ORAU Team **NIOSH Dose Reconstruction Project** Technical Basis Document for the Mound Site – Site Description	Document Number: ORAUT-TKBS-0016-2 Effective Date: 07/07/2006 Revision No.: 00 PC-1 Controlled Copy No.: _____ Page 1 of 33
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03/30/2004	03/30/2004	00	New Technical Basis Document for the Mound Site – Site Description. First approved issue. Initiated by Jeff Vollmer.
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ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
D&D	decontamination and demolition
DOE	U.S. Department of Energy
EEOICPA	Energy Employees Occupational Illness Compensation Program Act
ft	foot
LLW	low-level [radioactive] waste
LSA	low specific activity
MEMP	Miamisburg Environmental Management Project
NIOSH	National Institute for Occupational Safety and Health
ORAU	Oak Ridge Associated Universities
R&D	research and development
RTG	radioisotopic thermoelectric generator
SRP	Savannah River Plant
TBD	technical basis document
TRU	transuranic

2.0 INTRODUCTION

The National institute for Occupational Safety and Health (NIOSH) is responsible for developing the technical capabilities and guidance used to implement the Energy Employees Occupational Illness Compensation Program Act (EEOICPA). Oak Ridge Associated Universities (ORAU) is leading a team, identified as the ORAU Team, to support NIOSH in the performance of this major program. This technical basis document (TBD) represents support to the ORAU Team on documentation of historic practices at the Mound Laboratory site in Miamisburg, Ohio, and its predecessor facilities under the Dayton Project. This document supports evaluation of internal and external dosimetry data, site monitoring, and other pertinent data for unmonitored and monitored workers for use as a supplement to or substitute for individual monitoring data.

Technical basis documents and site profile documents are general working documents that provide guidance concerning the preparation of dose reconstructions at particular sites or categories of sites. They will be revised in the event additional relevant information is obtained about the affected site(s). These documents may be used to assist NIOSH in the completion of the individual work required for each dose reconstruction.

In this document the word "facility" is used as a general term for an area, building, or group of buildings that served a specific purpose at a site. It does not necessarily connote an "atomic weapons employer facility" or a "Department of Energy [DOE] facility" as defined in the Energy Employees Occupational Illness Compensation Program Act [EEOICPA; 42 U.S.C. § 7384l(5) and (12)]. EEOICPA defines a DOE facility as "any building, structure, or premise, including the grounds upon which such building, structure, or premise is located … in which operations are, or have been, conducted by, or on behalf of, the Department of Energy (except for buildings, structures, premises, grounds, or operations … pertaining to the Naval Nuclear Propulsion Program)" [42 U.S.C. § 7384l(12)]. Accordingly, except for the exclusion for the Naval Nuclear Propulsion Program noted above, any facility that performs or performed DOE operations of any nature whatsoever is a DOE facility encompassed by EEOICPA.

For employees of DOE or its contractors with cancer, the DOE facility definition only determines eligibility for a dose reconstruction, which is a prerequisite to a compensation decision (except for members of the Special Exposure Cohort). The compensation decision for cancer claimants is based on a section of the statute entitled "Exposure in the Performance of Duty." That provision [42 U.S.C. § 7384n(b)] says that an individual with cancer "shall be determined to have sustained that cancer in the performance of duty for purposes of the compensation program if, and only if, the cancer … was at least as likely as not related to employment at the facility [where the employee worked], as determined in accordance with the POC [probability of causation[1]] guidelines established under subsection (c) …" [42 U.S.C. § 7384n(b)]. Neither the statute nor the probability of causation guidelines (nor the dose reconstruction regulation) define "performance of duty" for DOE employees with a covered cancer or restrict the "duty" to nuclear weapons work.

As noted above, the statute includes a definition of a DOE facility that excludes "buildings, structures, premises, grounds, or operations covered by Executive Order No. 12344, dated February 1, 1982 (42 U.S.C. 7158 note), pertaining to the Naval Nuclear Propulsion Program" [42 U.S.C. § 7384l(12)]. While this definition contains an exclusion with respect to the Naval Nuclear Propulsion Program, the section of EEOICPA that deals with the compensation decision for covered employees with cancer [i.e., 42 U.S.C. § 7384n(b), entitled "Exposure in the Performance of Duty"] does not contain such an exclusion. Therefore, the statute requires NIOSH to include all occupationally derived radiation exposures at covered facilities in its dose reconstructions for employees at DOE facilities, including radiation exposures related to the Naval Nuclear Propulsion Program. As a result, all internal and

[1] The U.S. Department of Labor is ultimately responsible under the EEOICPA for determining the POC.

external dosimetry monitoring results are considered valid for use in dose reconstruction. No efforts are made

to determine the eligibility of any fraction of total measured exposure for inclusion in dose reconstruction. NIOSH, however, does not consider the following exposures to be occupationally derived:

- Radiation from naturally occurring radon present in conventional structures
- Radiation from diagnostic X-rays received in the treatment of work-related injuries

2.1 PURPOSE

The purpose of this document is to provide a Mound Laboratory Site Profile that contains technical basis information for use by the ORAU Team to evaluate the total occupational dose for EEOICPA claimants.

2.2 SCOPE

Mound Laboratory played an important role in the U.S. nuclear weapons program. Originally established in Dayton, Ohio, in the summer of 1943, the first location was selected to produce large quantities of polonium. This role grew to include nuclear weapons component development and production, and such secondary missions as radioactive waste management and recovery, the use of radioactive materials for nonweapons purposes and the purification of nonradioactive isotopes for scientific and commercial research. This TBD contains supporting documentation to assist in the evaluation of worker dose from these processes, using the methodology in NIOSH implementation guides (NIOSH 2002a,b).

Methods and concepts of measuring radiation exposure to workers have evolved since the beginning of Mound operations in 1943. An objective of this TBD is to provide supporting technical data to evaluate, with claimant-favorable assumptions, the total Mound occupational dose that can be associated reasonably with worker radiation exposure covered under EEOICPA legislation. This dose includes occupational internal and external exposures, occupationally required diagnostic X-ray examinations, and onsite exposure to site environmental releases. This TBD addresses evaluation of unmonitored and monitored worker exposure and missed dose. Consistent with NIOSH (2002a,b), this document identifies how to adjust the historic occupational dose to account for current scientific methods and protection factors.

In addition, this TBD presents technical basis methods used to prepare the Mound worker dose records for input to the NIOSH Interactive RadioEpidemiological Program and the Integrated Modules for Bioassay Analysis computer programs used to evaluate worker dose. Because information on measurement uncertainties is an integral component of the NIOSH approach, this document describes the uncertainty evaluation for the Mound exposure and dose records.

This TBD describes Mound facilities and processes and historic information related to worker internal and external exposures.

2.3 SITE ACTIVITIES AND PROCESSES

Dr. Charles Allen Thomas was director of Monsanto's central research department in Dayton when, in 1943, he was called into conference with General Leslie Groves. Following several days of discussions with General Groves, Monsanto accepted responsibility for the chemistry and metallurgy of polonium. This activity became known as the Dayton Project.

Monsanto started preliminary organization of the project at the company's central research department on Nicholas Road in Dayton in September 1943. When the project expanded to other locations during World War II, the original Nicholas Road location became known as Unit I. Table 2-1 lists this and other Mound Laboratory facilities.

Table 2-1. Locations and descriptions.

Location	Description
Unit I	Monsanto Central Research Department – 1515 Nicholas Road, Dayton, Ohio
Unit II	Monsanto rocket propellant laboratory off Betty Lane, adjacent to present St. Henry's Church next to Dayton Mall
Unit III	Bonebrake Theological Seminary, 1601 W. First St., Dayton, Ohio
Unit IV	Runnymede Playhouse, Dixon Ave. and Runnymede Road in Oakwood, Ohio
Unit V	Mound Laboratory, Miamisburg, Ohio
Warehouse	Warehouse at 3rd and Sears St., Dayton, Ohio
Marion	Duplicate production facility in Marion, Ohio

The Dayton Site's primary activity was to extract Po-210 from radioactive feedstock by the Hanford Works located in the state of Washington to fabricate atomic bomb irradiators. Hanford reactor n + Bi-209 = Bi-210 which decayed to Po-210 shipped to Mound. The processing involved removing Polonium from Bismuth. Polonium was never produced at Unit I. In later years, a variety of research projects were undertaken that involved other radioisotopes. The projects typically involved small quantities of isotopes such as ^{14}C and tritium, and curie quantities of some sealed sources.

Early in July 1943 it became apparent that the Nicholas Road location would not be sufficient to house polonium production operations, so Monsanto leased a building at 1601 West First Street in Dayton. This building, which was built in 1879 to house the Bonebrake Theological Seminary, became known as Unit III. All activities transferred to Unit III in October 1944.

As the magnitude of the polonium production project unfolded, and the staff grew to meet increased scientific demands, it became apparent that additional space was necessary. In February 1944, the Army Corps of Engineers leased the Runnymede Playhouse and turned it over to Monsanto. This location was designated as Unit IV.

Because further expansion was necessary in 1946, several floors were leased in a large warehouse in Dayton at Third and Sears Streets. Operations at this facility, known as the Warehouse, used only trace amounts of polonium, which were present from the analysis of environmental monitoring samples, bioassay samples from project personnel, and preliminary biological studies on the effect of polonium on laboratory animals.

As early as 1946, it became evident that a permanent polonium production facility was needed. The site selected for the permanent Mound Laboratory facility was on a hill 878-ft above sea level and about 200 ft above the Miami River in Miamisburg, Ohio. Mound Laboratory became the first permanent U.S. Atomic Energy Commission facility in May 1948. There were originally 14 buildings with 360,000 ft^2 of space. Polonium processing began in February 1949.

At the same time, a standby facility, which was a duplicate of the Mound T Building, was built in Marion, Ohio. Radioactive material was never brought to that facility, which was referred to as the Marion, Ohio, facility or just Marion. Process equipment there was later dismantled and the facility was turned over to the General Services Administration.

During the early years of the polonium production project, Monsanto operated a separate facility for the production of rocket propellant. This facility, known as Unit II, handled ammonium picrate and ammonium nitrate. This site is about a quarter of a mile east of Route 741 next to the present location of St. Henry Catholic Church.

During World War II the Dayton Project was tasked with developing neutron sources for use as initiators in atomic bombs. Research included the chemistry of polonium and other elements as neutron sources, and the majority manufacturing was of polonium-beryllium sources. In addition, the Project experimented with making liquid polonium sources and solid polonium sources of every sort. The basic process for manufacturing polonium-beryllium sources was to electroplate polonium onto an inert substrate, then chemically or electrochemically react some form of beryllium with the plated polonium to form a stable solid source.

During the early years of operating at the Mound facility in Miamisburg, OH; a number of small research activities were carried out involving radioisotopes of Ra-226, Ac-227, Th-228. Th-232, Th-230, Pa-231 and U-233. From the early 1950s to the early 1980s Mound conducted various programs involving extraction and purification of Ra-226, Ac-227, Th-230 and Pa-231. Ores were typically depleted of Uranium before processing.

The narrowly focused polonium production work expanded to the development and production of weapons components. Production of ^{238}Pu and ^{239}Pu grew from the early work with polonium. Mound's main focus was to support U.S. Department of Energy (DOE) weapons and nonweapons programs, especially in the areas of chemical explosives and nuclear technology. Its principal mission was to research, develop, and manufacture non-nuclear explosive components for nuclear weapons that were assembled at other sites.

Early programs investigated chemical and metallurgical properties of ^{210}Po and its applications. Research and development (R&D) included the fabrication of neutron and alpha sources for weapons and nonweapons use. Starting in the early 1950s, Mound developed radioisotopic thermoelectric generators (RTGs), which have been used on a variety of missions to provide heat and power for spacecraft. Po-210 production declined in the 1960s until it phased out in 1971.

Developing, producing, and providing surveillance of detonators for military applications began in 1957. Explosive timers were developed in 1959, and manufacture of the timers began in 1963. Ferroelectric transducers and firing set component development and manufacture began in 1962.

Tritium handling technologies began in the mid-1950s. Mound tritium programs supported weapons and nonweapons programs. Metal tritides were used at Mound primarily to trap ^{3}H using uranium tritides. In addition, research was conducted on metal tritides and tritium targets might also have been processed.

Other major operations included:

- Manufacture of enriched stable isotopes for medical, industrial, and general research
- Development and manufacture of chemical heat sources
- Recovery and purification of tritium from waste generated by Mound and other DOE sites
- Development of radioisotopic heat sources used by the National Aeronautics and Space Administration and other programs
- Research and development of chemical explosives and pyrotechnics, adhesives, plastics, and elastomers for the nuclear weapons program
- Research and development of thermonuclear energy fuel systems
- Research and development of the joining of exotic metals

- Development of instrumentation for the nuclear safeguard program
- Research and development of separation of gases and energy conversion systems
- Research and development of technologies for radioactive waste management

Chronology of Significant Mound Laboratory Programs and Events

Year	Activity
1943	Planning begins for Dayton facilities
10/44	Polonium operations begin at Unit III
1946	Mound Laboratory planning started.
1948	Mound Laboratory occupied.
1949	Polonium operations moved from Dayton Units to Mound Laboratory. First program separated Ra-226 from barium rich uranium ore, pitchblende residue called K-65 k-65 wt% Water 30% Lead Oxide 19% Barium Sulfate 7% (375 mg or Radium in the Barium) Silicon dioxide 35% Metals 9% Trace metals similar to Cotter Concentrate Experimental extraction of Ra-226 from the Ki-65 was conducted in the R Bldg. In October mound received 200 lbs of K-65 in a single drum. Study of processes for decon of rad waste generated by Pu production reactors at Hanford. From 1948-1952 three different types of processing wastes were studied to concentrate constituents such as Cs-137, Ru-106, SR-90, Zr-93, Co-60, Nb-94, Sb-125, Te-123, ni-63 and rare earth elements and Pu-239. Bench scale testing began in R building
1950	Separation of ^{208}Po and ^{209}Po from proton (accelerator) irradiation of bismuth. Separation of ^{227}Ac from irradiated ^{226}Ra. Uranyl sulfate – heavy water fuel system research. Civilian power reactor research involving uranium, ^{231}Pa, and ^{239}Pu; mission ended in 1963.
1951	Small amount of research with Ra-226 in preparation of cave operation in SW building. Involved irradiated Ra-226 and recovery of Ac-227 and Th-228 from Ra-226.
1952	Pilot plant installed in SW building for processing reactor waste. Reactor waste processing areas also included Warehouses 9 and 13, WD, SD, SW, R and M.
1953	SW Building (tritium handling) constructed with a dirt floor.
1954	Invention of the ^{210}Po-fueld thermoelectric generator. Initiation of several programs requiring tritium-handling technologies. Construction of thorium refinery for breeder reactor program (never operated).
1955	Repackaging of 6,000 55-gallon drums containing thorium ore and sludge occurred through 1965 at three different times to help prevent the possibility of further contamination. August 1955 small research program in R Bldg. Involving recovery and subsequent purification of Protactinium-231 from natural sources. June 1955- Radium Cave operation shut down in June (Ra-226, Ac-227, Th-228, Ra-223, Ra-224 daughters)
1956	Completed separation of 1.3 grams of ^{231}Pa in Building HH. Weighable quantities of ^{230}Th (ionium) separated. ^{239}PuBe neutron sources manufactured. Nuclear weapon detonator development, production, and surveillance; mission ended in 1989.
1959	^{239}Pu reactor fuels laboratory operational. Tritium waste recovery and purification facility operational. U-233 research involving about 10 research personnel
1960	Pu-238 used in large quantities in production operations. Process areas included the R, SM and PP Buildings.

1961	Development of ^{238}Pu heat sources for thermoelectric generators.
1963	Several Po and Gadolinium Polinide heat sources containing 100-1000 Ci of Po-210 were encapsulated in refractory metal.
1964	190 mg of Ac-227 was processed in the New cave area.
1965	Gaseous effluent control system operational in SW Building.
1966	Thorium ore and sludge moved to bulk storage in Building 21.
1967	1. 54,000 Ci of high purity Po-210 were processed for Mound experimental work and commercial use. 2. 14.5 kg of Pu-238 were recovered from waste material.
1968	PP Building 38 operational for processing ^{238}Pu.
1969	1. Waste line break and subsequent contamination of the abandoned Miami-Erie Canal bed with ^{238}Pu. Began tritium recycling from retired weapon parts. 2. Three thousand seven hundred and one Curies of Po-210 were produced for both internal and external customers. 3. Six Snap 27 sources were produced. Each source contained 3735 Ci of Pu-238
10/70 – 6/71	Plutonium inventory was reduced to a minimum level. 22.5 kg of Pu-238 scrap was shipped to SRS burial.
1972	Tritium effluent control project began. Non-weapons polonium work terminated.
1973	Pu-238 oxide was processed for 4 multihundred watt (4.2 Kq each) and 2 viking sources (1.2 Kg each)
1974	Thorium ore and sludge completely removed from site. ^{210}Po decontamination of Technical (T) Building completed.
1975	^{238}Pu recovery operations terminated.
1977	Californium Multiplier Neutron Radiography Facility installed.
1989	Removal of soil contaminated with uranium near Building 34.
1990	^{238}Pu decontamination of inactive laboratories in the Research (R) Building.
1991	Removal of ^{238}Pu-contaminated waste line connecting the HH Building with the WD facility.
1993	DOE decision to transfer defense mission from Mound. ^{238}Pu decontamination of PP Building 38 and Acid Leach Field (Area D).
1994	Demolition of SM Building structure contaminated with ^{238}Pu.
1995	All weapon components production terminated.
1996	Demolition of SD Building (sanitary waste treatment facility) and Building 21 (thorium ore and sludge bulk storage facility) including excavation of contaminated soil. Miami-Erie Canal removal action (^{238}Pu contaminated sediments) fieldwork begins in October.
1997	Removal of soil contaminated with ^{227}Ac at Area 7.
1998	Miami-Erie Canal removal action fieldwork completed; approximately 30,000 yd^3 removed for off site disposal.

2.3.1 Buildings with Radionuclide Activity

2.3.1.1 Dayton Project Buildings

The Warehouse was used to analyze trace quantities of ^{210}Po from environmental monitoring samples, bioassay samples from personnel, and preliminary research on the effects of polonium on laboratory animals. The warehouse facility was used for these analyses because of its very low polonium background. The trash from these analyses was disposed of in the general building trash. The Warehouse operations and equipment were transferred to Mound Laboratory in 1948. The active areas in the Warehouse were scrubbed down and returned to the building manager for renting to other tenants.

Unit I, the Monsanto Central Research Department facilities, was not used during the Dayton Project to produce polonium. After Word War II various research projects were set up in Unit I which did involve radioactive materials. Carbon-14 and tritium were two of the isotopes used in Unit I. Trace quantities of radioisotopes were discharged to the domestic sewer. On two occasions small quantities

of ^{14}C were incinerated in waste. No radioactive materials were buried on the site. Solid wastes were packed and shipped to Maxie Flats, Kentucky, for disposal.

Unit II and the Marion facility never had any radioisotopes whatsoever. Unit II was engaged exclusively in research on chemical explosives. The Marion facility was built as a duplicate of the T Building complex but was never operated. No radioactive materials were introduced into the Marion facility.

Unit III, the Bonebrake Theological Seminary, supported research into the manufacture of neutron sources. The principle radioisotope was ^{210}Po. All waste was packaged and shipped to Oak Ridge for burial. Operations at Unit III ceased in 1948 and were transferred to the Mound Laboratory. The facility was decontaminated and returned to its owner, the Dayton Board of Education. There was a successful polonium-boron trifluoride gaseous source made at Unit III in April 1948. Table 2-2 lists the rooms at Unit III, and Figure 2-1 shows the general layout of the site.

Unit IV, the Runnymede Playhouse in Oakwood, Ohio, was used to manufacture and calibrate neutron sources. The principle radioisotope was ^{210}Po. All of its waste was packaged and sent to Oak Ridge for burial. Operations at Unit IV ended in late 1948 and were transferred to the Mound Laboratory. By the spring of 1950, all Unit IV structures, services and utilities were removed to a depth of 7 ft, packaged, and shipped to Oak Ridge for burial. Clean fill dirt replaced the excavated soil. The property was returned to the Talbott family estate. Table 2-3 lists the rooms at Unit IV, and Figure 2-2 shows the general layout of the site.

Table 2-2. Unit III room key.

M	Marlite Electro-Deposition
11-A	Laboratory 11-A Neutron Source
11-B	Laboratory 11-B Process Research
21-A	Laboratory 21-A Production Research
25	Laboratory 25 Fundamental Research – Solution Preparation
L	Laundry
H-1	Hall – 1st Floor
H-2	Hall – 2nd Floor
H-3	Hall – 3rd Floor
L-A	Laboratory A Fundamental Research – Electro-Deposition
L-B	Laboratory B Fundamental Research – Migration Studies
Q	Quonset (“Y” Operations)
Q-HR	Quonset (“Y” operations) High Risk. This area was not an operating area and anyone entering was required to wear a respirator

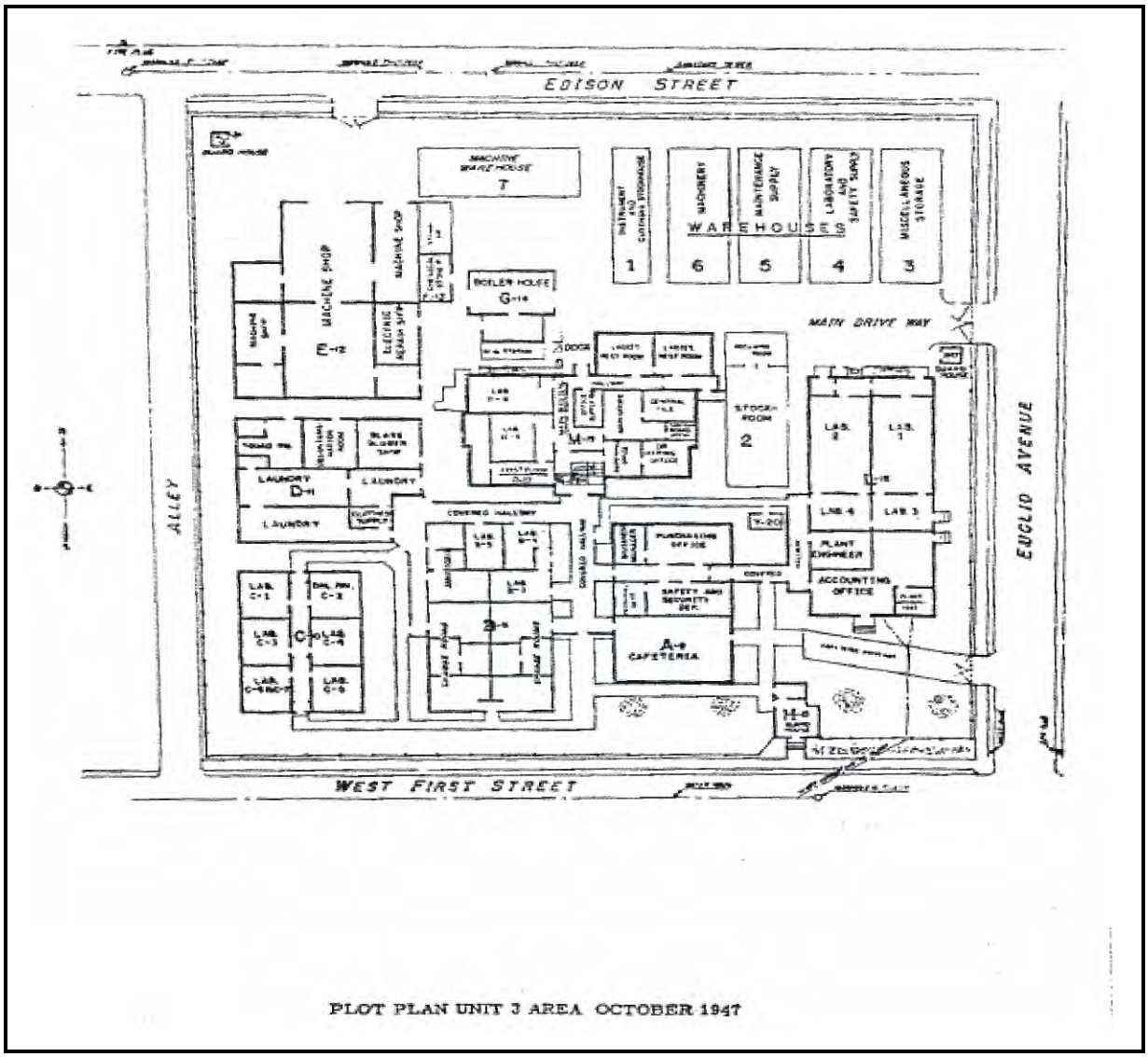

Figure 2-1. Unit III site map.

Table 2-3. Unit IV room key

P-1	East End of Process Laboratory #1
P-2	West End of Process lab #1
P-3	East End of Process Laboratory #2
P-4	West end of Process Laboratory #2
E-1	Above painting hood in Electrolysis Laboratory #1
E-2	Over canning dry box in Electrolysis lab #1
MA-1	West wall of Micro Assay Laboratory
M-1	Marlite room, Behind 100 gallon Pfauldler
M-2	Marlite Room, Under Exhaust Screen
M-3	Equipment area of Marlite room
M-4	North end of New marlite working area
M-5	South end of New Marlite working area
A-1	Auditorium near Chemical Stock room
D-1	Cleaning Room in Decontamination Laboratory
D-2	Storage room in Decontamination Laboratory
E-2	North end of Electrolysis Laboratory #2
E-4	South end of Electrolysis Laboratory #2
CR-1	West Counting Room
CR-2	East Counting room
AS-1	Cleaning and packing room in assay department

AS-2	Calorimetry room in assay department

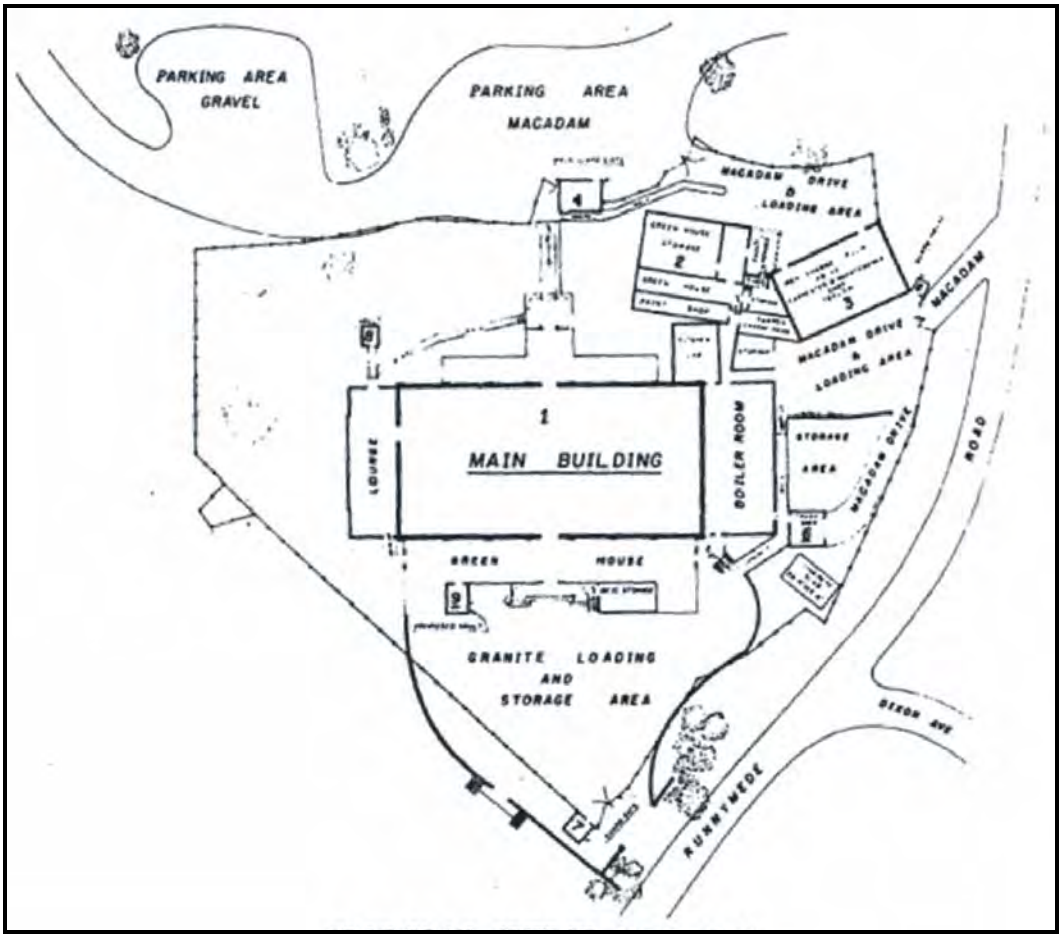

Figure 2-2. Unit IV site map.

2.3.1.2 Mound Laboratory, Miamisburg (Unit V)

Figure 2-1 shows the Mound Laboratory site. The buildings of concern at the Mound Laboratory include HH, PP (also called Building 38), R, SM, SW, T, and WD/WDA. Supporting buildings that were not directly involved in research or productions considered in this TBD evaluation include:

- Warehouses 9, 13, and 15
- Buildings 15, 21, 34, 50, 59, 68, B, E, H, I, M, P, RR, and SD

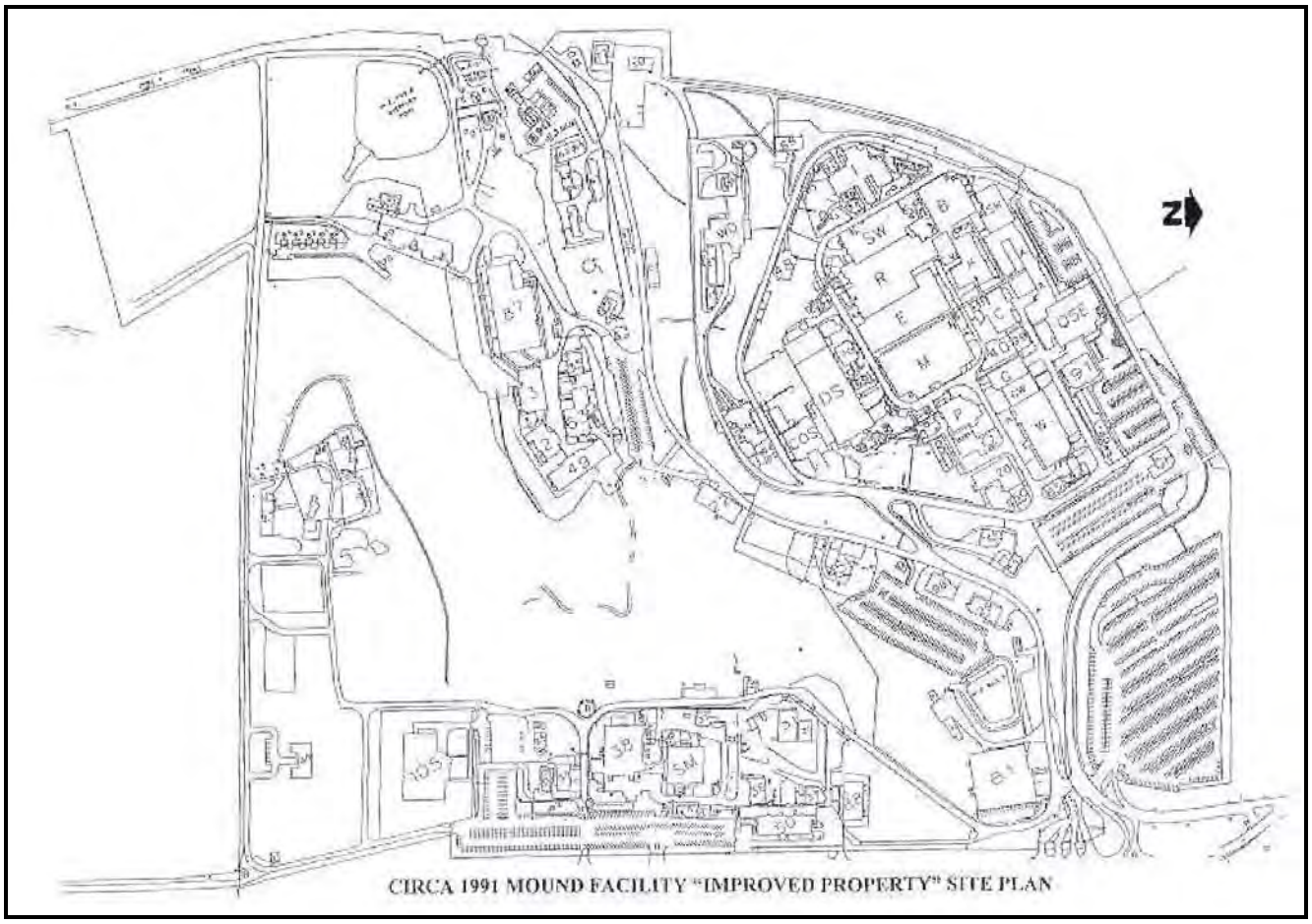

Figure 2-3. Mound (Unit V) site map.

HH Building
HH Building or *Hydrolysis House* derived its name from its primary function, the hydrolysis of highly radioactive bismuth chloride and aluminum chloride solutions. In 1963, the HH Building was converted to stable gaseous isotope separation using thermal diffusion, liquid diffusion, and cryogenic processes. Table 2-4 is a summary of the rooms, dates, and radionuclides for the HH Building. (All dates represent the duration of actual use of radioisotopes in the projects.)

PP Building (38)
The Plutonium Processing (PP) Building (38) was completed in December 1967. SM Building processes, fabrication operations, and recovery processes were transferred to PP Building along with waste treatment facilities, R&D, which included material research, and analytical laboratory support

Table 2-4. Radionuclides and related compounds for HH Building.

Rooms	Radionuclides and related compounds	Dates used
HH-3,4	H-3	1960-1990
	Xe (all isotopes)	1964-1983
	Stable isotopes, Kr-85	1964-present
HH-5	Pa-231, Fe-59, Al-26, Ca-45, Co-60, Cu-65	1955-1956
	U-233, -234, -235, -238, Th-230, -232, Pa-231, Th-230, -232 daughters	1956
	H-3	1960-1990
	Xe (all isotopes)	1964-1983
	Stable isotopes, Kr-85	1964-present
HH-6	Pa-231, Fe-59, Al-26, Ca-45, Co-60, Cu-65	1955-1956
	U-233, -234, -235, -238, Th-230, -232, Th-230, -232 daughters	1956
HH-8	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-209, -210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Te-121-134, Hg-203	1949-1958

	Kr-85, Xe (all radioisotopes)	1961-1963
HH-9	H-3	1965-1985
HH-10, 11, 12	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-209, -210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Te-121-134, Hg-203	1949-1958
HH-119, 120, 121, 122	H-3	1964-1980

Activities. PP Building was used primarily for processing ^{238}Pu dioxide received from the Savannah River Plant (SRP).

Plutonium dioxide was received in a powder form with the following isotopic mixture and a purity of 99.9% according to (King 1995).

(1 part per million) – 1E-4% Pu-236 3.0% Pu-240
80.2% Pu-238 0.6% Pu-241
15.9% Pu-239 0.1% Pu-242

Reference to ^{238}Pu in PP Building was a composite of the mixture identified above. This mixture included trace amounts of ^{241}Am, ^{237}Np, and ^{234}U. Dates represent the duration of radioisotope use in the projects.

Thorium-232 was often substituted for ^{238}Pu compounds for modeling purposes in research and development, because this isotope was less expensive and less hazardous, and had physical characteristics similar to ^{238}Pu. It is possible, therefore, to find ^{232}Th compounds identical to the ^{238}Pu compounds.

The term *high-fired*, which is sometimes used, implies that the plutonium compound has been heated in a plasma torch process such that the lung solubility type is definitely S. The term *non-high-fired* implies an absence of such heating and in extreme cases, where indicated, a lung solubility type of M or even F might exist where there is high solubility.

Table 2-5 summarizes PP Building rooms, dates, and radioisotopes.

R Building
R (for Research) Building, which was built in 1948, has handled a number of programs involving a number of radionuclides over the years. Some of the major programs are discussed below, as are elemental radionuclides and radioisotopic compounds from those processes.

Table 2-5. Radionuclides and related compounds for Building PP (38).

Room	Radionuclides and related compounds[a]	Dates used
PP-CORR-5A	PuO_2	1967-1974
PP-6	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967-1980
PP-6W	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967-pres
PP-CORR-10	PuO_2	1967-pres
PP-13, PP-14	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967-1980
PP-CORR-15, CORR-16, CORR-17	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967 -1974
PP-18	PuO_2, $Pu(NO_3)_4$	1967-pres
PP-24	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967-pres
PP-100	PuO_2	1967-pres
PP-113	Pu-(238,239)O_2 Varied orphaned sources	1957-1989 1988-pres
PP-CORR-115	Pu-(238,239)O_2	1967-pres
PP-127	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967-pres
PP-CORR-134, PP-CORR-135, PP-CORR-136	PuO_2	1967-pres
PP-CORR-140, PP-CORR-141, PP-CORR-142	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$, Th-232, ThO_2, $Th(NO_3)_4$, $Th(C_2O_4)_4$, $Th(OH)_4$	1967-pres

PP-143(A1)	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$, Th-232, ThO_2, $Th(NO_3)_4$, $Th(C_2O_4)_4$, $Th(OH)_4$	1967-1980
PP-142(A2)	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC, Th-232, ThO_2, $Th(NO_3)_4$, $Th(C_2O_4)_4$, $Th(OH)_4$, ThF_4	1967-1980
PP-145(A3)	PuO_2	1967-1982
PP-146(B1)	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC	1967-1980
PP-147(B2), PP-148(B3)	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC, Th-232, ThO_2, $Th(NO_3)_4$, $Th(C_2O_4)_4$, $Th(OH)_4$, ThF_4	1967-1980
PP-149(B4)	PuO_2	1967-1982
PP-150->156 (C1->C3, D1->D3)	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC	1967-1980
PP-157(E1),158(E2),162,163	PuO_2	1967-1980
PP-159(E3)	PuO_2, $Pu(NO_3)_4$, $Pu(OH)_4$, PuF_4	1967-1980

a. Plutonium-238 was the designated radioisotope in every room unless otherwise specified. Other isotopes of the mixture identified in the introduction along with small amounts of ^{241}Am, ^{237}Np, and ^{234}U. Thorium-232 was sometimes used as a stand-in for plutonium.

Beginning in the fall of 1948, R&D for the ^{210}Po program began. This was pilot-scale work for processing in T Building. R&D work with polonium extended into the 1970s.

Plutonium-238 research began in R Building in1959 and continued through the 1960s. The plutonium isotope concentration was the same as referenced in King 1995 for the material received at Mound from the Savannah River Site.

R&D was conducted with tritium in the “R” building. Experimentation with metal tritides and deuterides such as uranium tritide and lithium tritide occurred, as did developmental studies with tritiated water.

Some tritides and tritiated compounds were so poorly metabolized that their biological half-lives were in the order of hours. This was not true for uranium tritides.

Table 2-6 summarizes rooms, dates, and radioisotopes in R Building.

Table 2-6. Radionuclides and related compounds for R Building.

Rooms	Radionuclides and related compounds	Dates used
R-117, 120, 127, 128, 129, 130, 131, 133, 143, 144, 151, 152, 155, 159, 160, 161, 162 and 167	$AlCl_3$, $BiCl_4$, Ag-Po, Te-Po, $PoCl_2$, Po-210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70, -72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203	1948-1951
R-105, 106	H-3, HTO,	1958-1965
	H-3, Li(D,T), U-238(D,T)	1965-1978
R-108	Po-208, -210, H-3,	1948-1965
	H-3, Li(D,T), U-238(D,T), Ti(D,T), Other tritides (Type F, S)	1975-PRES
R-110	Po-208, -210	1955-1972
	H-3	1972-present
R-111	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-223, -224, -226, Th-228, -229, -239, Ac and Ra daughters Po-208, -210, H-3	1951-1965
R-112	H-3, Li(D,T), U-238(D,T), Other Tritides (Type F, S)	1973-1993
R-113,114,115	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-223, -224, -226, Th-228, -229, -239, Ac and Ra daughters	1951-1955
	Po-210, Pu-238, -239, Po/Be, PoF_2, Po/B, Pu/Be, PuF_2, Pu/B	1956-1961
	H-3	1978-present
R-116	Po-210, Pu-238, -239, Po/Be, PoF_2, Po/B, Pu/Be, PuF_2, Pu/B	1956-1961
	Pu-238, -239, PuBe, Am-241	1956-1962
	H-3, Li(D,T), U-238(D,T)	1960-1965
R-117	Pu-238, -239, Pu/Be, PuO_2, Pu-238/Zr, Pa-231, Po-210/Be, Th-230	1948-1990
R-118	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-223, -224, -226, Th-228, -229, -230, (Ac and Ra daughters)	1955
	U-234, -235, -238, Pa-231, Th-230, -232, and Th-232 daughters	1956-1958
R-119, 120, 121,123	Po-210, Bi-210, $AlCl_3$, $BiCl_3$, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1951
	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-226, Th-228, -229, -230, AcF_4, AcI_4, Ac-227 daughters,	1951-1953
	Pa-231, Th-230, -232, and Th-232 daughters, U-234, -235, -238	1956-1958
	Pu-239, Am-241	1956-1962
	Pu-238, Oxide, Neutrons	1959-1962
	Pu-238, $Pu(NO_3)_4$, $Pu(NO_3)_6$, PuO_2, Pu-Cu, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, Pu(OH), PuF_4, $PuCl_4$, Pu-Se, Pu-Zr, H-3, Pu rare earths, Po alloys and compounds	1959-1979
R-127	Po-210, Bi-210, $AlCl_3$, $BiCl_3$, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1951
	Fe-55, -59	1952-1954
	H-3	1956-1961
	PuO_2, PuF_4, Pu-$MoCl_4$, Pu-MoF_4	1965-1978
	H-3, Pu-239	1987-present
R-128	Po-210, Bi-210, $Po(NO_3)_4$, $PoCl_2$, Po/Ag, Po/Te	1948-1954
	PuO_2, PuF_4, Pu-$MoCl_4$, Pu-MoF_4.	1965-1978
	H-3, U(D,T)	1987-present
R-129,130	Po-210, Bi-210, $P(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1951
	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-223, -224, -226, Th-228, -229, -230	1951-1953
	Pu-238, PuO_2, PuF_4, Pu-$MoCl_4$, Pu-MoF_4, $PuCl_4$ (Th-232 compounds replacing Pu-238 compounds for analytical studies)	1965-1978
	H-3, Pu rare earths, Polonium alloys and compounds	1990-present
R-131	Po-210, Bi-210, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1951
	Pu-238, PuO_2, PuF_4, Pu-$MoCl_4$, Pu-MoF_4, $PuCl_4$, Cm-244	1965-1978
R-133	Po-210, Bi-210, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1954
	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-226, Th-228, -229, -230, AcF_4, AcI_4, Ac-227 daughters	1951-1953
	Pa-231, U-234, -235, -238, Th-230, -232; also Th-230, -232 daughters	1956-1958
	Pu-238, PuO_2, PuF_4, Pu-$MoCl_4$, Pu-MoF_4, $PuCl_4$, Cm-244.	1965-1978
R-134	H-2, U-238, U-238(D,T)	1986-present
R-137	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-226, Th-228, -229, -230, AcF_4, AcI_4, Ac-227 daughters	1951-1953
R-140	Th-228, -230, -232, U-234, -235, -238, Pu-238, -239, Po-208, -209, -210, Cs-137, Pa-231, Ac-227, Ra-223, -224, -226, Sr-90	1950-1969
	Pu-238, -239, -240, -241 (alloys, compounds and mixtures), $Pu(NO_3)_2$, Ac-227, Am-241	1969-present
R-142	Ra-226, $Ra(CO_3)$, $Ra(NO_3)_2$, $RaBr_2$, Ac-227, $Ac(C_2O_4)_4$, AcF_2, K-40, $Ba(NO_3)_2$, Th-228, -229, -230, radon and daughters, Po-208, -209, -210	1949-1953
	Pu-238,239, U-234,235,238, Th-230, Pa-231, Th-230 daughters	1956-1969
	PuO_2, (for Pu-238,239)	1966-1979

Table 2-6 (Continued). Radionuclides and related compounds for R Building.

Room	Radionuclides and related compounds	Dates used
R-143,144	Po-210, Bi-210, $AlCl_3$, $BiCl_3$, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1951
	PuO_2, (for Pu-238, -239)	1972-1976
R-145,147	Ra-226, $Ra(CO_3)$, $Ba(CO_3)$, $Ac(NO_3)_2$, Ra/Ba, Ac-227, $Ac(C_2O_4)_4$, AcO_2, Th-228, -229, -230	1949-1954
	Fe-59, Al-26, Ca-45, Co-60, Pa-231, Cu-65	1955-1956
	Pu-239, Am-241	1956-1959
	Pu-238 oxide, neutrons	1960-1962
	Pu-238, -239, PuO_2, U-234, -235, -238	1968-1975
R-148,149	Ra-226, Ra(CO3), Ba(CO3), Ac(NO3)2, Ra/Ba, Ac-227, Ac(C2O4)4, AcO2, Th-228, -229, -230, Po-208, Pa-231	1949-1954
	Fe-59, Al-26, Ca-45, Co-60, Pa-231, Cu-65, Pu-238	1954-1958
	Pu-238, $Pu(C_2O_4)4$, $Pu(NO_3)_4$, Th-230,	1960-1968
	PuO_2, Pm-146->149, $U(234)(NO_3)_4$, $U(234)O_2$, Pu/Zr	1970-1980
R-151	Po-210, Bi-210, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1951
	Pu-238, -239, $Pu(NO_3)_4$, $Pu(NO_3)_6$, PuO_2, Pu(OH), $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, $PuCl_4$, PuF_4, $Pu(SO_4)_2$, Np-237, and EDTA, citrates, and other substances acting like chelating agents were present	1958-1983
R-152	Po-210, Bi-210, $AlCl_3$, $BiCl_3$, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1954
	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-226, Th-228,229,230, AcF_4, AcI_4	1951-1953
R-155	Po-210, Bi-210, $AlCl_3$, $BiCl_3$, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1951
	U-235, -238, Pu-239, Np-237, Cm-244, Am-241, (the following were tried in combination with those listed: Ni-63, Co-60, Si-31, Z-65, Bi-210, Pb-210, Zr-95, Al-26 are rare earth elements)	1956-1969
R-159	Po-210, Bi-210, $AlCl_3$, $BiCl_+$, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1951
	U-235, -238, Pu-239, Np-237, Cm-244, Am-241, (the following were tried in combination with those listed: Ni-63, Co-60, Si-31, Z-65, Bi-210, Pb-210, Zr-95, Al-26 are rare earth elements)	1956-1969
R-160,161	Po-210, Bi-210, $AlCl_3$, $BiCl_3$, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1951
	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-226, Th-228, -229, -230	1951-1953
R-162	Ru-106, Cs-137, Sb-125, Te-121,127, Zr-93,95, Nb-94, Sr-90, Pu-238, -239, Y-88, -90, -91, Ce-144 and other rare earths	1948-1951
	Pu-238, -239	1950
	U-233, -235, -238	1958-1959
R-166	Po-210	1961-1968
R-167	Ru-106, Cs-137, Sb-125, Te-121->134, Zr-93, -95, Nb-94, Sr-90, Pu-238, -239, Y-88, -90, -91, Ce-144 and other rare earths	1948-1951
	Pu-239, U-234, -235, -238, I-131, Cs-137, Ce-144, Sr-90, Tc-99, Xe-133, Y-88, -90, -91	1949-1952
	Fe-55, -59, Al-26, Ca-45, Co-60, Pa-231, Cu-65.	1954-1955
	Pu-239, Ac-227, neutrons	1955-1957
	U-233, Th-229, -230, -232	1958
	Sr-90, Y-88, -90, -91, Pa-231.	1960-1962
	Pa-231, -233, Ce-141, -144, Am-241, Cm-244, U-233, Th-230, -232, Ra-226, Ti-208	1956-1987
R-168	U-238, UF_4, UO_2	1958
R-169	Th-230, -232, U-234, -235, -238, Pu-238, -239, Po-208, -209, -210, Cs-137, Pa-231, Ac-227, Ra-223, -224, -226	1960-1980
	U-235, -238, Pm-147, Ca-45	1980-present
R-170	U-238, Ca-45	1960-1964
R-171,172	Ra-223, -224, -226, $Ac(NO_3)_2$, Ac-227, $Ac(C_2O_4)_4$, AcO_2, Th-228, -229, -230, Ac and Ra daughters	1949-1954
	U-235, -238	1961-1963
	Pu-238, -239, -240, -241 (compounds, alloys and mixtures), Am-241, Ac-227, Ra-226	1965-1991
R-175,176	H-3	1970-present
R-197A	Pu-238, -239, PuO_2, Cm-244	1970-present
R-198	Pu-238, -239, $Pu(NO_3)_4$, PuO_2, PuF_4, Np-237, Ac-227, Cm-244, H-3, Po-210, PoF_4, Li(D,T), U-234, -235, -238, U(D,T), Am-241, Pr-146->149	1956-1982
R Building crawl space	Pu-238, -239, Ra-226, Ac-227, Po-210, Th-228, -229, -230	1948-present
R-CORR-5	Ac-222	1948-1984

SM Building

Special Metallurgical (SM) Building was built in 1960 and became operational in 1961. It was designed for the reception of a liquid plutonium nitrate mixture from the SRP that was used in a variety of programs, mainly heat source projects. In addition, SM Building housed recovery processing, waste treatment facilities, R&D, and analytical support activities.

Table 2-7 summarizes SM Building rooms, dates, and radioisotopes.

Table 2-7. Radionuclides and related compounds for SM Building.

Room	Radionuclides and related compounds	Dates used
SM-1	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4	1961-1962

	$Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, $PuO_2.XH_2O$, PuO_2, $Pu(C_2O_4)_4$, $PuO_2.5H_2O$, Pu(OH), $Th(NO_3)_4$, ThO_2, $Th(OH)_4$, $ThO_2.XH_2O$	1962-1967
SM-2	PuO_2	1961-1967
SM-3,10	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, Pu-238, neutrons	1961-1967
SM-20	Sealed sources	1961-1967
SM-21	PuO_2, Th-232 oxide (EDTA and citrates acted like chelating agents)	1961-1967
SM-26	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4	1961-1967
SM-27,28	$Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, PuO_2, $Pu(C_2O_4)_4$, $PuO_2.5H_2O$, Pu(OH), PuF_4, $PuCl_4$	1961-1965
	$Pu(NO_3)_4$, $Pu(NO_3)_4.5H_2O$, PuO_2, $PuO_2.X\ H_2O$, $Pu(C_2O_4)_4$, Pu(OH)	1965-1967
SM-34	$Pu(NO_3)_4.5H_2O$, PuO_2, $Pu(SO_4)_2$, PuF_4, $Am(NO_3)_4$, AmO_2, $Am(SO_4)_2$, AmF_4, $Np(NO_3)_4$, UO_2, $U(SO_4)_2$, UF_4	1963-1967
SM-35,35 A	$Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, PuO_2, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, $Pu(OH)_4$, PuF_4, $PuCl_4$	1961-1965
	$Pu(NO_3)_4$, $Pu(NO_3)_4.5H_2O$, PuO_2, $PuO_2.X\ H_2O$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1965-1967
SM-38 (SM-I)	$Pu(NO_3)_4$, PuO_2, $Pu(SO_4)_2$, PuF_4, $Am(NO_3)_4$, AmO_2, $Am(SO_4)_2$, AmF_4, $Np(NO_3)_4$, NpO_2, $Np(SO_4)_2$, NpF_4	1963-1967
	$Np(NO_3)_4$, UO_2, $U(SO_4)_2$, UF_4, $Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, PuO_2, $Pu(C_2O_4)_4$, PuO_2	1965-1970
SM-39	$Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, PuO_2, $Pu(C_2O_4)_4$, $PuO_2.5\ H_2O$, $Pu(OH)_4$, PuF_4, $PuCl_4$	1961-1965
	$Pu(NO_3)_4$, $Pu(NO_3)_4.5H_2O$, PuO_2, $PuO_2.X\ H_2O$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1965-1967
SM-58, 59 (A&B)	$Pu(NO_3)_4$, PuO_2, $Pu(SO_4)_2$, PuF_4, $Am(NO_3)_4$, AmF_4, AmO_2, $Am(SO_4)_2$, $Np(NO_3)_4$, NpO_2, $Np(SO_4)_2$, NpF_4, $U(NO_3)_4$, UO_2, $U(SO_4)_2$, UF_4	1963-1967
SM-60	PuO_2	1965-1967
SM-61,62	PuO_2, Th-232 (EDTA and Citrates acted like chelating agents)	1961-1967

SW Building

SW Building is similar to R Building in that it consists of many laboratories engaged in a variety of research, development, analytical, recovery, and surveillance activities. The "old cave" and "new cave" areas consisted of several rooms which were set up for "hot" work with several types of alpha and gamma radiation and project capabilities. Other major programs were the thorium refinery project, rare isotope program, neutron source, ^{234}U separation program, and the tritium programs. The tritium programs include the tritium enrichment, effluent capture, process development, component evaluation, and scrap recovery and tritium waste solidification.

SW building was used in the Cotter Concentrate (St. Louis Ariport Cake) starting in the early 1970s and terminated late in that decade. Pilot plant operations in SW were to recover Th-230 and Pa-231.

Cotter Concentrate Weight %

Uranium oxide – 21,740 g/drum

Th-232 – 99.9 g/drum

Pa-231 – 0.060 g/drum

Th-230 – 11.1 g/drum

Ave. moisture content 47%

The Old Cave was built in the early 1950s and occupied approximately 1,000-ft^2 area located in the Semi-Works (SW) Building. Radium-226 and ^{227}Ac were processed from 1951 to 1955 in this area. This process could result in possible contamination requiring decontamination efforts at various times during operations. From 1955 until 1959, D&D activities occurred in the old cave as manpower and budgets permitted. The cave structure was removed, including the exhaust systems. In March 1959, the old cave was cleaned and decontaminated.

SW-19 was the Old Cave, where radium–actinium separation and processing was conducted. The area was originally drained by a concrete channel and sumps and later filled with several feet of gravel and concrete due to high concentrations of radium and radon. By 1957, the area was filled over with additional concrete for radiation protection purposes. SW-19 had a history of elevated

radon concentrations that were reduced by ventilation of the underground tunnel in 1980. A 1990 DOE study showed an average radon concentration in SW-19 was found to be 5.8 picocuries per liter. Elevated radon, thoron, and actinon concentrations in the tunnel were also observed due to underlying contamination.

SW-22 was the New Cave and had few radon problems.

The radionuclides and their respective compounds that were present in SW-1A cave (King 1995) include:

Radium-226	Radium carbonate
Actinium-227	Radium nitrate
Radium bromide	Actinium oxalate
Actinium bromide	Potassium-40
Radon and daughters	Thorium-228, -229, -230

Table 2-8 summarizes rooms, dates, and radioisotopes for SW Building.

Table 2-8. Radionuclides and related compounds for SW Building.

Room	Radionuclides and related compounds[a]	Dates used
SW-2	H-3	1973-present
SW-8	H-3, tritides(Li, Ba, Ti, Ca, U-238, Others), U-235	1957-present
	Xe(All Isotopes)	1957-1960
	U(238)(D,T), Li(D,T), Ba(D,T), Ti(D,T)	1960-1985
SW-9	H-3, tritides (Type F, S),	1965-present
	U(D,T), Li(D,T), U/Al(D,T), Other tritides (Type F, S)	1989-present
SW-10	H-3	1967-1972
SW-11->16	Ru-106, Cs-137, Sb-125, Te-121,127, Zr-93, -95, Nb-94, Sr-90, Pu-238, -239, Y-88, -90, -91, rare earths (especially Ce).	1951-1953
	Th-228, -232, U-238, Ra-224, -228, Th-232 daughters	1955
	Fe-55, -59, Al-26, Ca-45, Co-60, Pa-231, Cu-65	1956
	H-3, Li tritide	1959-1965
	H-3, U(D,T), Li(D,T), LiO(D,T), U-238, U-235, sOBT, other tritides (Type F)	1959-1978
	H-3, U-238, U tritide	1964-1974
	H-3, U(D,T), U-238, Pu-239, other tritides (Type F, S)	1968-pres
	H-3, Tritides (type S)	1964-1975
	H-3 Oxide	1975-1985
	H-3, U-238, sOBT, tritides (Type F)	1975-1978
SW-19	Ra-226, $Ra(CO_3)$, $Ra(NO_3)_2$, $RaBr_2$, Ac-227, $Ac(C_2O_4)_4$, AcF_4, K-40, Th-228, -229, -230, radon and daughters	1951-1953
	H-3, Pu-239, U-238, U-235, tritides (Type F, S), Rn-222 and daughters	1962-1988
	H-3, Pu-239, U-238, tritides (Type F) Ra daughters	1973-pres
SW-20,21	H-3	1961-1973
SW-22	U-232, -233, Th-228, -229, Ra-224, -225, Ac-225, Fr-221, At-217, Th-228 daughters	1966-1975
	Th-230, -232, U-234, -235, -238, Pa-231, Ac-227, Ra-223, -224, -226, $Ac(NO_3)$, AcO2.	1970-1979
	Po-208, -209, -210, Po-210 daughters	1976-1979
	Pu-238, Pu-239, U-233 (Type F, M)	1984-1986
SW -128, 129,130,134	Th-230, -232, U- -234, -235, -238, Pa-231, Ac-227, Ra-223, -224, -226	1970-1979
SW-132	Th-230, -232, U-234, -235, -238, Pa-231, Ac-227, Ra-223, -224, -226, $Ac(NO_3)$, AcO_2	1970-1979
	Po-208, -209, -210, Po-210 daughters	1976-1979
SW-136,137	Th-230, -232, U-234, -235, -238, Pa-231, Ac-227, Ra-223, -224, -226, $Ac(NO_3)$, AcO_2	1964-1979
SW-140	Ac-227, $Ac(NO_3)_2$, AcO_2	1964-1968
	Th-230, -232, U-234, -235, -238, Pa-231, Ac-227, $Ac(NO_3)$, AcO_2, Ra-223, -224, -226	1974-1979
	Po-208, -209, -210, Po-210 daughters	1976-1979
SW-142	Ra-226, $Ra(CO_3)$, $Ra(NO_3)_2$, $RaBr_2$, Ac-227, $Ac(C_2O_4)_4$, AcF_2, K-40, Th-228, -229, -230, Po-208, -209, -210, radon and daughters	1950-1961
	H-3, Li tritide	1959-1969
	H-3, U-238, U(D,T), Pu-239, other tritides (Type F, S), U-233	1969-1985

SW-146,147	H-3, U-238, U(D,T).	1967-1985
	Tritiated stainless steel	1985-pres
SW-149,149A	All radionuclides in SW Building	1965-1968
	H-3, HTO, tritiated organics	1969-present

Table 2-8 (Continued). Radionuclides and related compounds for SW Building.

Room	Radionuclides and related compounds	Dates used
SW-150,152	H-3, U-238(D,T), Other tritides (Type F, S)	1968-present
	H-3, U-238 tritides (Type F, S)	1973-present
SW-200	H-3	1958-present
SW-202	Po-210	1958-1962
	H-3.	1963-present
SW-205	H-3	1958-present
SW-208	H-3, U-238(D,T), Pu-239, other tritides (Type F)	1965-present
SW-210	H-3, U-238(D,T), Pu-239, other tritides (Type F)	1968-1989
SW-219	Pu-238/Be, Pu-239/Be, Am-241, Pu-239	1962-1965
	Po-210, Pu-238, -239	1966-1971
	H-3	1968-1978
	H-3, U-238(D,T), tritides (Type F, S)	1968-1980
	H-3, U-238(D,T), tritides (Type F)	1985-present
SW-231	H-3, HTO	1970-present
SW-238,240	H-3, U-238(D,T), U-238, U-235, natural U, other tritides (Type F, S)	1968-present

a. sOBT = (physiologically) soluble, organically bound tritium.

T Building

T Building was host to a number of research, development, and production programs with various radioisotopes. The two major programs were the polonium and tritium programs. From 1949 to 1973, ^{210}Po programs included processing and separation, fuels research and development, neutron source, and other research, development, and production programs. This work was performed on the first and second floors of T Building.

An extensive renovation program from 1966 to 1968 prepared the way for additional R&D work, but the renovations were never used due to unanticipated funding reductions. T Building was essentially dormant from 1969 to 1972 due to this loss of funding. Tritium programs resumed in the 1970s.

Other activities in T Building included nondestructive testing, environmental testing, gamma and mass spectroscopy, calorimetry, neutron activation analysis, and safeguards R&D.

Table 2-9 summarizes T Building rooms, dates, and radioisotopes.

Table 2-9. Radionuclides and related compounds for T Building.

Room	Radionuclides and related compounds	Dates used
T-1W, 2W, 4E	Pu-238,-239, U-233,-235,-238, H-3	1965-1987
T-5W	H-3, HTO	1956-1962
		1975-1982
T-5E	Pu-238, -239, H-3, Co-60, Ir-192, Fe-55, -59, Ra-226, Am-241, Cd-109	1955-present
T-8	Po-210	1949-1965
T-9, 9A	H-3, Pu-238 (encapsulated)	1987-present
T-13	Po-210	1949-1953
T-15B, 18	Neutron generator, neutron activation on surfaces	1963-present
T-16A	H-3, tritiated organics	1984-present
T-19, 19A	Pu-238, -239, H-3, Co-60, Ir-192, Fe-55, Ra-226, Am-241, Cd-109; all were encapsulated	1985-present
	H-3, tritiated organics	1985-present
T-20	No radioactive work performed	1985-present
T-22	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Z-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203	1949-1969
	Pu-238, -239	1979-present

Table 2-9 (Continued). Radionuclides and related compounds for T Building.

Room	Radionuclides and related compounds	Dates used
T-25, 26, 27	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203.	1949-1969
	Pu-238,239 (encapsulated)	1979-present
T-28->35	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203.	1949-1969
T-36, 36A	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203.	1949-1969
	Classified	1985-present
T-37	H-3, U-238(D,T), Pu-238(encapsulated), tritiated organics	1985-present
T-40	H-3, Pu-238 (encapsulated)	1985-present
T-41	H-3	1985-present
T-46	Po-210	1949-1969
T-48, 49, 50	H-3, U-238, tritides (Type F, S)	1983-present
T-53, 54, 55, 55A	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203.	1949-1969
T-57	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203.	1949-1971
	H-3	1985-present
T-58	H-3	1985-present
T-59	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203.	1949-1969
	H-3, U(D,T)	1985-present
T-61, 61A	Po-210, Pu-238, -239	1960-1963
	Po-210	1964-1966
	H-3, U(D,T)	1973-present
T-63	H-3, HTO	1973-present
T-72, 73, 74, 75, 92, 93, 96, 97, 98	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203.	1949-1969
T-99	$AlCl_3$, $BiCl_4$, Ag-Po, Te-Po, $PoCl_2$, Po-210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203	1947-1969
	H-3	1984-present
T-100, 102, 103, 104	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203	1949-1969
	H-3	1972-present
T-208A	Pu-238, -239, H-3, Co-60, Ir-192, Fe-55, Ra-226, Am-241, Cd-109, Po-210; all were encapsulated...	1947-present
T-229	Po-210, Pu-238, -239	1963-1964
	Rn-222, Po-210,214,218, Bi-210, Pb-210,214	1978-1988
	Pu-238, -239 (encapsulated)	1989-present
T-234	H-3, U-238 tritides, other tritides (Type F)	1988-present
T-236	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203	1949-1973
	H-3, U-235, -238, -239, Pu-238, -239 (Pu was encapsulated)	1985-present
T-237	Ag-Po, Te-Po, $PoCl_2$, Po-208, -209, -210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203	1949-1971
	H-3, Pu-238, -239 (Pu was encapsulated)	1985-present

Table 2-9 (Continued). Radionuclides and related compounds for T Building.

Room	Radionuclides and related compounds	Dates used
T-238	H-3, Pu-238, -239 (Pu was encapsulated)	1985-present
T-242	Po-210	1949-1964

T-243	H-3, HTO	1956-1982
T-245	Po-210	1949-1969
	Pu-238 (encapsulated).	1968-1974
T-246	H-3	1972-1980
T-247	Po-210, classified	1949-1958
	Po-208, -209, -210, rare earth polonides, Pm-147	1966-1969
T-248-259	Po-210, neutrons	1949-1965
	Room T-257 only, orphan sources	1993-present
T-260	Po-210	1949-1969
	Po-208, -209, -210, rare earth polonides, Pm-147	1966-1969
T-266, 267	Po-210, Bi-209, -210	1949-1969
	Po-208, -209, -210, rare earth polonides, Pm-147	1963-1966
	H-3, U-238(D,T), other tritides (Type F).	1988-present
T-270	Po-210, Bi-209, -210	1949-1963
T-274	External dose only	1948-1971
	Po-210, Bi-210, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,-72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203.	1966-1969
	H-3, U-238(D,T)	1986-pres
T-275, 276	$AlCl_3$, $BiCl_4$, Ag-Po, Te-Po, $PoCl_2$, Po-210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203	1949-1969
T-277, 279	Am-241, Pu-239, neutrons	1949-1964
	Po-210	1949-1969
	Bi-209, -210	1964-1969
T-300A	Orphan sources, sources left in containers	
T-307	Po-210	1949-1964
	H-3	1972-present
T-310	$AlCl_3$, $BiCl_4$, Ag-Po, Te-Po, $PoCl_2$, Po-210, Bi-210, $Po(NO_3)_2$, Fe-55, -59, Si-31, Co-60, Pb-209, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70, -72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-134, Hg-203	1949-1969
	Pu-238, -239, -240, -241, Pm-147, U-233, -235, Am-241, H-3	1969-1983
	Pu-238, -239 (encapsulated)	1986-present
T-311	Po-210.	1949-1969
	Pu-238, -239 (encapsulated)	1986-present
T-319	Pu-238, -239, -240, -241, Pm-147, U-233, -235, Am-241, H-3, HTO	1949-present

WD and WDA Buildings

WD Building, which became operational in February 1949, is the central facility at Mound for the treatment of radioactive liquid wastes. From its inception, this facility included a low-level alpha wastewater system, with SW, R, PP, SM, HH, T, B, and H Buildings as sources. On arriving at WD Building, wastewater is precipitated, coagulated, and filtered, and the sludge is solidified so it can be shipped off the site. The supernatant from the clarifloculator is filtered, neutralized to the proper pH, monitored to see if below standard, and released to the Great Miami River.

The WDA alpha wastewater treatment facility was built in 1966 as an annex to WB Building for the treatment of plutonium wastewater from the PP and SM Buildings. It was designed as both a high-risk drumming station and a low-risk wastewater treatment facility.

Table 2-10 summarizes rooms, dates, and radioisotopes for WD and WDA Buildings.

Table 2-10. Radionuclides and related compounds for WD and WDA Buildings.

Room	Radionuclides and related compounds	Dates used
WD-1, 8, 101, 104	Ag-Po, Te-Po, $PoCl_2$, Bi-210, $Po(NO_3)_2$, Si-31, Sb-124, Sn-121, Zn-65, Cr-55, V-52, Ga-70,72, Se-75, Ag-112, Hg-203	1949-1958
	Am-241, Ac-227, Ra-223, -226, $Ac(C_2O_4)_4$, Th-228, -229, -230, U-234, -235, -238, Pu-238, -239, Po-208, -209, -210, Cs-137, Pa-231, AcO_2, $Ac(NO_3)_2$, $AcBr_4$, AcF_4, K-40, $Ba(NO_3)_2$, Np-237, H-3, rare earth isotopes, tritiated octane, Co-60, Sr-90, Fe-55, -59, Te-121-134, UO_2	1949-1990
	Th-228, -232, Ra-224, -228, U-238	1955
	Pu-236, -238, -239, -240, -241, -242, $Pu(NO_3)_4$, PuO_2, $Pu(SO_4)_2$, $Pu(OH)_4$, PuF_4 (also nitrate, sulfate, oxide, and fluoride compounds of Am-241, Np-237, and U-234)	1961-1974
	Th-230, -232, U-234, -235, -238, Pu-238, -239, Pa-231, Ac-227, Ra-223, -224, -226	1974-1979

WD-9	H-3, U-239(D,T), U-235, -238, -239, Pu-238, -239, Am-241, Rn-222, Po-208, -209, -210 and Po-210 daughters, Bi-210, -214, Pb-210, -214, Ra-223, -224, -226 and Ra daughters, U(D,T), Li(D,T), U/Al(D,T)	1973-present
WD-10	Pu-236, -238, -239, -240, -241, -242, $Pu(NO_3)_4$, PuO_2, $Pu(SO_4)_2$, $Pu(OH)_4$, PuF_4 (also nitrate, sulfate, oxide, and fluoride compounds of Am-241, Np-237, and U-234)	1961-1974
WD-107	Cs-137, Am-241, Np-237, U-235,238	1976-1981
WD-108	Pu-236, -238, -239, -240, -241, -242, $Pu(NO_3)_4$, PuO_2, $Pu(SO_4)_2$, $Pu(OH)_4$, PuF_4 (also nitrate, sulfate, oxide, and fluoride compounds of Am-241, Np-237, and U-234)	1949-1981
WDA-110	Pu-236, -238, -239, -240, -241, -242, $Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, PuO_2, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, $Pu(OH)_4$, PuF_4 (also nitrate, sulfate, oxide, and fluoride compounds of Am-241, Np-237, and U-234)	1966-1970
	H-3	1967-present
WDA-112	Pu-236, -238, -239, -240, -241, -242, $Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, PuO2, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, $Pu(OH)_4$, PuF_4 (also nitrate, sulfate, oxide, and fluoride compounds of Am-241, Np-237, and U-234)	1966-1979
	Cs-137	1980-1984
WDA-113	Cs-137, Co-60, I-131, Pu-238, -239	1979-1994
WDA-118A	Co-60, Cs-137, I-131, Sr-90	1977-1981
WDA-118B	Pu-238, -239, H-3	1975-1985
	Co-60, Cs-137, Mn-54, Sr-90	1981-present
WD-Penthouse	Th-230, -232, U-234, -235, -238, Pu-238, -239, Pa-231, Ac-227, Ra-223, -224, -226, -228, Co-60, Cs-137, Np-237, Sr-90, Po-208, -209, -210, Am-241, H-3, Te-121-134, Fe-55, -59	1949-present

Warehouse 9 (1953)
All of the drums stored in Warehouse 13 from the Purex/Bismuth phosphate materials decontamination were moved to Warehouse 9 in preparation for shipment off the site. The following radionuclides of concern and their compounds are of equal concern:

Antimony-125
Cesium-137
Niobium-94
Plutonium-238 and -239
Rare earths (especially cerium)
Ruthenium-106
Strontium-90
Tellurium-121 and -127
Yttrium-88, -90, and -91
Zirconium-93 and -95

Warehouse 13 (1953)
This warehouse was used for the storage and shipment of several drums of sludge from the Purex/Bismuth phosphate decontamination program. The settling and mixing tanks were also taken there. The following radioisotopes and their compounds are of equal concern:

Antimony-125
Cesium-137
Niobium-94
Plutonium-238 and -239
Rare earths (especially cerium)
Ruthenium-106
Strontium-90
Tellurium-121 and -127
Yttrium-88, -90, and -91
Zirconium-93, -95

This warehouse was also used for temporary storage for drums of low level contamination from the $^{226}Ra/^{227}Ac$ decontamination operations. Radioisotopes of concern and their compounds are:

Actinium fluoride
Actinium oxalate
Actinium-227
Barium nitrate
Potassium-40
Radium bromide
Radium carbonate
Radium nitrate
Radium-226
Radon and daughters
Thorium-228
Thorium-229
Thorium-230

Actinium-227 is the major radionuclide of concern. Radium-226 and ^{228}Th are of nearly equal concern, and ^{208}Po, ^{209}Po, and ^{210}Po are of much less concern. The remaining isotopes are of small concern.

Warehouse 15 (1955–1961)
This warehouse stored 1,650 tons of the ^{232}Th refinery program (Monex) sludge. It was highly corrosive and continually leaked through the barrels causing much contamination. More than 34 isotopes were identified from the feedstock of this program with most being nonradioactive. Radioisotopes of concern and their compounds are:

Radium-228 and -224
Thorium-232 daughters (especially thallium-208)
Thorium-232 and -228
Uranium-238

Thorium-228 and -232 and ^{224}Ra are equal as major radionuclides of concern. Uranium-238 is a secondary concern. However, when considering the quantity or mass of radionuclides, and not activity, 99% are ^{232}Th.

Building 21
This building was constructed in 1964 for bulk storage of thorium ores and sludge from the old Monex project, a ^{232}Th refinery program. It was originally designed like a silo with no doors or windows; oxalate sludge was stored in one side and hydroxide sludge in the other. Until 1973 at least 117 55-gallon leaky drums remained outside the building. Contamination of the surrounding grounds occurred from fugitive dust resulting from the dumping of this sludge into this silo. From October 1974 to July 1975, the sludge was repackaged in 55-gallon drums and shipped off the site. Radionuclide contents of the sludge were primarily thorium isotopes, rare earth isotopes, uranium, and others.

A total of 1,252 55-gallon drums of Cotter Concentrate were stored in Building 21 from 1975 until 1987 when they were shipped off the site. This concentrate contained significant quantities of the following, which are radionuclides of concern:

Actinium nitrate
Actinium oxide
Actinium-227
Protactinium-231
Radium-223, -224, and -226
Thorium-230 and-232
Uranium-234, -235, and -238

Thorium-230 was the major radionuclide of concern with more than 95% of the activity.

Fourteen elements beside the isotopes listed above are in the Cotter Concentrate. There is no indication that these 14 elements are radioactive.

The surrounding grounds served as storage for ^{238}Pu waste packages in 1967. There was leakage of the plutonium waste packages. The area around Building 21 was contaminated because of the leakage of the Monex sludge drums, the debris from dumping sludge through the roof, and repackaging into drums.

Building 34
This building has a dual purpose: It was a drop test area for waste packages and an area for simulation of pyrophoric metal training for the fire fighters. The empty low specific activity (LSA) containers were dropped in various ways to test and ensure their structural integrity. Similar tests were done on drums.

Depleted uranium and metal shavings of various types were used in firefighting practice to simulate pyrophoric situations. Radioisotopes of concern include ^{238}U oxide.

Building 50
Building 50 is designated as the assembly and testing building for RTGs. In Building 50, RTGs are assembled in an inert atmosphere. All plutonium used as the heat source is encapsulated, which gives little probability for a radionuclide release. External dose is still possible from gamma and neutron flux.

Associated with the RTG program is a testing program. Approximately 20 tests (vibration, space simulation, extreme heat, extreme cold, shock, vacuum performance, etc.) are done on the RTG module.

Building 59
This building contains a subcritical assembly, which has the capability to produce fission products. However, all fission products were sealed in aluminum containers, so the probability of contamination is remote. The water surrounding the containers inside the assembly is constantly monitored and contamination has been observed.

Californium-252 and enriched uranium were used for irradiation. These radioisotopes were encapsulated in metal cladding, so there is no concern for internal dosimetry. Some intentional irradiation is done, with the major contaminants being ^{55}Fe, ^{59}Fe, and ^{60}Co. Radionuclides of concern are:

Californium-252
Cobalt-60
Iron-55 and -59
Uranium-234, -235, and -238

The historical radionuclides of major concern were ^{252}Cf and ^{235}U, equally. This building has not been operational since 1990 and is not likely to operate again. In the future, radionuclides of concern will be ^{235}U and ^{59}Fe in the form of rust during building demolition.

Building 68
This building functions as a decontamination and decommissioning staging area and handles the radionuclide waste from R Building.

A corollary activity of this area is to perform testing on empty LSA containers. These are dropped in various ways to test and ensure their structural integrity. Similar tests are also done on drums. Radioisotopes of concern are ^{238}Pu oxide and ^{239}Pu oxide.

B Building
From around 1950 to about 1955, this building was used for biological research of the effects of ^{210}Po, ^{227}Ac, and other alpha emitters on animals. The results were used to estimate the effects of radionuclides used at Mound on humans. Biological testing was discontinued in about 1955 when detonator manufacturing began.

A *Biological Research Quarterly* from June 1954 discusses mice and rat experiments, which were conducted over a 2-year period with ^{210}Po. In another experiment rats were given a ^{227}Ac solution that also contained ^{227}Th, ^{223}Ra, ^{239}Rn, ^{215}Po, and ^{211}Bi.

A report by D. S. Anthony and K. A. Bush discusses experimental results of single acute and multiple exposures of ^{210}Po to rats with higher dosages of polonium than previously reported. In addition, studies with plutonium were done with a special emphasis on ^{238}Pu. Other reports discuss experimental work using ^{226}Ra and ^{227}Ac.

Room B-146
This was a laboratory where early research was done. Radioisotopes of concern and their compounds are:

Actinium-227	Polonium-215
Bismuth-211	Radium-223 and -226
Plutonium-238	Radon-219
Polonium-210	Thorium-227

Polonium-210 was the major radionuclide of concern with ^{227}Ac being secondary. B-Building was decontaminated by July of 1955.

Rooms E-141, -142, -144, -155
In use from 1981 to the present, Room E-141 uses small amounts of radionuclide standards of varying amounts and kinds as tracers for environmental testing. The tracers are in liquid form with only ^{210}Pb being encapsulated. They are used and stored in Room E-141, and are used in rooms E-142, 144, 155, which are also environmental laboratories. Radionuclides of concern are:

Plutonium-238, -239	Thorium-229, -230
Tritium	Uranium-232, -234, -236, -238
Lead-210	

Rooms E-174, -175, -177, -185, -194
These rooms have been used for cold storage and, therefore, were thought not to contain radionuclides. However, recent surveys found items in these rooms contaminated with alpha, beta, and gamma radiation. The following specific results were found:

Room E-174—alpha from an unknown source

Room E-175—beta and gamma from an unknown source

Room E-177—beta and gamma from a U-235 rod, epoxy metallurgical sample, metal chips

Room E-185—(~1985-present) alpha and beta on metallurgical sample contaminated with ^{235}U, a second sample with suspected contamination from ^{232}Th

Room E-194—alpha from possible plutonium, beta and gamma from possible ^{235}U or ^{238}U

An overview of operations in E-Building includes the following radionuclides of concern:

Nitrate and chloride solutions of:

Lead-210	Thorium-229 and -230
Plutonium-238, -239, and -242	Tritium
Polonium-210	Uranium-232, -234, -235, -236, and -238

Plutonium-238 was the major radionuclide of concern with ^{210}Po second and tritium third.

H Building
Although this building houses many innocuous functions such as the credit union and change rooms, there are activities that have the potential for radionuclide intakes.

The laundry had a “hot laundry” capability to handle clothes exposed to radionuclides, which is the primary reason the structure was built. Bioassay and other environmental laboratories in H-Building have the potential for low levels of exposure. Most radionuclides are tracer nitrate and chloride

solutions of ^{238}Pu, ^{239}Pu, ^{242}Pu, ^{232}U, ^{236}U, and ^{229}Th. Tritium and ^{210}Po could be included. It has been suggested that ^{226}Ra, ^{228}Th, and ^{227}Ac be included in the list.

Radionuclides and related compounds of concern are:

Actinium-227
Plutonium-238, -239, and -242
Polonium-210
Radium-226
Thorium-228 and -229
Tritium
Uranium-232 and -236

Plutonium-238 was the major radionuclide of concern with ^{210}Po second and ^{227}Ac third.

I Building
I-Building refers to the Isolation Building, where low-level counting of bioassay (urine and fecal) samples and environmental counting for soil, vegetation, etc., were performed from 1955 to the present. There is little concern about the possibility of uptakes. This area is used for nondestructive testing and the assembly of explosive devices. No radionuclides are used.

M Building
Room M-20 had a Livermore drybox. In addition, ^{238}U was machined in this building.

R&R Building
This small building between the SM and PP Buildings was used for sorting plutonium solid waste, some of which could be reprocessed. The compound forms of the plutonium and lung solubility types are as follows:

- Plutonium oxide, PuO_2, Type S; this could also take the form of a plutonium oxide hydrate—$PuO_2.XH_2O$
- Plutonium hydroxide, $Pu(OH)_4$, Type S
- Plutonium nitrate, $Pu(NO_3)_4$, Type M; this could also take the form of plutonium nitrate pentadhydrate, $Pu(NO_3)_4.5H_2O$

Plutonium-238 was the major radionuclide of concern; ^{239}Pu was second.

SD Building (57, 112, and 113) (1947–1970)
The SD Building was a sanitation building that could have had some contaminated sludge from broken lines or pipes. Contamination would have been minor in concentration but could have contained radionuclides from polonium processing. Radionuclides of concern and related compounds are:

Antimony-124
Bismuth-210
Cesium-137
Chromium-55
Cobalt-60
Gallium-70 and -72
Iron-55,59
Lead-209
Mercury-203
Plutonium-238 and -239
Polonium chloride
Polonium nitrate
Polonium-208, -209, and -210
Selenium-75
Silicon-31
Silver polonide
Tellurium polonide
Silver-112
Strontium-90
Tellurium-121 and possibly Te--134
Tin-121
Vanadium-52
Zinc-65

Polonium-210 was the major radionuclide of concern, with ^{238}Pu second and ^{65}Zn third.

Building 19
The building is a 4,800-ft^2 Quonset hut and contains a small office and an area for storing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) materials. The building was constructed in 1962 for Mound Salvage storage and sales. Since 1988 it has been used to store CERCLA soil drums and empty drums. Low-level waste (LLW) and LSA drums have also been stored in this building. Plutonium-238 and ^{232}Th were the primary isotopes in the LLW and LSA drums.

Building 22
Building 22 is a 9,090-ft^2 one-story steel frame building constructed in 1966 for office space and storage of items to be sold. In 1995 the building was modified to handle radioactive LLW solid waste.

Building 23
Building 23 is a 3,422-ft^2 one story steel frame building constructed in 1966 as a warehouse used for preparation and shipping of LLW. It was later used to store mixed and transuranic (TRU) mixed waste. The building was modified in 1994 to contain spills.

Building 30
Building 30 contains a counting laboratory. Liquid scintillation counting for tritium and gross alpha and beta counting were performed in this building. The facility performed gamma scans of drums and boxes. Several years ago the facility was converted from office space to a counting laboratory.

Building 31
Building 31 is a 3,000-ft^2 metal fabricated building constructed in 1966. The building is used for storage and preparation of LLW waste.

Building 31A
Building 31A is a 2,650-ft^2 metal fabricated building constructed in 1986 to store LSA and TRU waste. The building is currently used for storage of TRU wastes.

Building 35
Building 35 is a 2,500-ft^2 metal fabricated building constructed in 1967 for X-ray and eddy-ray current nondestructive testing. The facility was also used as the control room for the ^{252}Cf multiplier (CFX) neutron radiography facility.

Building 39
Building 39 is a 3,515-ft^2 metal fabricated building constructed in 1967 to build Fiberglass wooden boxes for radioactive trash for the D&D activities. Indications are that gamma spectroscopy on these boxes was also performed in this building. From 1984 to 1988 the building was either inactive or used for storage. Since 1988 the building has been used as a maintenance shop.

Building 45
Building 45 is a 9,582-ft^2 concrete building constructed in 1967. The building is the health physics calibration laboratory. The facility has equipment for calibration of health physics instrumentation and dosimeters. The facility houses a well calibration area, a beta calibration area, a calibration and repair area, a dosimeter preparation area, an X-ray calibration area, and a low-scatter neutron and maximum field calibration area.

Building 58
Building 58 is a 6,100-ft^2 concrete building constructed in 1977. The building is the alpha and beta filter and plenum exhaust for SW Building.

Building 72
Building 72 is a 2,400-ft^2 metal frame building constructed in 1984. The building is site hazardous storage waste facility. Liquid scintillation vials are stored in this facility.

Building 90
Building 90, constructed in 1985, housed the unit controls and feed operations for the retort unit (rotary kiln thermal treatment unit) located in the burn area. Operations ended in January 1996.

Building 94
Building 90 is a 1,240-ft^2 metal building constructed in 1985. The building is used for CERCLA contractor staging and storage of soil and water samples.

Building 123 (Rubb)
In addition to fulfilling a variety of uses, this temporary structure has also had different names, including WTS Rubb from 1989 into the 1990s and the Rubb Building later in the 1990s. More recently, it has been called Rubb Building 123.

Rubb Building 123 was constructed in 1989 and was deconstructed in 2001. The building was used to store heavy equipment in 1989. Beginning in 1994, LSA boxes containing soils from the WTS line cleanup were emptied and sampled in the building. The boxes being opened were randomly selected from a population of nearly 700 boxes to achieve a 95% confidence level. The purpose of this process was to conduct content verifications of the boxes. The results of this verification sampling eventually lead to the ability to ship the boxes as LLW.

In the 1990s the Rubb Building 123 was also used for storage of heavy-duty equipment for the D&D group. Heavy-duty equipment stored in this structure was likely used in the demolition of site buildings and in the cleanup of contaminated areas on the plant site.

Rubb Building 123 was also used as a decontamination location for heavy equipment that had been used by D&D in the demolition of site buildings and in the cleanup of contaminated areas on the plant site.

The Brickmaker
The Brickmaker, built in 1992, was a temporary structure to house equipment to compress and to de-water low-level radioactively contaminated soils into extruded bricks that could be placed in LLW boxes for disposal off the site. The project area consisted of two temporary steel-framed Rubb®-brand buildings, an office trailer, and a lined in-ground pit to receive water from the process.

Building 124 (CWPF)
Building 124, also know as the Consolidated Waste Processing Facility (CWPF), was constructed in 1998. Building 124 performed various volume reduction or repackaging functions that are routinely performed at MEMP. The building processed LLW from various demolition sites and safe-shutdown activities as well as legacy waste streams. Building 124 is in an Underground Radiological Materials Area.

The ASA included a list of expected process input materials, as described in Section 2.3. The list included, but was not limited to:

- Non-structural equipment and debris (soft objects such as rags and bags for compaction)
- Structural steel for decontamination, size reduction, and release
- Soils and other demolition debris for blending to reduce the radioactive material content to meet specific waste profiles

- Drums, boxes, and other types of containers in order to puncture the container lids to vent gas, sample and analyze the released gas and to install filter vents

- Liquids generated by the air recirculation unit or tritium-contaminated liquids collected during opening or repackaging containers with tritium contamination

- Various types of waste packages for sampling, consolidation, or repackaging, or other activities that ensure that the waste is packaged in a form suitable for shipment off the site and final disposal.

At Building 124 the stack was monitored for potential air emissions of:

- Tritium
- Pu-238
- Pu-239 and -240
- U-233 and -234
- U-238

Area 8, Thorium Contaminated soils from area 1 and 9

The area is located northwest of Building 31, on the SM/PP hill on the eastern side of Mound site. The area is approximately 25,000 ft^2. Soil was buried in this area from decontamination activities from repackaging of Th-232 sludges in 1965 and 1966. Pu-238 was detected at a maximum concentration of 24 pCi/g. The maximum Thorium concentration was 254.3 pCi/g.

Area 10, Debris from Dayton Units

The area is located west of Building 30, on the slope of the SM/PP hill on the East Central portion of Mound site. It was used for disposal of contaminated concrete from Dayton Units. One hundred and sixty truckloads from Unit IV and one hundred truckloads from Unit III were deposited here. The area is approximately 15,000 ft^2. The primary contaminant was Po-210. Soil was buried in this area in 1950.

Area 12, Thorium Contaminated soil

The area is located west of Building 38, on the SM/PP hill on the East Central portion of Mound site. Th-232 and Pu-238 contaminated soil from SM building and Thorium contaminated soil from area 1 were placed in this area in 1965.

WTS Pipline

The pipeline line ran from SM building and Building 38 to the WD building. In 1969 the high-risk waste line ruptured below the WD building. The pipline may have leaked in other locations as well along its path.

2.3.2 Buildings without Radionuclide Activity

The following buildings have not supported radionuclide activities: 1, 2, 3, 13, 14, 16, 17, 24, 25, 26, 27, 28, 29, 33, 36, 37, 40, 41, 42, 43, 44, 46, 47, 48, 49, 51, 55, 56, 60, 61, 63E, 63W, 65, 66, 67, 69, 70, 71, 73, 74, 79, 85, 87, 88, 49, 91, 92, 93, 95, 96, 98, 99, 100, 101, 102, 104, 105, 106, 120, A (Administration), C (Old Cafeteria), COS, DS, G, Generator-1, Generator-6, GH, GP-1, GP-5, GP-8, GP-44, GS, GW, Modular 4, OSE, OSW, P (Power Plant), PH, SST, W, WH-1, WH-2, WH-3, and Magazines 5, 6, 7, 8, 10, 11, 20, 52, 53, 54, 64, 80, 81, 82, 83, and 84.

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