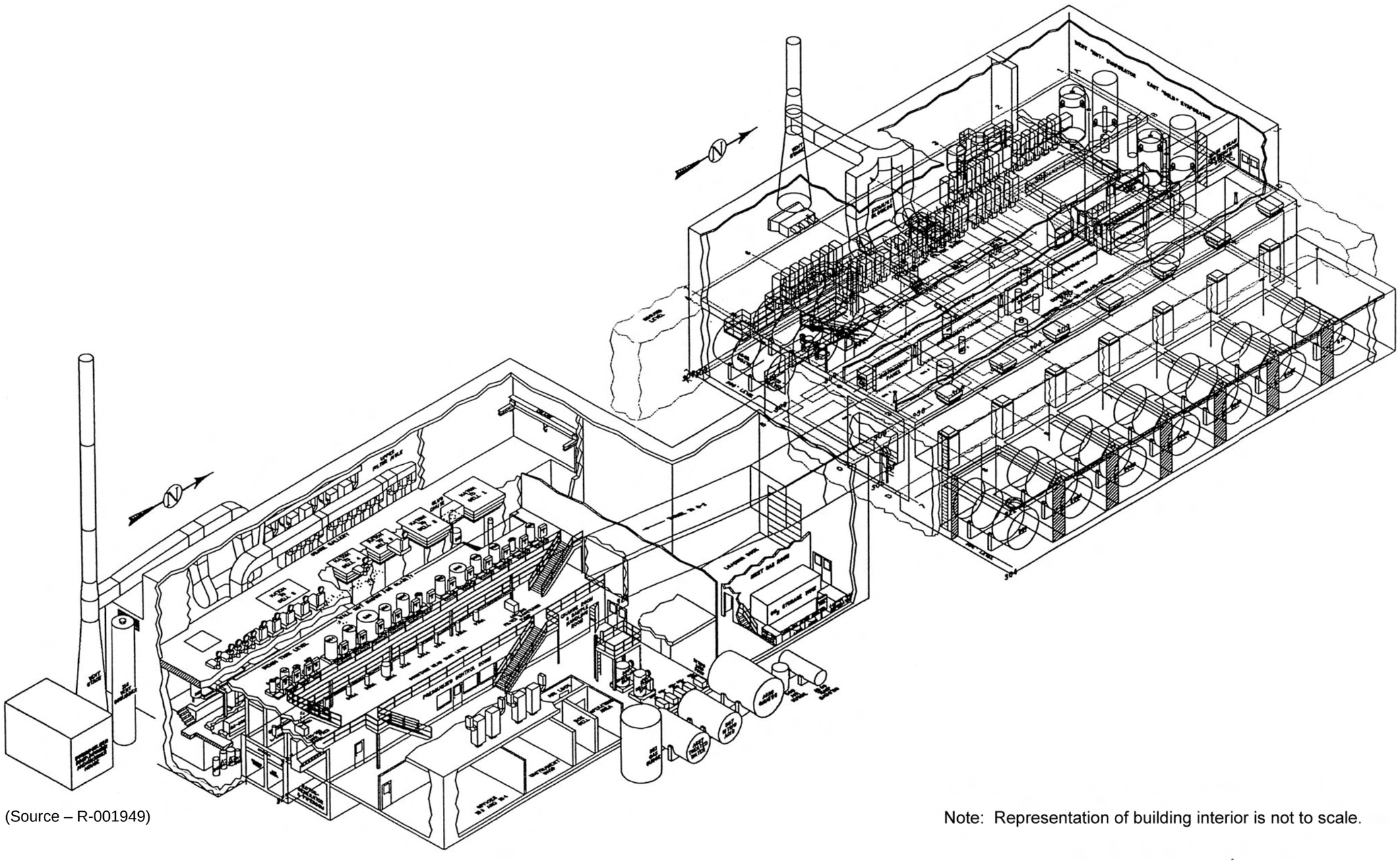
Date	Noteworthy Event
1954 - 1960s	Several G2 areas were decontaminated and converted to office, laboratory, and library space. H2 waste treatment continued. Building H2 waste incinerator was shut down. SPRU ventilation stack was moved to the Radioactive Materials Laboratory. Remaining SPRU waste was removed from Tank Vaults and processed (1965). Significant decontamination and modifications were performed in Building H2 (1966). Use of Building H2 evaporators was discontinued.
1970s	Waste baler moved from L7 to Building H2. Facilities Deactivation Program initiated (1977). Reuse water system operational (1977). Use of Tank Vaults for Radioactive Materials Laboratory waste and water collected from Building G2/H2 Pipe Tunnel sump discontinued (1978). Building F5 (Slurry Drum Storage) removed (1978). Routine entry into several SPRU areas discontinued.
1980s	G3 Pump House and Scrubber Stack removed (1986). Comprehensive SPRU physical inspection and radiological surveys conducted, including Subsurface Penetrating Underground Detector (SPUD) surveys (1989). New Hillside Water System put on line (1989).
1990s	Current SPRU Maintenance and Surveillance Program initiated (1990). Memo of understanding between DOE and Naval Reactors signed, establishing roles and responsibilities for decommissioning SPRU (September 1992).
1998	SPRU Tank Vaults inspected.

Reference: Separations Process Research Unit (SPRU) History and Current Status, April 1998 (R-000255).

REDOX and PUREX processes performed in G2 generated waste that moved through the G2-H2 Pipe Tunnel and was treated in H2. Interconnectivity also included:

- Building H2 nitrogen was supplied from G2, and G2 cooling water came from H2 (C-000461).
- Uranium solution was concentrated and drummed in H2 and returned to G2 for reuse (C-000461).
- The carbon dioxide fire fighting system storage tanks and controls were located in G2.
- A separate header connected to a storage tank in H2, but the main control valve and panel was located in G2 (C-000476).
- The H2 compressed air header originated at the main header in G2, and valve and filter controls were located in G2 (C-000476).
- Alarm and intercom systems of both buildings were interconnected. Any alarm in H2 simultaneously set off in G2 (C-000476).
- The buildings were established as a material balance area for accountability (C-000476).
- G2 personnel supported H2 activities and vice versa (C-000475).

An isometric drawing of the 1949 G2 and H2 configuration is provided in Figure 6-1.



(Source – R-001949)

Note: Representation of building interior is not to scale.

Figure 6-1. G2-H2 Isometric Drawing, 1949 Configuration

6.1 Building G2 History

The SPRU pilot plant was used for research in Building G2 between 1950 and 1953 to test chemical processes for separating plutonium and uranium from radioactive material encased in aluminum, called slugs. REDOX chemical test runs were performed until the end of 1950, and PUREX test runs until mid-1953 when the technique was successfully exported for use at Hanford and the Savannah River Site (R-000255). Separated plutonium was transferred to the Los Alamos National Laboratory (C-000469).

REDOX and PUREX Process Summary

The following narrative and figures describe the processes that occurred during SPRU operations. More detailed information on the REDOX and PUREX chemical processes and G2 equipment used for the processes is available in the October 1992, *Preliminary Evaluation of the Status of the Separation Process Research Unit (SPRU)* report (R-001949) and in the following Appendix B drawings.

Drawing No. 2828-92-2, Flow Diagram, March 29, 1948
Drawing No. 2828-92-3, Flow Diagram, June 29, 1948
Drawing No. 2828-92-4, Flow Diagram, May 8, 1948
Drawing No. 2828-92-5, Flow Diagram, March 17, 1948
Drawing No. 2828-92-6, Flow Diagram, May 17, 1948
Drawing No. 2828-92-7, Flow Diagram, June 29, 1948
Drawing No. 2828-92-8, Flow Diagram, May 8, 1948.

SPRU REDOX runs started in 1950, and the program was completed at the end of the year. The DuPont Company believed that mixer-settlers would be adopted for the PUREX process planned for the Savannah River Plant it was building, so during 1951, associated studies were conducted at the SPRU pilot plant. A series of demonstration runs were performed during the first half of 1952, and alternate PUREX processes were studied and further head-process refinements were developed in the second half of 1952 and the first half of 1953 (R-000472).

Separations were accomplished in equipment located in concrete-shielded G2 cells. Many variations were tested, but the general process is diagrammed in Figure 6-2 and summarized as follows:

(1) Dissolution of slugs (Cell No. 2)

- Slugs were dropped into the dissolver.
- The aluminum slug jacket was dissolved, and the dissolved aluminum transferred to waste storage areas.
- Irradiated uranium metal was dissolved for subsequent processing.

(2) Head-end separation (Cell No. 1)

- Prior to solvent extraction, the slug solution was processed, including precipitation and centrifugation to remove specific fission products.

(3) Feed preparation (Cell No. 1)

- The slug solution (hot feed) was chemically adjusted to meet solvent extraction process requirements (1AF stream – aqueous feed).
- Reagent streams (cold feed) were chemically adjusted at the Weigh Tank level to meet solvent extraction process requirements (1AX stream – organic extraction reagent; 1AS stream – aqueous scrubbing reagent).

(4) Chemically adjusted hot feed (1AF) and cold feed (1AX and 1AS) streams were processed through the solvent extraction units. The extraction process consisted of three cycles:

- First extraction cycle: Uranium and plutonium were separated from the radioactive fission products and each other:
  - In Cell No. 3 (the 1A bank), the 1AF aqueous feed, the 1AX organic extraction reagent, and 1AS aqueous scrubbing reagent streams were continuously contacted, resulting in the 1AP organic product stream containing uranium and plutonium and the 1AW aqueous waste stream containing fission products.
  - In Cell No. 4 (the 1B bank), the 1AP organic product stream was contacted with the 1BS organic reagent and 1BX aqueous reagent streams in a continuous manner, resulting in the 1BP aqueous product stream containing the plutonium and the 1BU organic product stream containing the uranium.
  - In Cell No. 5A (the 1C bank), the 1BU organic product stream was contacted with the 1CX aqueous reagent stream, resulting in the 1CW organic waste stream containing low-level fission products and the 1CU scrubbed aqueous product stream containing uranium.
- The second plutonium extraction cycle involved additional removal of residual fission products from the recovered plutonium using either the solvent extraction method (described here) or the ion-exchange method.
  - In the 1BP concentrating system, the 1BP aqueous product stream from the 1B bank was chemically adjusted, resulting in the 2AF feed stream.
  - In the 2A bank (Cell No. 5D), the 2AF feed stream was contacted with the 2AS aqueous reagent and 2AX organic reagent streams in a continuous manner, resulting in the 2AW aqueous waste stream containing low-level fission products and the 2AP organic stream containing the plutonium.
  - In the 2B bank (Cell No. 5C), the 2AP organic stream was contacted with the 2BX aqueous reagent stream, resulting in the 2BW organic waste stream containing low-level fission products and the 2BP aqueous product stream containing the plutonium.
- The second uranium extraction cycle involved additional removal of residual fission products of recovered uranium using the solvent extraction method.
  - In the 1CU concentrating system, the 1CU scrubbed aqueous product stream from the 1C bank was chemically adjusted, resulting in the 1DF feed stream.
  - In the 1D bank (Cell No. 5B), the 1DF feed stream was contacted with the 1DX organic reagent and 1DS aqueous reagent streams in a continuous manner, resulting in the 1DU organic stream containing uranium and the 1DW aqueous waste stream containing low-level fission products.
  - In the 1E bank (Cell No. 5C), the 1DU organic stream was contacted with the 1EX aqueous reagent stream, resulting in the 1EW organic waste stream containing low-level fission products and the 1EU scrubbed aqueous product stream containing the uranium.

Organic waste streams from the PUREX process were washed for reuse in the solvent extraction process. The aqueous waste solutions were transferred to Building H2 for concentration and storage.

The processes performed in G2 involved both radioactive and chemical constituents. Tables 6-2 and 6-3 summarize the hazardous and radioactive materials that were, or are, present in Buildings G2 and H2, the tunnels, and the Tank Farm.

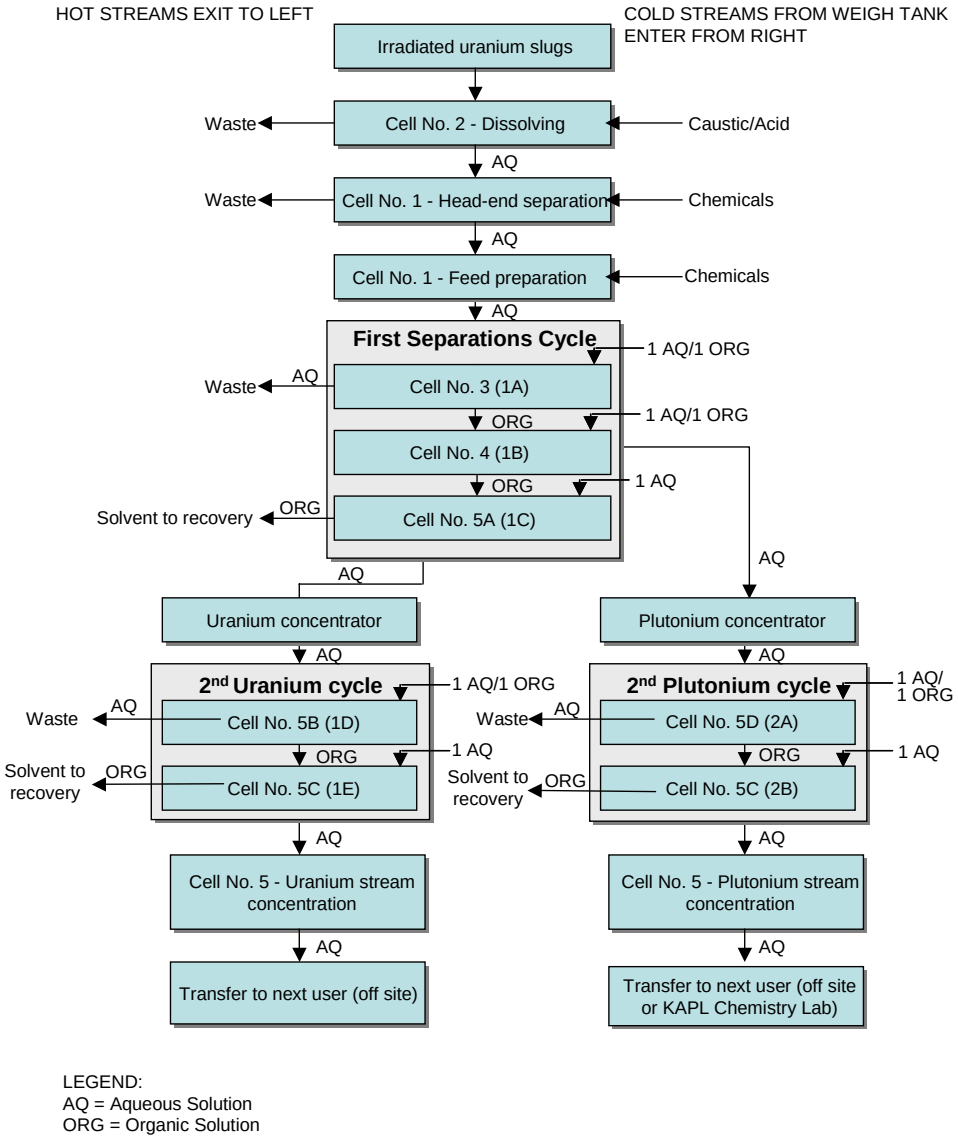


Figure 6-2. G2 Separations Process Summary

Table 6-2. SPRU Radioactive Constituents based on Historical Radiological Surveys

Radionuclide (half-life)		
Am-241 (430 yrs)	Pr (isotope unknown)	Th-231 (26 hours)
Ba-137m (2.6 minutes)	Pu-238 (88 yrs)	Th-234 (24 days)
Cs-134 (2.1 yrs)	Pu-239 (24,000 yrs)	U-234 (240,000 yrs)
Cs-137 (30 yrs)	Pu-240 (6,500 yrs)	U-235 (700 million yrs)
Eu-154 (8.8 yrs)	Pu-241 (14 yrs)	U-238 (4.5 billion yrs)
Eu-155 (5 yrs)	Ra-226 (1,600 yrs)	Y-90 (64 hours)
H-3 (12 yrs)	Sr-90 (29 yrs)	
Pa-234m (1.2 minutes)	Thorium (isotope unknown)	

Section 5.5, Chemical Analysis, provides general information about the chemicals that may be present in the SPRU facilities. Table 6-3 summarizes the hazardous materials associated with SPRU or subsequent processes.

Table 6-3. SPRU-Related Hazardous Constituents and Products

Chemical/Compound/Product	Description and Reference
Acetone	Control valve cleaning following degreasing using CCl_4 and acetone (R-000009, p. 1).
Acidified methyl isobutyl ketone	Unknown (R-001949).
Aluminum (Al)	Detected in 1965, Tank Farm Vault. See aluminum nitrate and aluminum oxide below (R-000026, p. 1, R-000048, p. 34).
Aluminum nitrate Al $(NO_3)_3$	Used in uranium transfer. REDOX only (R-000026, p. 1).
Aluminum oxide, Alumina (Al_2O_3)	Nitric acid solution, ultrasene, and a slurry of Al_2O_3 in water and in acid were used as decontaminating agents for small pieces of equipment such as the caps of sample bases and the interface liquid level floats from the 1C bank (located in Cell No. 5A) (R-000048, p. 34).
Ammonium bifluoride (NH_4HF_2)	Tank decontamination Cell No. 1 (R-000046, pp. 63, 65).
Amsco (Product)	Purchased from the American Spirits Company, possibly used as a diluting agent and as a calibrating fluid or solvent (C-000493, p. 2).
Bismuth (Bi(III))	Laboratory studies. Retention of iodine in process solutions by mercuric salts was studied as a way to hold iodine in solution during various steps of the bismuth phosphate process according to a document dated 1953. It was not clear from the reference whether this activity was associated with SPRU processes in Buildings G2 or H2 (R-000025, p. 1).
Cadmium (Cd)	Elevated concentration noted during 1998 Tank Farm Vault inspection. Vault #509C had the greatest concentration. Vaults 509D and 505 did not have detectable concentrations (R-000025).
Calcium (Ca)	Detected in 1965, Tank Farm Vault. See calcium hypochlorite below (R-000034, p. 82).
Calcium hypochlorite $(Ca(ClO))_2$	Perchloron. Prevents algae growth in cooling tower. Also used in internal tank decontamination (R-000034, p. 82).
Carbon tetrachloride (CCl_4)	Control valve degreasing (R-000009, p. 1).
Cerium (Ce)	Rare earth found in 1BP (located in Cell No. 4) (R-000048, p. 29).
Copper (Cu)	Detected in 1965, Tank Farm Vault. Laboratory studies involving complexing agents tried included copper (Cu(II)). It was not clear from the reference whether this activity was associated with SPRU processes in Buildings G2 or H2. Also, possible result of copper piping deterioration (R-000025).
Floor sealant (Product)	Unknown constituents. The sealant was described generally as a combustible material.
Hexone	Used in SPRU. Open air burning in 1958 proposed. Hexone distilled (relatively free of radioactivity), then proposed to ship to Hanford (C-001957). REDOX process Cell No. 5 - flammable solvent (R-001949, p. 9; R-002087, p. 21).
Hydrocarbons	Back-up generators, pumps/motors, tar, grease.
Hydrofloric acid (HF)	Reacts with solvents and metals. Decontamination of tanks in Cell No. 1 (R-000046, p. 65).

Chemical/Compound/Product	Description and Reference
Iodine (I)	Cake wash, radio-iodine analysis. The iodine balance in the PUREX head-end was described as a method for radio-iodine analysis based on extraction and carrier precipitation and was used for dissolver and hot feed solutions (R-000026, p. 1).
Iron (Fe)	Detected in 1965, Tank Farm Vault. Associated with the second Pu cycle. Iron powder was used in SPRU. Hanford report Hw-22086 reported that sponge iron is satisfactory for use in REDOX plant for making ferrous sulfamate (R-000039, C-000493).
Kerosene (Product)	Amsco (a diluent) and ultrasene kerosene (R-000001, p. 7).
Lead (Pb)	Flooring, plating, paint (lead-based). Lead shields were placed around the flange connections at the top of the simmer tank and the centrifuge agitator shaft to reduce the radiation level. Also, final degradation of radioactive materials. Laboratory studies (R-000046, p. 58).
Magnesium (Mg)	Detected in 1965, Tank Farm Vault. See discussion of magnesium oxide below (R-000001, p. 3).
Magnesium oxide (MgO)	Cake. Magnesium oxide (MnO_2) was used during centrifuging (R-000001, p. 3).
Manganese (Mn)	Elevated concentration noted during 1998 Tank Farm Vault Inspection and detected in 1965. Vault 509D had the greatest concentration. See discussion manganese dioxide, manganese nitrate, sodium permanganate and potassium permanganate below (R-000026, p. 3).
Manganese dioxide (MnO_2)	Cake in the centrifuge (R-000026, p. 3).
Manganese nitrate ($Mn(NO_3)_2$)	Added with permanganate as a part of the head-end treatment in Runs 1-7, July 1952, KAPL 785. Discussed as general use in process (R-000026, p. 3).
Manganese (II) (Mn(II))	Formed by the radiation-induced decomposition of the MnO_2 cake in the centrifuge (R-000041).
Mercury (Hg, Hg (II))	Elevated concentration noted during 1998 Tank Farm Vault inspection. Vaults 509B and 509C had the greatest concentrations. Air sparging/iodine laboratory studies. It was not clear from the air sparging reference whether or not this activity was associated with SPRU processes in Buildings G2 or H2. Equipment may also contain as follows: meters, fluorescent lamps, batteries, switches & relays, vacuum gauges/tubes, thermostats, mercoid switches, thermowells, thermocouples, thermometers (R-000025, p. 1; C-000031, p. 3).
Niobium (Nb)	Detected in 1965, Tank Farm Vault. Nb-Zr decontamination. Used in centrifugation (Cell No. 1). Following the completion of the PUREX runs, the pilot plant was reportedly used from at least December 1953 through March 1954 to prepare source material for another project, which was concerned with the isolation of radioactive Nb-Zr (R-000014, p. 2; R-000001, p. 3).
Nitric Acid (HNO_3)	Used for decontamination of Cell No. 1 (R-002087, p. 26).
Nitrogen gas	Nitrogen was blown through service lines to displace water in the vessel hosting jackets prior to the entry of steam in order to prevent steam hammering. Nitrogen is not likely to remain in G2 (C-000503, R-001949).
Oil (Product)	Spindle oil, pump oil, motor oil, oil to suppress dust. May contain PCBs or other constituents (R-001949, p. 49; R-002087, p. 21).
Oxalic acid $(COOH)_2$	Tank decontamination Cell No. 1 (R-000046, pp. 63, 65).
Permanganate (MnO_4)	Water treatment, head-end step. Added with manganese nitrate as a part of the head-end treatment in Runs 1-7, July 1952, KAPL 785. Sodium permanganate was substituted for potassium permanganate to take advantage of greater solubility and ease of solution (R-000049).
Peroxide	Peroxide preparation, second Pu cycle, to concentrate Pu solution. The elute is precipitated with peroxide. Sulfamic acid introduced as a part of a flush process. Additional steps described included mention of chemicals as follows: a sulfate wash of the resin and elution with nitric acid plus sulfamic acid produced an elute, which was precipitated with peroxide prior to shipment to Los Alamos (June 1952) in the second Pu cycle, which resulted in concentration of the plutonium solution (R-000038, p. 1).
Potassium permanganate ($KMnO_4$)	Sodium permanganate was substituted for potassium permanganate to take advantage of greater solubility and ease of solution (R-000049).
Ruthenium (Ru)	Scrubber contaminant. Approximately 3 percent of the ruthenium (Ru) was found in the scrubber. What was described as a "major portion of ruthenium" was evolved in the simmer tank and plated out on the walls of the tank (R-000026, pp. 3, 4; R-000046, p. 58).
Shop Coolant D-3 (Product)	Unidentified coolant. Possibly ethylene glycol or similar.
Silica	Entrained silica particles heavily laden with Zr and Nb accounted for most of excess activity in runs 18 and 19 resulting in low gamma decontamination factor of the uranium streams. Postulated that the silica particles resulted from dissolution of slug jacket loading material (R-000049).
Silicon (Si)	Detected in 1965, Tank Farm Vault (R-000049).

Chemical/Compound/Product	Description and Reference
Silver (Ag, Ag (II))	Elevated concentration noted during 1998 Tank Farm Vault Inspection. Vaults 509B and 509C had the greatest concentration. It was not clear from the reference whether this activity was associated with SPRU processes in Buildings G2 or H2. Complexing agents tried included silver Ag (I) (R-000025, p. 1).
Sodium (Na)	Detected in 1965, Tank Farm Vault. See discussion of sodium carbonate, sodium hydroxide, and other sodium compounds below (R-000026, p. 1).
Sodium carbonate (Na_2CO_3)	Washing agent (decontamination solvent) (R-000026, p. 1).
Sodium chloride	Unknown (R-001949).
Sodium citrate ($C_6H_5Na_3O_7$)	Decontamination of Cell No. 1. Cake Dissolving: Originally the procedure was discussed whereby the solid material was to be sent directly to storage in mild steel tanks without further concentration and with little or no neutralization. Sodium citrate and nitric acid (solvents) were considered and several tests were made (R-000046, pp. 50, 63, 65).
Sodium dichromate	Corrosion prevention in cooling towers south of G2 and adjacent to H2. Sodium dichromate was added to the basin to reduce the amount of corrosion in pipes (R-000034, p. 82).
Sodium hydroxide (NaOH)	Used to adjust the pH evaporation. Washing agent (decontamination solvent). Discharge to Mohawk River. Reacts with w/solvents and acids. NaOH spray is a part of the G2 cleaning process. Decontamination of Cell No. 1 (R-001949).
Sodium nitrate ($NaNO_2$)	Sodium nitrate ($NaNO_2$) was used in the second uranium run (November 1952-January 1953) to treat the feed mixture. Sodium nitrate was also added to manganese dioxide (MnO_2) particles as they passed through the centrifuge to the feed during the plutonium valence adjustment, resulting in a deterioration of the Nb-Zr decontamination. By product of nitric acid + solvent + metal. Part of flush in second Pu cycle run with Na_2SO_4 and Fe (NO_3) (R-000047, p. 2; R-000047, p. 3).
Sodium permanganate ($NaMnO_4$)	Sodium permanganate was substituted for potassium permanganate to take advantage of greater solubility and ease of solution (R-000049; R-000001, p. 4).
Sodium sulfate (Na_2SO_4)	Cold 2AF mixture with Fe (NO_3) and $NaNO_2$ second Pu cycle.
Sulfamic acid (NH_2SO_3H)	Part of flush process. Ion exchange for second plutonium sequence additive (R-000001, p. 13).
Tributyl phosphate (TBP)	At least some needed to be butanol free, of the purest grade to avoid possible formation of nitration products (C-000493).
Trisodium phosphate (Na_3PO_4)	Decontamination of cells (R-000046, p. 67).
Ultrasene	Type of kerosene that replaced Amsco (a diluent) because of flash point. Closed-cup flash point of ultrasene is 160 degrees F, approximately 15 degrees higher than Amsco (R-000049).
Versene	Ethylene diamine tetracetic acid. Chelating agent used to control metal ions over a broad pH range in aqueous systems.
Zinc (Zn (II))	Elevated concentration noted during 1998 Tank Farm Vault inspection. Vault #509C had the greatest concentration. Laboratory studies involving retention of iodine in process solutions by mercuric salts. It was not clear from the reference whether this activity was associated with SPRU processes in Buildings G2 or H2. Complexing agents tried included Zn (II) (R-000025, p. 1).
Zirconium (Zr)	Detected in 1965, Tank Farm Vault. Head-end step during SPRU (R-000001, p. 3).

Decontamination activities performed after SPRU test runs were completed are summarized in Table 6-4, Building G2 Decommissioning Activities Summary.

Periodic inspections of G2 were conducted after SPRU decommissioning (R-000025). Between May 1989 and October 1989, three inspections were conducted on the Lower and Upper Sample Aisles, Cell No. 5 complex, Cell Access Aisle, Pump Room, and Cells No. 1, 2, 3, and 4 (R-001949, p. 82). Between May 10, 1989 and June 15, 1989, the Upper and Lower Sample Aisles; Cell 1, 2, 3, 4, and 5; and the Cell Access Aisle, Motor Generator Room, and Pump Room were entered. The Crossover Tunnel, G1 West Tunnel, G2 Process Tunnel, G2 Hot Tunnel, and the G2-H2 Tunnel also were inspected (R-001949, p. 88). The October 1992 document, *Preliminary Evaluation of the Status of the Separation Process Research Unit (SPRU)*, reports results of the inspections (R-001949).

Table 6-4. Building G2 Decommissioning Activities Summary

Date	G2 Decommissioning Activity
1953	Process cell inlet dampers were closed (R-001949, p. 3), however HEPA filtered exhaust system was left operational and running to maintain the facilities at negative pressure (R-000255). Removed fuses from electrical disconnect switches. Shut down electrical, steam, and gas services. Blanked-off cell open process lines. Flushed processing tanks and pipelines with nitric acid and water, except those normally containing organic solvents. Cells No. 3 and 4 tanks were flushed sufficiently to permit entry, but Cell No. 3, 527 (IAW) tank remained highly contaminated. Cell No. 5 tanks did not emit significant dose rates, but had internal contamination (reported after 1953 R-002036, p. 17) (R-000059, p. 7). Cells No. 3 and 4 cleanups included replaced cell covers, flushed and emptied equipment, and locked door completed. Cell No. 5 "greenhouse," disassembled and discarded as waste. This eliminated the worst G2 plutonium contamination source and Cell No. 5 decontamination completed. The greenhouse was an enclosure around concentrator units in Cell No. 5. (C-000486). Crane Gallery surplus equipment removal and decontamination completed. Filter aisle(s) general cleanup completed. Lower Sample Aisle decontamination completed. Aboveground storage tanks on the east side of G2 contained treated water, caustic material (50 percent sodium hydroxide [NaOH]), and acid material (60 percent nitric acid [HNO_3]) (R-001935, p. 5). The tanks were removed and reused at West Milton.
1954	Blanked-off vents, cut piping, and disconnected electrical service in banks 1A and 1B; mixer-settler banks (with exception of 1A in Cell No. 3 and 1B in Cell No. 4) remained in G2 as of February 1954. DC circuits formerly used to operate mixer-settler banks disconnected. Ventilation system installed to maintain a negative pressure between cells and other areas of Building G2. Cells No. 3 and 4 mixer/settlers removed. Fuses removed from process equipment circuits except for sump pumps; other electrical equipment remained as per original drawings. Cell No. 4 1B bank removed (however, the summary document reviewed did not contain 1B bank disposal or decontamination information (R-001935, p. 8). Cells No. 1, 2, 3, 4, and 5 air supply shut off by closing Crane Gallery dampers. Vents leading to bank 1C were also blanked-off.
1959	Equipment moved in office space areas behind a barrier wall near cell areas.
Mid-sixties	Curies quantities of plutonium and mixed fission products disposed, leaving residual contamination on floor, walls, overhanging pipes, process tanks and in-process pipes and tanks (R-000155, p. 1). Process lines isolated. Contaminated solid waste packaged and shipped for off-site disposal (R-001949, pp. 5, 6). Gross contamination from floor and equipment surfaces, loose equipment and debris, and liquid and sludge process tanks removed. Loose contamination was removed from floor and equipment surfaces. Movable equipment and loose debris were removed. Liquids and sludge were removed from process tanks. G2 ventilation stack was removed and relocated to another site at KAPL (R-000255).
1970s 1980s	A ventilation system reverse flow occurred in either the late 1970s or early 1980s, contaminating previously decontaminated areas such as sample aisles (I-000418). In 1977, a KAPL Facilities Deactivation Program was initiated; use of the SPRU Tank Farm was discontinued and routine entry into the SPRU facilities was no longer allowed. In the mid- to late-1980s, the G3 pump house and scrubber stack were removed and the radioactive laundry line between H2 and K4 (the radioactive laundry) was removed (R-000255). KAPL performed a comprehensive physical inspection and radiological survey of the SPRU buildings and a new Hillside Drain system was put online.
1999	Autoclave test in room G2-174 dismantled (C-001950, p. 1). G1/G2 test functions relocated to facilities (C-001950, p. 1).

Waste Management

Liquid waste generated during SPRU research activities was sent to H2 for treatment. Radioactive solid waste produced by SPRU research activities included combustible waste, incinerator ash, evaporator sludge, and contaminated equipment and miscellaneous materials. Miscellaneous radioactive material items such as decontamination materials (mops, rags, etc.), paper used as floor covering, protective clothing, air system filters, floor sweepings, and tools that could not be effectively cleaned to acceptable levels was collected, segregated, packaged, and stored until disposed off site (R-001949).

During SPRU research activities, two incinerators were used at KAPL. The Cold Incinerator (Unregulated Incinerator) was located in the KAPL Building J-3 Lower Level. The Hot Incinerator, also referred to as the Pilot Incinerator, was located on the north side of Building F1, east of H2.

The Cold Incinerator was used to dispose of uncontaminated combustible waste, consistent with the industrial and municipal practices of the time. The waste was primarily from offices and laboratories and consisted of materials such as paper scrap, cardboard, and plastic. Although waste segregation programs ensured that waste burned in the Cold Incinerator came from areas that were not producing contaminated waste, low-level radioactive waste was inadvertently burned in a few instances. Even when properly segregated wastes were burned, naturally occurring radionuclide concentrated in the ash. As a result, Cold Incinerator ash usually contained detectable radioactivity. Although ash radioactivity was very low, the ash was disposed as radioactive waste (R-001949).

Hot Incinerator development began in March 1949, with burning tests of non-radioactive waste beginning in February 1950. Incineration began in February 1951, following tests and modifications. The incinerator operated in a partial vacuum to ensure that exhausted radioactive materials passed through the scrubber and filter. The Hot Incinerator was placed in standby status, dismantled, and removed by August 1952. During the months the Hot Incinerator was operated, approximately 20,000 pounds of low-level radioactive combustible waste were burned. Incinerated solid waste was shipped to the Lake Ontario Ordnance Works until 1954, stored until 1958, and then shipped to Oak Ridge National Laboratory for disposal (R-001949).

Building G2 Post-1953

Use of SPRU facilities for REDOX and PUREX research was terminated in June 1953. Shortly afterwards, the Control Room, portions of the constant head tank levels, the Rotameter Room, and change rooms were converted to a machine shop, test areas, drafting rooms, engineering and scientific offices, and library space for KAPL research (R-000155, pp. 1, 2). Documentation and evidence of other G2 activities and modifications from the mid-1950s to the early 1990s for KAPL activities included:

- A letter dated December 11, 1953 stating, “Most of the equipment described is still in use, although some of it was devoted purely to REDOX work and has since been either dismantled or modified. At the present time, the pilot plant is being used to prepare source material for another project that is concerned with the isolation of radioactive zirconium-niobium. This work was scheduled to be suspended in the early part of March 1954” (R-000472).
- A wastewater concentrator in the north end of Building G2 listed as KAPL SWMU-026 (R-002170) consisted of two 50-gallon wastewater accumulation tanks (one polyethylene, the other stainless steel), a steam- and electric-heated stainless steel 55-gallon wastewater concentrator drum, two overflow collection tanks (one stainless steel, the other polyethylene), and several secondary containment structures. The wastewater concentrator unit operated in the mid-1980s, to concentrate non-hazardous Corrosion Coolant Test Facilities (CCTF – a Naval Reactors facility) wastewater. SWMU-026 is no longer listed on the RCRA permit.
- The Experimental Engineering Laboratory utilized G2 areas modified after 1954, including the truck well and storage area that became the autoclave area. In 1999, a turnover report outlined

KAPL activities to be moved to another KAPL facility and listed equipment that would remain, to be dispositioned with G2 (C-001950).

- In 1961, either the Lower or Upper Filter Room was converted to a KAPL laundry facility (references do not specify which) (C-000106, pp. 1-2).
- KAPL used the Lower Filter Area as a welding school in 1976 (R-002085, p. 4).

6.2 Building H2 History

Building H2 was the SPRU waste processing facility constructed to store and process radioactive liquid waste from the G2 process pilot plant and operated from July 1949 to October 1953. It processed waste generated in G2 that was sent to H2 through drain lines in the tunnels and in drums. Drums permitted settling of solids so that the supernatant only was decanted into the H2 waste disposal system, and permitted oil removal (C-000450). It also processed waste from the laundry, hot incinerator scrubber, and from other site laboratories conducting research.

During this time, H2 processed large quantities of liquid waste. For example, in the first three quarters of fiscal year (FY) 1952, 2,705,000 gallons of radioactive liquid waste was processed (R-000505). A March 16, 1950 letter stated, "At the present time we are receiving approximately 2,500 gallons a day of waste from G-1, E-1, and G-2 buildings" (C-000460). A plan to send waste from Building F to Building H using disposable hoses rather running a new drain line was also considered (C-000470). On January 31, 1952, a KAPL letter was issued stating that the additions of drain lines were no longer allowed without approval from the person responsible for H2 waste management. The letter expressed concern that non-radioactive waste was being sent to H2 and being processed at an unnecessarily high cost, and that the quantities of waste being sent to H2 were overloading H2's capacity (C-000451). A KAPL instruction was issued stating that new waste lines into H2 must be approved, including new tie-in lines to existing drain headers and that non-routine (frequency of less than once per day), large (greater than 500 gallons) waste volumes must also be approved before waste could be sent to H2 (C-000452). Instructions were also given to personnel in E1, G1, and the Radioactive Materials Laboratory (C-000448), E-2 (C-000454), and G2 (C-00449) on how to transport waste drums to H2.

As more waste was sent to H2, internal procedures were developed to help manage the volume. In May 1952, a letter stated that casks (drums) brought to H2 for treatment must be tagged with the contents and the source (C-000454). In another memo, H2 operators expressed concern about the presence of tributyl phosphate in the laboratory wastes, and requested that tributyl phosphate not be poured into the sinks, "except for extremely small amounts where the total amount discarded will not be in excess of 5-10 ml per laboratory per day" (R-000447).

Building H2 was exhausted through glass wool and HEPA filters and released through a 60-foot high exhaust stack.

In 1953, SPRU decommissioning began. H2 tanks and lines were flushed with nitric acid and water. HEPA filtered exhaust ventilation systems remained operational to maintain negative pressure in the facility. The H2 incinerator was shut down in 1954.

Between July and December 1963, the following Building H2 changes were initiated:

- A small temporary ion exchange filter system for processing waste evaporator distillate before release to the sewer system was installed (R-001993, p. 3).
- The east and west evaporator systems were decontaminated and a new evaporator heat exchanger and slurry pump installed (R-001993, p. 3).
- The Slurry Drum Facility was built on the north side of H2 after 1963 to manage slurry drums.

- Two K5 30,000-gallon retention pits were reactivated for diverting Building H2 process steam condensate water and evaporator distillate, providing an additional control point for Building H2 liquid effluent (R-001993, p. 3).
- Preparations began for installing a separate controlled drainage line from the Radioactive Materials Laboratory to Building H2 to isolate Radioactive Materials Laboratory wastes from the low-level large volume wastes generated by other KAPL activities (R-001993, p. 4).

Radioactive liquid waste that was stored in the underground Tank Farm was disposed in 1964 and 1965. More than 20,000 gallons of waste was processed and disposed off-site. Waste processing methods included packaging evaporated liquid and solidified slurry with absorbent material in concrete-shielded drums and pumping and solidification of liquid directly with cement and/or absorbent material in large volume steel tanks. The solidified waste and containers were transported for off-site burial in reusable concrete-shielded or lead-shielded shipping containers (R-001949, I-000422).

Additional Building H2 cleanup performed in 1966 included:

- Removing loose contamination from floor and equipment surfaces
- Isolating process lines
- Removing movable equipment and loose debris
- Removing liquid and sludge from process tanks
- Relocating 332-foot level condenser cooling water supply and return pipes and concrete curbs surrounding the duct penetrations in the 332-foot level floor (R-002108, pp. 18-19)
- Packaging and shipping contaminated waste for off-site disposal (I-000422).

The 1966 cleanup also entailed removing 14 steel filter boxes, numbered 12 to 25, located in two banks toward the south end of the 332-foot level. In July 1966, contamination was found on top of the filter boxes in the area where a barrel had exploded several years previously. The average reading was 30 milliRem per hour beta-gamma (C-000427). Removing the filter boxes involved removing or relocating and sealing ductwork servicing the filter boxes, relocating the vent header line condenser to the 319-foot level, and removing vent header ductwork.

The neutralizer cells reportedly were taken out of service in 1984 (I-000426).

Throughout the post-SPRU period, radiological incident reports and other documentation indicate radioactive contamination in H2 from both SPRU and non-SPRU program use (I-000422). On June 13, 1986, radioactivity measuring 1,000 counts per minute was found on one strand of a mop head. The mop was used to dry mop the 332-foot level work area only. Preliminary isotopic analysis indicated gamma activity from cesium-137 and cesium-134 (C-000860, Attachment 1, Radiological History for H2). Similarly, floor sweepings of an area in Building H2 surveyed on December 3, 1987 showed 3,000 counts per minute beta-gamma radioactivity. Isotopic analysis of the contaminated debris showed fission product activity typical of contamination found in Radioactive Materials Laboratory waste that is approximately 3 to 7 years old (C-000860, Attachment 1, Radiological History for H2). On January 13, 1988, while performing routine housekeeping on the 332-foot level of Building H2, a radioactive waste processor accumulated debris, including a bolt, on a dust mop from a fixed contamination area under the south exhaust fan. The bolt and floor debris were surveyed. The bolt measured 300 counts per minute fixed beta-gamma and no detectable alpha. The floor debris measured 1,000 counts per minute beta-gamma and no detectable alpha. The primary isotope identified on the bolt and in the debris was cesium-137. The bolt apparently vibrated loose from the base of the fan belt guard, releasing formerly fixed contamination (C-000860, Attachment 1, Radiological History for H2).

The 309-foot level North Hopper Cell was last accessed in 1989. The dose rate at that time was 10 milliRem per hour with a limit of 2 hours restricted personnel access into the room (R-001836).

The 319-foot level former RW Cell was last accessed in 1979, when the dose rate was 10 milliRem per hour with a limit of 2 hours restricted personnel access into the room (R-001836).

6.3 Tunnel History

Between 1950 and 1954, SPRU facilities and KAPL laboratories in buildings E1, E2, E3, E4, D3, D4, and G1 managed liquid waste using drain lines that traversed the tunnels to the H2 waste management process equipment (R-001949). Treated process liquids were returned to E1, G1, D4, and Radioactive Material Laboratory laboratories through pipes in the H2, G2, and G1 Tunnels (R-000255, p. 13).

Following SPRU decommissioning, pipes and equipment were generally drained and flushed with nitric acid and water for decontamination. Some pipes were cut, capped, or turned off with a valve (R-00156, p. G-79). However, no specific records indicate which pipes were cleaned or modified.

In 1964, 20 pounds of mercury present for an indefinite period in the G1 Tunnel were removed from the floors (C-000860, Attachment 3).

During or shortly after the SPRU research activities ended, p-traps and vents were installed in E1 and G1 laboratory drains to collect chemicals such as heavy metals and mercury. Although not specifically documented, the p-traps and vents were disconnected possibly in the late 1970s (I-000421).

The Radioactive Materials Laboratory radioactive liquid waste reuse system was activated in 1977, using the SPRU tunnels to transport liquid waste from the Radioactive Materials Laboratory and the D, E, and G buildings to H2 for treatment and processing. This is a “closed loop” system that treats wastewater in ion exchange resin columns in H2 and returns clean water to the laboratories.

Sometime in the 1980s, it was reported that liquid waste from the Radioactive Materials Laboratory was not reaching H2; apparently the pipes were clogged enough that liquid input to the system did not reach H2. The system was flushed with water in an attempt to clean it out, but eventually an eighteen-inch section of pipe outside the G1 West Tunnel was replaced (I-000422). When this pipe was replaced, it was noted to be approximately 90 percent full of solids and sludge (I-000421).

In 2001, drain lines from the D, E, and G building complex were rerouted to a waste management facility in building E11. Only the Radioactive Materials Laboratory continues to use the H2 radioactive liquid waste reuse system.

The E1 laboratory liquid waste originally went through the E1 tunnels, the G1 tunnel, and the G2 Hot Tunnel to H2. Most original tunnel piping and equipment remains in the E1 tunnels. G1 laboratory liquid waste went from the G1 tunnels to the G2 Hot Tunnel to H2.

In order to lower the dose rates in the work area above the tunnel ceiling, lead shielding was added in the 1990s to the two interceptors in the eastern portion of the E1 Tunnel below Room E135 (C-000298, p. 1; C-000637). The interceptors are 30-gallon drums with a sump pump.

After SPRU operations ended in 1953, at least two contamination events occurred in the E1 and G1 East tunnels. Water infiltrated the E1 and G1 Tunnels in the late 1980s and early 1990s. The E1 interceptors overflowed due to pump failure, filling the sump with water and sludge and highly contaminating the E1 tunnel and sumps. Secondly, until 2001, the E1 and G1 laboratories continued using the tunnel system to H2. In the late 1990s, the E1 Tunnel piping was flushed (I-000422). In 2001, the D, E, and G building complex drain lines were rerouted to a new waste management facility in building E11.

The Crossover Tunnel managed G2 waste and processing liquids and other laboratory waste. In 1983, an interceptor tank connected to the Radioactive Materials Laboratory reuse system overflowed in the Crossover Tunnel. The interceptor was subsequently by-passed (R-000114, p. 2).

The G2-H2 Tunnel transported liquid waste and process liquids from G2 process areas and other buildings to the H2 liquid waste process and storage areas. The G2-H2 Tunnel connects the G2 Hot and Process Tunnels on the south to the H2 Pipe Tunnel on the north (C-000014, p. 6).

In 1976, the G2-H2 Tunnel sump was connected to one of the three 10,000-gallon storage tanks on the lower level of H2 (C-000142). Following the 1989 inspection, KAPL addressed G2-H2 Tunnel water infiltration (C-000196) by installing a plastic hose that pumped water from the tunnel floor sump to processing equipment in the H2 lower level, preventing water buildup on the tunnel floor. Concrete slab hatchway leaks were caulked and the floor was grouted (C-000196).

During the 1989 inspection, the sump at the north end of the tunnel was observed to be highly radioactive (1-Rem per hour) and contained sludge (R-001949). During the 1980s, sludge was cleaned out of the same sump (I-000422). The source of inflow to the sump is unknown. It is speculated the seepage in the north end of the tunnel could be the source, or that the interconnectivity of the SPRU sumps with the G2-H2 sump being the low point in the system is the cause.

Reportedly, the G2-H2 Tunnel was periodically flooded to reduce worker radiation doses (I-000422). Watermarks in the flat portion of the tunnel are consistent with a 1-foot lip at the south end of the tunnel, adjacent to the H2 Tunnel and Building H2 connection. G2-H2 Tunnel water seepage to surrounding soil was not known to occur and watermarks were not attributed to tunnel pipe leaks (C-000997, p. 1).

6.4 Tank Farm History

Following SPRU decommissioning in 1953, Tank Farm use continued for storage of liquid waste until 1978 (R-000255, p. 3). The first comprehensive cleanout of the tanks occurred in 1965, when SPRU and other KAPL waste in the tanks was removed and disposed of off-site (R-000056, p. 1).

In the 1965 cleanout, radioactive SPRU liquid waste stored from 1954 in Tank Farm Tanks 505 and 509A and in H2 Neutralizer Cell No. 4, Tank 320, was removed. The 22,550 gallons of waste consisted of "2,377 Curies of activity (fission products), 903 Kg of depleted uranium, and 539 grams of plutonium" (C-000118, p. 1).

Between March and October 1978, the Tank Farm tanks were emptied of all liquid waste. Letter A0-6191-606, Contaminated Liquid Waste Disposal, H2 Tank Farm, Request for Concept Approval, outlined the method proposed for disposing of an estimated 26,915 gallons of contaminated liquid waste stored in the H2 Tank Farm. Liquid from the tanks was to be transferred to the south tank, A525-A, using remotely operated steam adductors. The liquid was then to be pumped from the A525-A tank using an installed evaporator feed pump and temporary piping to the pump discharge line, and then run through the pipe chase to the temporary volumetric filler located at the 332-foot level of H2. From the volumetric filler, the liquid waste was to be solidified and sealed in 55-gallon drums and shipped for disposal to the Chem Nuclear Facility located in Barnwell, South Carolina (C-002033, pp. 1-2, 4-5; C-002052, p. 2).

There have been no Tank Farm construction modifications except for addition of a surveillance camera in each Tank Farm vault for monitoring groundwater infiltration and plastic piping to allow for vault draining following the 1989 inspection (R-001949).

Water infiltration into the Tank Farm vaults has been a continuous problem. Water leaked into the tank vaults as early as 1952, in "considerable" quantities. Concern was expressed because the water had to be processed through the evaporators, causing them to run at near capacity (C-000458). Draining accumulated water and maintaining dry vaults was recommended and implemented in 1956 as a groundwater contamination preventative measure (R-000057, pp. 3-8; C-000063, pp. 2-3; C-000067, p. 1).

In 1952, a drainage tile system designed to alleviate rainwater seepage was installed above the Tank Farm vaults. The tile sections connect at the 320 foot elevation to the main drainage system, which runs parallel to the east side of the Tank Farm, along the north side of H2, and down an embankment to a concrete catch basin. The catch basin drains to the storm sewer, but also overflows to the drainage ditch along the east side of the road to the lower level (R-000057, pp. 3-8, C-000063, pp. 2-3).

Table 6-5 presents the approximate amount of water on vault floors in 2000 and historically (R-001304, Attachment 1, p. 8).

Table 6-5. Estimated Water Present on Vault Floors from 1978 to 2000 (Gallons)

Vault	1978(1)	1989(2)	1998(3)	2000(4)
505	375	60	25	N/A
509A	6,000	275	4,500	7,907
509B	1,325	315	50	N/A
509C	8,145	20	20	N/A
509D	2,375	0	0	N/A
509E	8,250	2,650	800	1,482
578	970	0	0	N/A

(1) 1978 values from ES-RJC-9803, Historical Review of Tritium Concentrations in Knolls Site Samples, November 11, 1998; there was no tarp over the Tank Farm at this time.
(2) 1989 volumes are totals of volumes pumped prior to the inspection plus residual volumes estimated by visual observation during inspection.
(3) 1998 volumes estimated from visual observation during the inspection.
(4) 2000 volumes pumped from April to August 2000; only vaults 509E and 509A were pumped at this time.

In the spring of 1952, four test wells were drilled around the Tank Farm in response to concerns about the potential soil and groundwater contamination near H2 and the Tank Farm. Test wells No. 1 (35.9 feet deep) and No. 2 (134.5 feet deep) were drilled approximately 7 feet north of the Tank Farm, approximately 10 feet apart. Test Well No. 3 (35.9 feet deep) was drilled east of the Tank Farm in the 509C Vault area. Test Well No. 4 (32.9 feet deep) was drilled approximately 5 feet south of the Tank Farm. Well tests (in particular from Well No. 1) between 1952 and 1956 suggested some leaking or seepage of radioactive liquids from Tank Farm vaults and possible seepage from the H2 tunnel. The Tank Farm vaults were determined to be the most probable groundwater contamination source.

Additional sampling from sample points No. 1 and No. 4 indicated gross beta activity in the range of less than or equal to 4.2×10^{-9} to $(1.41 \pm 0.88) \times 10^{-8}$ microCuries per milliliter and gross gamma activity in the range of less than or equal to 1.8×10^{-8} to $(3.15 \pm 2.22) \times 10^{-8}$ microCuries per milliliter. Strontium-90 was identified in these samples. Gross alpha analysis indicated all samples to be less than or equal to 10^{-9} microCuries per milliliter (R-000057, pp. 3-8; C-000063, p. 1; C-000154, Table 1 and Figure 1). Core boring samples obtained near the Tank Farm in 1974 failed to demonstrate discernible levels of ground contamination (C-000445).

In 1983, a tarp intended to divert water from the Tank Farm area to the H2 Hillside Drain system was installed over the Tank Farm (R-001304, Attachment 1, p. 7). Following the 1989 inspection, a new plastic tarp was installed over the Tank Farm and covered with gravel. The second tarp was still in place in 1997 (C-000396, p. 4). Plans to periodically pump down the vaults following the 1989 inspection were abandoned and the vaults were not pumped down before the 1998 inspection. Vaults 509A and 509E were pumped intermittently from April to August 2000 (R-001304, Attachment 1, p. 16), after which KAPL planned to pump down the Tank Farm vaults at least every 3 years (R-001304, Attachment 1, p. 8).

Tank and Vault 505 Contamination History

Table 6-6 describes the radiological history resulting from the vault and tank inspections and the resulting radiological survey and analysis findings. Table 6-7 summarizes 505 Tank and Vault chemical history.

Table 6-6. Tank and Vault 505 Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
6/1/1963	505 Tank	Volume of waste = 11,000 gallons (Note: R-002047, p. 4, suggests tank overflow into the vaults during the past)	Radiochemical analysis identified: Plutonium (accountability) – 81 g, Plutonium (observed) – 11 g Uranium (accountability) – 308 kg, Uranium (observed) – 181 kg Cs-137 (observed) – 377 Ci, Sr-90 (observed) – 354 Ci (R-000115, p. 4)
4/1/1965	505 Tank	Volume of waste = 8,250 gallons	Unknown method of identification: Pu – 9 g, Depleted Uranium – 136 kg, Cs-137 – 283 Ci, Sr-90 – 266 Ci (C-000118, attachment b, p. 2)
12/1971	505 Vault	None	General radiation in cell: 1 Rem/hr – 2 Rem/hr beta 100 mRem/hr – 150 mRem/hr gamma (R-000385, Table 4)
12/1971	505 Tank	Volume of sludge heel – 300 gallons	Concentration of tank contents: 1 x 10^3 pCi/gal alpha 1x 10^8 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers results current	505 Tank	Approximate volume = 250 gallons (Cs-137 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (2.33 ± 0.02) x 10^{-3} gamma; (2.62 ± 0.04) x 10^{-3} beta; (7.83 ± 0.48) x 10^{-5} alpha; (3.1 ± 1.0) x 10^{-6} tritium Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 115; Ca – 70; U – 1200; Ba – <6; Mg – 25; Ni – 115; Si – 55; Al – 55; B – <0.3; Fe – 225; Zr – 25; Cu – 3; Mn – 7; Be – <0.03; Cr – 8; Pb – 5; Nb – 3; P – 280; Ti – <1 (C-002033, encl. pp. 1-2; C-002049, attachment)
9/12/1989	505 Vault	Vault structurally sound Piping and pipe fittings in vault sound Residual water covers vault floor to maximum depth ¼ inch at drainage channel; dirt, dust, and debris visible beneath clear water; waterproofing material from walls visible at various locations on floor Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping; less in this vault than noted in other vaults Streaks of water on west and south walls with actual water drops or sheeting on west wall; condensation appears to be cause of water, similar to what was observed in 509B Vault Water lines on vault walls and tank to about 5 feet above floor; no water was pumped from this vault prior to inspection Air flow into vault during inspection > 26 ft^3/min; normally no air flow	Gamma readings range from <1 mRem/hr 1 foot below ceiling to 114 mRem/hr at 304-foot level Beta and gamma readings range from <100 mRem/hr 1 foot below ceiling to 400 mRem/hr at 304-foot level Data indicate contamination contribution from sludge heel in tank Reading from tool elbow which rubbed against south wall about 12 feet from floor had no detectable contamination by direct probe; tool head and camera housing, which came into contact with west end of tank, read 4,200 cpm above background beta-gamma by direct probe Floor contamination measured by radiation levels taken from 409 detergent-dampened rag: 0.3 mRem/hr open window and 0.2 mRem/hr closed window with RO-2 radiac; Q-tips swiped on rag read 3,400 cpm above background beta-gamma and 20 cpm alpha Vault surface radionuclide distribution and Ci content: Cs-137 – 88.7%, 0.80 Ci content, 0.0092 g Pu-239 – 0.6%, 5.4x10^{-3} Ci content, 0.087 g Am-241 – 0.1%, 9x10^{-4} Ci content, 0.0002 g Sr-90 – 10.6%, 0.096 Ci content, 0.7x10^{-3} g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level):

Date	Area	Visual Impressions	Summary Findings (Reference)
			No information due to blockage in lines (new lines subsequently installed) (C-000203, Part I, pp. 18-19)

Table 6-7. Tank and Vault 505 Chemical History

Date	Area	Summary Findings (Reference)
Unknown (prior to 3/17/1965)	505 Tank	X-ray fluorescence identified in g/gal: U – 13.7, Cr – 1.7, Mn – 0.57, Fe – 1.2, Ni – 0.20, Pb – 0.04, Al – not given, Si – not given (R-000115, p. 3)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	505 Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 115; Ca – 70; U – 1200; Ba – <6; Mg – 25; Ni – 115; Si – 55; Al – 55; B – <0.3; Fe – 225; Zr – 25; Cu – 3; Mn – 7; Be – <0.03; Cr – 8; Pb – 5; Nb – 3; P – 280; Ti – <1 (C-002033, encl. pp. 1-2; C-002049, attach.)

Tank and Vault 509A Contamination History

Table 6-8 describes the radiological history resulting from 509A Tank and Vault inspections including visual observations and summarized radiological survey and analysis findings. Table 6-9 summarizes 509A Tank chemical history.

Table 6-8. Tank and Vault 509A Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
6/1/1963	509A Tank	Volume of waste = 11,000 gallons (Note: R-002047, p. 4, suggests there was past Tank overflow into the Vaults)	Radiochemical analysis identified: Pu (observed) – 464 g, U (observed) – 611 kg Cs-137 (observed) – 636 Ci Sr-90 (observed) – 704 Ci (C-000118, attach. b, p. 2; R-000115, p. 4)
4/1/1965	509A Tank	Volume of waste = 1,350 gallons	Unknown method of identification: Pu – 452 g, Depleted U – 604 kg, Cs-137 – 520 Ci, Sr-90 – 520 Ci (C-000118, attach. b, p. 2)
12/1971	509A Vault	None	General radiation in cell: 1 Rem/hr – 2 Rem/hr beta 100 mRem/hr – 150 mRem/hr gamma (R-000385, Table 4)
12/1971	509A Tank	Volume of sludge heel = 350 gallons	Concentration of Tank contents: 1 x 10^4 pCi/gal alpha 1x 10^8 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509A Tank	Approximate volume = 5,775 gallons (Cs-137 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (2.19 ± 0.05) x 10^{-4} gamma; (3.04 ± 0.04) x 10^{-3} beta; (4.11 ± 0.37) x 10^{-6} alpha; (4.7 ± 0.7) x 10^{-6} tritium (C-002033, encl. pp. 1-2; C-002049, attachment)
9/12/1989	505 Vault	Vault structurally sound Piping and pipe fittings in vault sound Residual water covers vault floor to maximum depth ¼ inch at drainage channel; dirt, dust, and debris visible beneath clear water; waterproofing material from walls visible at various locations on floor. Tar-like substance (believed to be sealant applied to ceiling) present on	Gamma readings range from <1 mRem/hr 1 foot below ceiling to 114 mRem/hr at 304-foot level Beta and gamma readings range from <100 mRem/hr 1 foot below ceiling to 400 mRem/hr at 304-foot level Data indicate contamination contribution from sludge heel in tank Reading from tool elbow which rubbed against south wall about 12 feet from floor had no detectable contamination by direct probe; tool head and camera housing, which came into contact with west end of tank, read 4,200 cpm above

Date	Area	Visual Impressions	Summary Findings (Reference)
		portions of ceiling, walls, floor, and outer tank and piping; less in this vault than noted in other vaults Streaks of water on west and south walls with actual water drops or sheeting on west wall; condensation appears to be cause of water, similar to what was observed in 509B Vault Water lines on vault walls and tank to about 5 feet above floor; no water was pumped from this vault prior to inspection Air flow into vault during inspection > 26 ft^3/min; normally no air flow	background beta-gamma by direct probe Floor contamination measured by radiation levels taken from 409 detergent-dampened rag: 0.3 mRem/hr open window and 0.2 mRem/hr closed window with RO-2 radiac; Q-tips swiped on rag read 3,400 cpm above background beta-gamma and 20 cpm alpha Vault surface radionuclide distribution and Curie content: Cs-137 – 88.7%, 0.80 Ci content, 0.0092 g Pu-239 – 0.6%, $5.4x10^{-3}$ Ci content, 0.087 g Am-241 – 0.1%, $0.9x10^{-3}$ Ci content, 0.0002 g Sr-90 – 10.6%, 0.096 Ci content, $0.7x10^{-3}$ g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level): No information due to blockage in lines (new lines subsequently installed) (C-000203, Part I, pp. 18-19)

Table 6-9. Tank 509A Chemical History

Date	Area	Summary Findings (Reference)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509A Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 350; Ca – 45; U – <20; Ba – 10; Mg – 35; Ni – 10; Si – 10; Al – 2; B – 4; Fe – 10; Zr – 1; Cu – 0.5; Mn – 1; Be – <0.01; Cr – 0.7; Pb – <0.6; Nb – 0.4; P – 10; Ti – <0.4 (C-002033, encl. pp. 1-2; C-002049, attachment)

Tank and Vault 509B Contamination History

Table 10-9 describes the radiological history resulting from 509B Tank and Vault inspections, including visual observations and summarized radiological survey and analysis findings. Table 6-11 summarizes 509B Tank chemical history.

Table 6-10. Tank and Vault 509B Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	509B Vault	None	General radiation in cell: 1 Rem/hr – 2.5 Rem/hr beta 100 mRem/hr – 150 mRem/hr gamma (R-000385, Table 4)
12/1971	509B Tank	Volume of sludge heel = 250 gallons	Concentration of tank contents: 1×10^4 pCi/gal alpha $1x\ 10^7$ pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509B Tank	Approximate volume = 1,150 gallons (Cs-137 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): $(7.56 \pm 0.22) \times 10^{-5}$ gamma; $(1.46 \pm 0.02) \times 10^{-3}$ beta; $(2.04 \pm 0.10) \times 10^{-5}$ alpha; $(3.4 \pm 1.0) \times 10^{-6}$ tritium (C-002033, encl. pp. 1-2; C-002049, attach.)
9/11/1989	509B Vault	Vault structurally sound Piping and pipe fittings in vault sound	Gamma readings range from 3 mRem/hr 1 foot below vault ceiling to 35 mRem/hr at the 307-foot level

Date	Area	Visual Impressions	Summary Findings (Reference)
		Ranges from film to approximately ½ inch water (near drainage channel leading to sump) over floor; clear water; dirt, concrete dust, and debris visible through water Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping Streaks of water on west and south walls; west wall appeared to be damp believed to be significant condensation Several water lines on tank and walls up to approximately 6.5 feet from floor; darkest water line at approximately 18 inches from floor; inconsistent with 295 gallons removed from Vault sump prior to inspection (would have been to less than 3 inches) Cement waterproofing material installed on lower 3 feet of walls not readily apparent Air flow into vault during inspection > 69 ft^3/min; normally no air flow	Beta and gamma readings range from <100 mRem/hr 1 foot below vault ceiling to 300 mRem/hr at the 307-foot level Data indicate contamination contribution from sludge heel in tank Reading from tool elbow which contacted south wall near ladder about 12 feet from floor was 800 cpm beta-gamma by direct probe; reading from tool head and camera housing was 30,000 cpm beta-gamma by direct probe and 2.4 mRem/hr open window with RO-2 radiac Floor contamination samples from a 409 detergent-dampened rag measured with an RO-2 radiac: 2.2 mRem/hr open window and 0.6 mRem/hr closed window; Q-tips swiped on rag read 10,000 cpm beta-gamma and 30 cpm alpha Vault surface radionuclide distribution and Curie content: Cs-137 – 36.2%, 0.74 Ci content, 0.0086 g Pu-239 – 27.8%, 0.57 Ci content, 9.2 g Am-241 – 2.7%, $5.5x10^{-3}$ Ci content, 0.017 g Sr-90 – 33.3%, 0.68 Ci content, $5.0x10^{-3}$ g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level): Cs-137 – $5.1x10^{-3}$ filtrate, $4.9x10^{-5}$ in crud Pu total – $2.5x10^{-5}$ filtrate, $2.0x10^{-5}$ in crud U-234 – $9.1x10^{-5}$ filtrate, not detected in crud U-238 – $1.0x10^{-4}$ filtrate, not detected in crud Sr-90 – $2.8x10^{-3}$ filtrate, $6.7x10^{-6}$ crud Tritium – filtrate not analyzed, crud not analyzed (C-000203, Part I, pp. 10-11)

Table 6-11. Tank 509B Chemical History

Date	Area	Summary Findings (Reference)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509B Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 500; Ca – 20; U – 20; Ba – 7; Mg – 6; Ni – 3; Si – 3; Al – 2.5; B – 1.5; Fe – 0.8; Zr – 0.6; Cu – 0.4; Mn – 0.15; Be – 0.01; Cr – <0.5; Pb – <0.6; Nb – <0.4; P – <10; Ti – <0.4 (C-002033, enclosure pp. 1-2; C-002049, attachment)

Tank and Vault 509C Contamination History

Table 6-12 describes the radiological history resulting from 509C Tank and Vault inspections, including visual observations and summarized radiological survey and analysis findings. Table 6-13 outlines 509C Tank chemical history.

Table 6-12. Tank and Vault 509C Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	509C Vault	None	General radiation in cell: 5 Rem/hr beta 250 mRem/hr gamma (R-000385, Table 4)

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	509C Tank	Volume of sludge heel = 200 gallons	Concentration of tank contents: 1 x 10^4 pCi/gal alpha 1x 10^7 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509C Tank	Approximate volume = 8,145 gallons (Cs-137 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (4.24 ± 0.07) x 10^{-4} gamma; (4.69 ± 0.05) x 10^{-3} beta; (1.47 ± 0.08) x 10^{-5} alpha; (1.6 ± 1.0) x 10^{-6} tritium (C-002033, encl. pp. 1-2; C-002049, attach.)
9/8/1989	509C Vault	Vault structurally sound Piping and pipe fittings in vault sound Ranges from film to approximately ½ inch water (near drainage channel leading to sump) over floor; clear water; dirt, concrete dust, and debris, as well as cement waterproofing material from walls, visible through water Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping; one location of tar on piping above tank is discolored and water (from ceiling above) drips off tar at the rate of 1 drop per minute Streaks of water on west and south walls; streaks begin high on walls and end on floor, appear to be moist Water line evident on walls and Tank 18 inches above floor Air flow into vault during inspection > 160 ft^3/min; normally no air flow	Gamma readings range from 7 mRem/hr 1 foot below vault ceiling to 74 mRem/hr at the 307-foot level Beta and gamma readings range from <100 mRem/hr 1 foot below vault ceiling to 300 mRem/hr at the 307-foot level Data indicate contamination contribution from sludge heel in tank Reading from tool elbow which contacted south wall about 12 feet from floor was 200 cpm beta-gamma on a large area wipe; reading from camera which was in contact with west end of tank was 7,500 cpm beta-gamma and 400 cpm alpha Floor contamination samples from a 409 detergent-dampened rag measured with an RO-2 radiac: 0.5 mRem/hr open window and <0.2 mRem/hr closed window; Q-tips swiped on rag read 3,000 cpm above background beta-gamma Vault surface radionuclide distribution and Curie content: Cs-137 – 82.8%, 1.1 Ci content, 0.013 g Pu-239 – 0.8%, 0.011 Ci content, 0.18 g Am-241 – 0.1%, 1.3x10^{-3} Ci content, 0.0004 g Sr-90 – 16.4%, 0.22 Ci content, 1.6x10^{-3} g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level): Cs-137 – 1.1x10^{-3} filtrate, 1.9x10^{-5} in crud Pu total – 1.9x10^{-5} filtrate, 8.7x10^{-5} in crud U-234 – 2.3x10^{-4} filtrate, not detected in crud U-238 – 2.4x10^{-4} filtrate, not detected in crud Sr-90 – 3.6x10^{-3} filtrate, 1.5x10^{-4} crud Tritium – filtrate not analyzed, crud not analyzed (C-000203, Part I, pp. 12-13)

Table 6-13. Tank and Vault 509C Chemical History

Date	Area	Summary Findings (References)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509C Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 280; Ca – 100; U – 30; Ba – <2; Mg – 20; Ni – 2; Si – 7; Al – 0.6; B – 1.5; Fe – 1.7; Zr – <0.3; Cu – 0.15; Mn – 0.15; Be – <0.007; Cr – <0.5; Pb – <0.6; Nb – <0.4; P – <10; Ti – <0.4 (C-002033, encl. pp. 1-2; C-002049, attach.)
Unknown (The document reporting results is dated 2/21/1990.)	509C Tank	Shotgun swab sample analysis (metals) results given in net concentration per gram of waste (ppm): Arsenic – 166 Lead – 10,536 Barium – 68,600 Selenium – 207 Cadmium – 65 Silver – 105 Chromium – 3,474 Mercury – 217 (C-000201, p. 2)

Tank and Vault 509D Contamination History

Table 6-14 describes the radiological history from 509D Tank and Vault inspections, including visual observations and summarized radiological survey and analysis findings. Table 6-15 summarizes 509D Tank chemical history.

Table 6-14. Tank and Vault 509D Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	509D Vault	None	General radiation in cell: 400 mRem/hr – 1 Rem/hr beta 15 mRem/hr – 35 mRem/hr gamma (R-000385, Table 4)
12/1971	509D Tank	Volume of sludge heel = 300 gallons	Concentration of tank contents: 1 x 10^4 pCi/gal alpha 1x 10^7 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers results current	509D Tank	Approximate volume = 2,375 gallons (Cs-137 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (7.92 ± 0.22) x 10^{-5} gamma; (6.52 ± 0.10) x 10^{-4} beta; (4.66 ± 0.31) x 10^{-6} alpha; (6.1 ± 1.1) x 10^{-6} tritium (C-002033, encl. pp. 1-2; C-002049, attach.)
9/6/1989 – 9/7/1989	509D Vault	Vault structurally sound Piping and pipe fittings in vault sound Some grind marks noted on tank (evidently from original construction) No active water leakage noted; stalactites hanging from ceiling; vertical stains on walls; several horizontal lines on tank and walls at common elevations indicating standing water in the past at different levels up to 5 feet above floor Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping; one location of tar on piping above tank is discolored and water (from ceiling above) drips off tar at the rate of 1 drop per minute Floor of vault covered with approximately 1/8" to ¼" of dirt, dust, and debris With exception of horizontal water lines, this vault is similar in appearance to 509E and 578 Vaults Air flow into vault during inspection > 160 ft^3/min; normally no air flow	Gamma readings range from <1 mRem/hr at the 331-foot level to 12 mRem/hr at the 310-foot level Beta and gamma readings range from <100 mRem/hr at the 331-foot level to 100 mRem/hr at the 306-foot level Data indicate contamination contribution from sludge heel in tank Floor contamination samples from a 409 detergent-dampened rag read 200 cpm above background beta-gamma with no detectable alpha Vault surface radionuclide distribution and Curie content: Cs-137 – 46.6%, 0.072 Ci content, 8.3x10^{-4} g Pu-239 – None detected Am-241 – None detected Sr-90 – 53.4%, 0.083 Ci content, 0.61x10^{-3} g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level): Cs-137 – 1.5x10^{-1} filtrate, 7.9x10^{-3} in crud Pu total – 5.0x10^{-5} filtrate, 3.1x10^{-5} in crud U-234 – 5.8x10^{-4} filtrate, not detected in crud U-238 – 5.9x10^{-4} filtrate, not detected in crud Sr-90 – 1.4x10^{-2} filtrate, 3.6x10^{-4} crud Tritium – filtrate not analyzed, crud not analyzed (C-000203, Part I, pp. 14-15)

Table 6-15. Tank and Vault 509D Chemical History

Date	Area	Summary Findings (Reference)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509D Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 310; Ca – 30; U – <15; Ba – 3; Mg – 10; Ni – 8; Si – 8; Al – 1.2; B – 8; Fe – 2; Zr – <0.3; Cu – 0.15; Mn – 0.4; Be – <0.007; Cr – 0.3; Pb – <0.6; Nb – <0.4; P – 25; Ti – <0.4 (C-002033, enclosure pp. 1-2; C-002049, attachment)

Date	Area	Summary Findings (Reference)
Unknown (the document reporting results is dated 2/21/1990)	509D Tank	Shotgun swab sample analysis (metals) results given in net concentration per gram of waste (ppm): Arsenic – 92 Barium – 19,100 Cadmium – 90 Chromium – 3,904 Lead – 4,116 Selenium – 66 Silver – 79 Mercury – 1,400 (C-000201, p. 2)

Tank and Vault 509E Contamination History

Table 6-16 describes the radiological history from 509E Tank and Vault inspections, including visual observations and summarized radiological survey and analysis findings. Table 6-17 summarizes 509E Tank chemical history.

Table 6-16. Tank and Vault 509E Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	509E Vault	None	General radiation in cell: 370 mRem/hr beta 175 mRem/hr gamma (R-000385, Table 4)
12/1971	509E Tank	Volume of sludge heel = 400 gallons	Concentration of tank contents: 1 x 10^4 pCi/gal alpha 1x 10^7 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509E Tank	Approximate volume = 8,250 gallons (Cs-137, Cs-134 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (3.36 ± 0.02) x 10^{-2} gamma; (2.69 ± 0.04) x 10^{-2} beta; (3.7 ± [unreadable]) x 10^{-7} alpha; (1.6 ± 0.12) x 10^{-5} tritium (C-002033, encl. pp. 1-2; C-002049, attach.)
9/5/1989	509E Vault	Vault structurally sound Piping and pipe fittings in vault sound Water leaking into vault from at least two locations in ceiling at rate of one drop every 10-15 seconds; vault floor is damp; two stalactites noted on ceiling, 4 to 6 inches long, located where water is leaking in; believed to be tar-like substance with yellowish color possibly from dissolved minerals associated with leakage Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping Floor of vault covered with approximately 1/8" of dirt, concrete dust, and debris; remains of cement waterproofing from walls on floor Air flow into vault during inspection > 160 ft^3/min; normally no air flow	Gamma readings range from 11 mRem/hr 1 foot below the ceiling to 69 mRem/hr 1 foot above the floor Beta and gamma readings range from <100 mRem/hr 1 foot below the ceiling to 200 mRem/hr 1 foot above the floor Data indicate contamination contribution from sludge heel in tank Floor contamination samples from a 409 detergent-dampened rag read 3.5 mRem/hr open window and 0.2 mRem/hr closed window with an RO-2 ionization chamber detector; calculated to be greater than 70,000 cpm beta-gamma Vault surface radionuclide distribution and Curie content: Cs-137 – 78.8%, 0.64 Ci content, 0.0074 g Pu-239 – 6.3%, 0.051 Ci content, 0.82 g Am-241 – 0.6%, 4.9x10^{-3} Ci content, 0.0014 g Sr-90 – 14.2%, 0.12 Ci content, 0.88x10^{-3} g Vault sump sample radionuclide analysis results (µCi/ml) (pre-inspection samples collected from existing lines connected to common header in H2, 309-foot level): Cs-137 – 7.6x10^{-3} filtrate, 7.1x10^{-5} crud Pu total – 1.0x10^{-5} filtrate, 2.5x10^{-5} crud U-234 – 1.0x10^{-5} filtrate, not detected in crud U-238 – 5.2x10^{-6} filtrate, not detected in crud Sr-90 – 2.9x10^{-3} filtrate, 5.9x10^{-5} crud Tritium - <2.6x10^{-7} filtrate, crud not analyzed (C-000203, Part I, pp. 16-17)

Table 6-17. Tank and Vault 509E Chemical Analysis History

Date	Area	Summary Findings (Reference)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	509E Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 265; Ca – 80; U – <15; Ba – <2; Mg – 10; Ni – 2; Si – 15; Al – 2.5; B – 4; Fe – 8; Zr – <0.3; Cu – 0.4; Mn – 2; Be – <0.007; Cr – 0.7; Pb – 0.7; Nb – <0.4; P – 40; Ti – 1.3 (C-002033, encl. pp. 1-2; C-002049, attach.)

Tank and Vault 578 Contamination History

Table 6-18 describes the radiological history from 578 Tank and Vault inspections, including visual observations and summarized radiological survey and analysis findings. Table 6-19 summarizes 578 Tank chemical history.

Table 6-18. Tank and Vault 578 Radiological History

Date	Area	Visual Impressions	Summary Findings (Reference)
12/1971	578 Vault	None	General radiation in cell: 2 Rem/hr – 3 Rem/hr beta 150 mRem/hr gamma (R-000385, Table 4)
12/1971	578 Tank	Volume of sludge heel – 100 gallons	Concentration of tank contents: 1 x 10^4 pCi/gal alpha 1x 10^7 pCi/gal beta-gamma (R-000385, Table 4)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	578 Tank	Approximate volume = 970 gallons (Cs-137, Cs-134, Co-60 observed in gamma spectra Gross beta expressed as equivalent Sr-Y-90)	Radiochemical results (µCi/ml): (1.09 ± 0.01) x 10^{-3} gamma; (9.15 ± 0.07) x 10^{-3} beta; (1.03 ± 0.05) x 10^{-4} alpha; (1.1 ± 0.02) x 10^{-4} tritium (C-002033, encl. pp. 1-2; C-002049, attach.)
8/30/1989 – 8/31/1989	578 Vault	Vault structurally sound Piping and pipe fittings in vault structurally sound No active water leakage noted Floor damp Sump connected to vault empty (prior to inspection) Tar-like substance (believed to be sealant applied to ceiling) present on portions of ceiling, walls, floor, and outer tank and piping Floor of vault covered with approximately 1/16" mixture of dirt, concrete dust, debris Cement water proofing material installed on lower 3 foot of walls appears to have fallen off and is visible on floor Air flow into vault through hatch opening provided drying effect during inspection (air flow during inspection ~ 28 ft^3/min); normally no air flow	RO-7-ID: Gamma readings range from 8 mRem/hr 1 foot below vault ceiling to 52 mRem/hr 1 foot above vault floor RO-7-IM: Beta and gamma readings range from <100 mRem/hr 1 foot below vault ceiling to 500 mRem/hr 1 foot above vault floor Data indicate contamination contribution from sludge heel in tank RO-2 radiac: Readings on walls range from 300 cpm beta-gamma, 50 cpm alpha at 12 feet from floor to 18,000 cpm beta-gamma, 1,600 cpm alpha at 1 to 2 feet from floor (readings taken of swipes from inspection equipment which came into contact with walls at these locations only) RO-2 radiac: Floor contamination measured by radiation levels taken from cotton swab: 0.6 mRem/hr open window and 0.2 mRem/hr closed window Vault surface radionuclide distribution and Curie content: Cs-137 – 65.2%, 1.1 Ci content, 0.013 g Pu-239 – 4.5%, 0.077 Ci content, 1.2 g Am-241 – 0.4%, 6.7x10^{-3} Ci content, 0.002 g Sr-90 – 29.9%, 0.51 Ci content, 3.7x10^{-3} g

Date	Area	Visual Impressions	Summary Findings (Reference)
		Blank flanges removed from two pipes (flanges hanging from pipe ends with studs and nuts attached) extending from west wall	(C-000203, Part I, pp. 5-7)

Table 6-19. Tank and Vault 578 Chemical Analysis History

Date	Area	Summary Findings (Reference)
Unclear; possibly 1965; letter from 1977 or 1978 considers these results current	578 Tank	Spectrographic chemical analysis (ppm in liquid waste with error of ± 2): Na – 285; Ca – 45; U – <15; Ba – <2; Mg – 25; Ni – 12; Si – 15; Al – 6; B – 6; Fe – 20; Zr – 1.5; Cu – 0.8; Mn – 0.8; Be – <0.007; Cr – 1.7; Pb – 1.5; Nb – 0.3; P – 15; Ti – 0.4 (C-002033, encl. pp. 1-2; C-002049, attach.)
Unknown (The document reporting results is dated 2/21/1990)	578 Tank	Shotgun swab sample analysis (metals) results given in net concentration per gram of waste (ppm): Arsenic – 94 Barium – 3,005 Cadmium – 81 Chromium – 2,004 Lead – 2,726 Selenium – 123 Silver – 115 Mercury – 1,210 (C-000201, p. 2)