

| | |
|---|---|
| <p>ORAU Team NIOSH Dose Reconstruction Project</p> <p>Technical Basis Document for the Mound Site – Site Description</p> | <p>Document Number: ORAUT-TKBS-0016-2 Effective Date: 07/07/2006 Revision No.: 00 PC-1 Controlled Copy No.: _____ Page 1 of 33</p> |
| <p>Subject Expert: Jeff Vollmer</p> <p>Document Owner</p> <p>Approval: <u>Signature on File</u> _____ Date: <u>03/29/2004</u> Jeff Vollmer, TBD Team Leader</p> <p>Approval: <u>Signature on File</u> _____ Date: <u>03/29/2004</u> Judson L. Kenoyer, Task 3 Manager</p> <p>Concurrence: <u>Signature on File</u> _____ Date: <u>03/29/2004</u> Richard E. Toohy, Project Director</p> <p>Approval: <u>Signature on File</u> _____ Date: <u>03/30/2004</u> James W. Neton, OCAS Health Science Administrator</p> | <p>Supersedes:</p> <p style="text-align: center;">None</p> |

TABLE OF CONTENTS

| <u>Section</u> | <u>Page</u> |
|---|-------------|
| Record of Issue/Revisions | 3 |
| Acronyms and Abbreviations | 4 |
| 2.0 Introduction | 5 |
| 2.1 Purpose | 6 |
| 2.2 Scope | 6 |
| 2.3 Site Activities and Processes | 6 |
| 2.3.1 Buildings with Radionuclide Activity | 10 |
| 2.3.1.1 Dayton Project Buildings..... | 10 |
| 2.3.1.2 Mound Laboratory, Miamisburg (Unit V) | 13 |
| 2.3.2 Buildings without Radionuclide Activity | 31 |
| References | 32 |

LIST OF TABLES

| <u>Table</u> | <u>Page</u> |
|---|-------------|
| 2-1 Locations and descriptions..... | 7 |
| 2-2 Unit III room key..... | 11 |
| 2-3 Unit IV room key | 12 |
| 2-4 Radionuclides and related compounds for HH Building | 14 |
| 2-5 Radionuclides and related compounds for Building PP (38) | 15 |
| 2-6 Radionuclides and related compounds for R Building | 17 |
| 2-7 Radionuclides and related compounds for SM Building..... | 18 |
| 2-8 Radionuclides and related compounds for SW Building | 20 |
| 2-9 Radionuclides and related compounds for T Building..... | 21 |
| 2-10 Radionuclides and related compounds for WD and WDA Buildings | 23 |

LIST OF FIGURES

| <u>Figure</u> | <u>Page</u> |
|----------------------------------|-------------|
| 2-1 Unit III site map..... | 12 |
| 2-2 Unit IV site map..... | 13 |
| 2-3 Mound (Unit V) site map..... | 14 |

RECORD OF ISSUE/REVISIONS

| ISSUE AUTHORIZATION DATE | EFFECTIVE DATE | REV. NO. | DESCRIPTION |
|--------------------------|----------------|----------|--|
| 03/30/2004 | 03/30/2004 | 00 | New Technical Basis Document for the Mound Site – Site Description. First approved issue. Initiated by Jeff Vollmer. |
| 03/30/2004 | 07/07/2006 | 00 PC-1 | <p>Page change revision initiated for biennial review. Incorporates NIOSH formal review comments. Changes were made to the required language on pages 5 and 6 in Section 2.0. No sections were deleted. Approved issue of Rev 00 PC-1. This revision results in no change to the assigned dose and no PER is required. Training required: As determined by the Task Manager. Initiated by Paul J. Demopoulos.</p> <p>Approval:</p> <p><u>Signature on File</u> _____ <u>06/06/2006</u> Stanley J. Waligora, TBD Team Leader</p> <p><u>Signature on File</u> _____ <u>06/06/2006</u> John M. Byrne, Task 3 Manager</p> <p><u>Signature on File</u> _____ <u>06/07/2006</u> Edward F. Maher, Task 5 Manager</p> <p><u>Signature on File</u> _____ <u>06/06/2006</u> Kate Kimpan, Project Director</p> <p><u>Signature on File</u> _____ <u>07/07/2006</u> James W. Neton, Associate Director for Science</p> |

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 causation¹] 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 3 rd 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 ¹⁴C 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 ft² 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 ^3H 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 | <p>Polonium operations moved from Dayton Units to Mound Laboratory. First program separated Ra-226 from barium rich uranium ore, pitchblende residue called K-65</p> <p>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</p> <p>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.</p> <p>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</p> |
| 1950 | <p>Separation of ^{208}Po and ^{209}Po from proton (accelerator) irradiation of bismuth.</p> <p>Separation of ^{227}Ac from irradiated ^{226}Ra.</p> <p>Uranyl sulfate – heavy water fuel system research.</p> <p>Civilian power reactor research involving uranium, ^{231}Pa, and ^{239}Pu; mission ended in 1963.</p> |
| 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 | <p>Invention of the ^{210}Po-fuelled thermoelectric generator.</p> <p>Initiation of several programs requiring tritium-handling technologies.</p> <p>Construction of thorium refinery for breeder reactor program (never operated).</p> |
| 1955 | <p>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.</p> <p>August 1955 small research program in R Bldg. Involving recovery and subsequent purification of Protactinium-231 from natural sources.</p> <p>June 1955- Radium Cave operation shut down in June (Ra-226, Ac-227, Th-228, Ra-223, Ra-224 daughters)</p> |
| 1956 | <p>Completed separation of 1.3 grams of ^{231}Pa in Building HH.</p> <p>Weighable quantities of ^{230}Th (ionium) separated.</p> <p>$^{239}\text{PuBe}$ neutron sources manufactured.</p> <p>Nuclear weapon detonator development, production, and surveillance; mission ended in 1989.</p> |
| 1959 | <p>^{239}Pu reactor fuels laboratory operational.</p> <p>Tritium waste recovery and purification facility operational.</p> <p>U-233 research involving about 10 research personnel</p> |
| 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 ²¹⁰Po 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 World 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 |

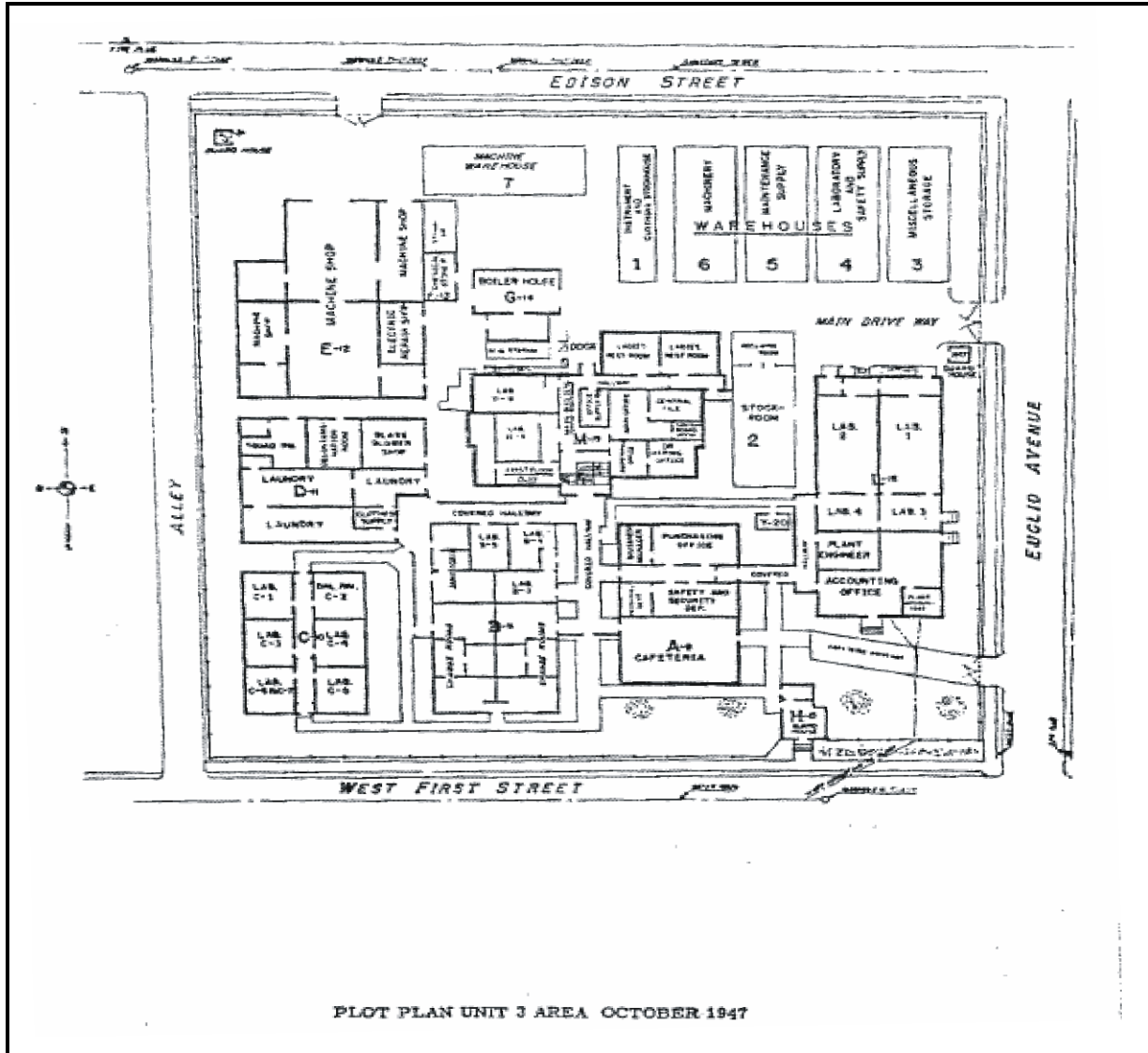


Figure 2-1. Unit III site map.

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 Pfaudler |
| 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 |
|------|--------------------------------------|

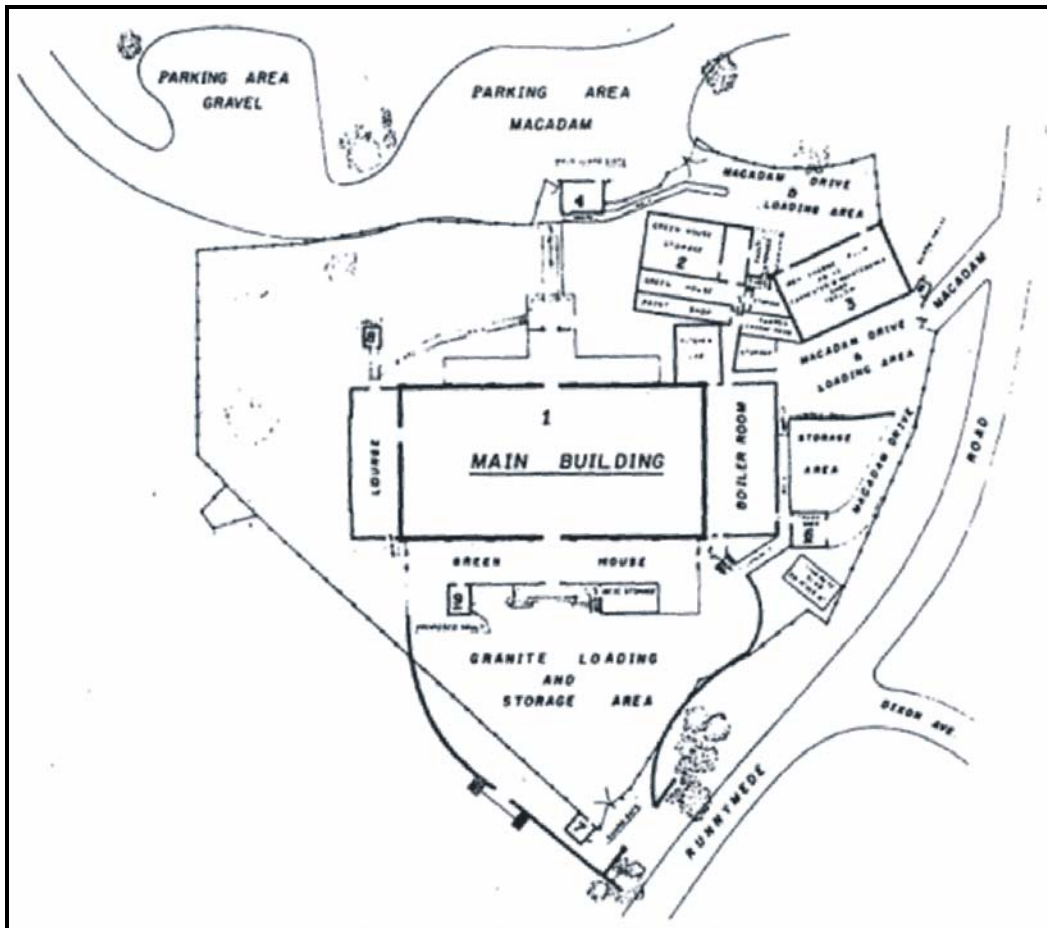


Figure 2-2. Unit IV site map.

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

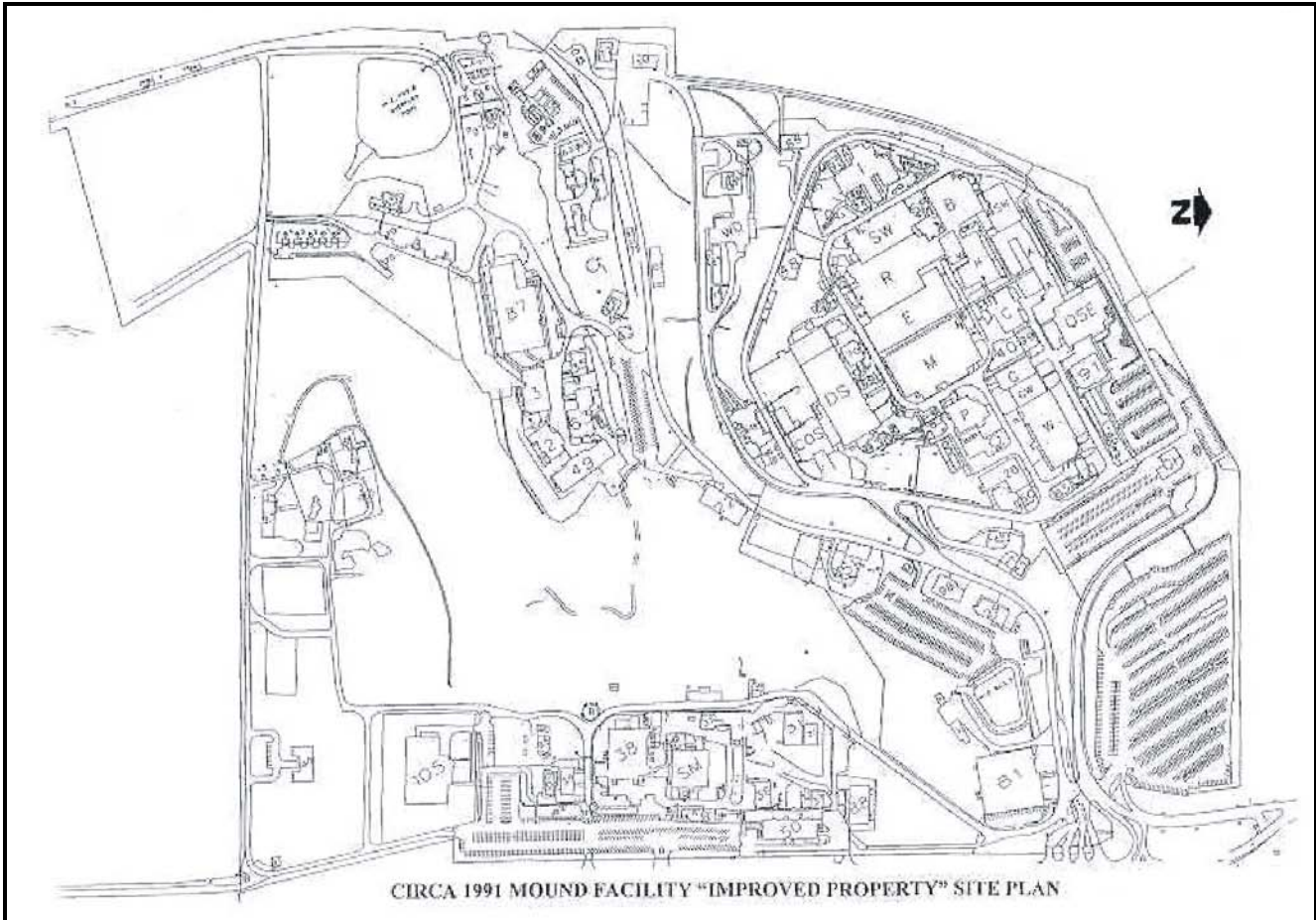


Figure 2-3. Mound (Unit V) site map.

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 |
| HH-6 | Stable isotopes, Kr-85 | 1964-present |
| | 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 ²³⁸Pu 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 ²³⁸Pu in PP Building was a composite of the mixture identified above. This mixture included trace amounts of ²⁴¹Am, ²³⁷Np, and ²³⁴U. Dates represent the duration of radioisotope use in the projects.

Thorium-232 was often substituted for ²³⁸Pu compounds for modeling purposes in research and development, because this isotope was less expensive and less hazardous, and had physical characteristics similar to ²³⁸Pu. It is possible, therefore, to find ²³²Th compounds identical to the ²³⁸Pu 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 ₂ O ₄) ₄ , Pu(OH) ₄ | 1967-1980 |
| PP-6W | PuO ₂ , Pu(NO ₃) ₄ , Pu(C ₂ O 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 ₂ O ₄) ₄ , Pu(OH) ₄ | 1967-1980 |
| PP-CORR-15, CORR-16, CORR-17 | PuO ₂ , Pu(NO ₃) ₄ , Pu(C ₂ O 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 ₂ O 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 ₂ O 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 ₂ O ₄) ₄ , Pu(OH) ₄ , Th-232, ThO ₂ , Th(NO ₃) ₄ , Th(C ₂ O ₄) ₄ , Th(OH) ₄ | 1967-pres |

| | | |
|-------------------------------|--|-----------|
| PP-143(A1) | PuO ₂ , Pu(NO ₃) ₄ , Pu(C ₂ O ₄) ₄ , Pu(OH) ₄ , Th-232, ThO ₂ , Th(NO ₃) ₄ , Th(C ₂ O ₄) ₄ , Th(OH) ₄ | 1967-1980 |
| PP-142(A2) | PuO ₂ , Pu(NO ₃) ₄ , Pu(C ₂ O ₄) ₄ , Pu(OH) ₄ , PuF ₄ , PuC, Th-232, ThO ₂ , Th(NO ₃) ₄ , Th(C ₂ O 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 ₂ O ₄) ₄ , Pu(OH) ₄ , PuF ₄ , PuC | 1967-1980 |
| PP-147(B2), PP-148(B3) | PuO ₂ , Pu(NO ₃) ₄ , Pu(C ₂ O ₄) ₄ , Pu(OH) ₄ , PuF ₄ , PuC, Th-232, ThO ₂ , Th(NO ₃) ₄ , Th(C ₂ O 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 ₂ O 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 ²⁴¹Am, ²³⁷Np, and ²³⁴U. Thorium-232 was sometimes used as a stand-in for plutonium.

Beginning in the fall of 1948, R&D for the ²¹⁰Po 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 in 1959 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, H-3, Li(D,T), U-238(D,T) | 1958-1965 1965-1978 |
| R-108 | Po-208, -210, H-3, H-3, Li(D,T), U-238(D,T), Ti(D,T), Other tritides (Type F, S) | 1948-1965 1975-PRES |
| R-110 | Po-208, -210 H-3 | 1955-1972 1972-present |
| R-111 | Ac-227, AcO ₂ , Ac(NO ₃) ₄ , Ac(C ₂ O 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 ₂ O ₄) ₄ , Ra-223, -224, -226, Th-228, -229, -239, Ac and Ra daughters Po-210, Pu-238, -239, Po/Be, PoF ₂ , Po/B, Pu/Be, PuF ₂ , Pu/B H-3 | 1951-1955 1956-1961 1978-present |
| R-116 | Po-210, Pu-238, -239, Po/Be, PoF ₂ , Po/B, Pu/Be, PuF ₂ , Pu/B Pu-238, -239, PuBe, Am-241 H-3, Li(D,T), U-238(D,T) | 1956-1961 1956-1962 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 ₂ O ₄) ₄ , Ra-223, -224, -226, Th-228, -229, -230, (Ac and Ra daughters) U-234, -235, -238, Pa-231, Th-230, -232, and Th-232 daughters | 1955 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 Ac-227, AcO ₂ , Ac(NO ₃) ₄ , Ac(C ₂ O ₄) ₄ , Ra-226, Th-228, -229, -230, AcF ₄ , AcI ₄ , Ac-227 daughters, Pa-231, Th-230, -232, and Th-232 daughters, U-234, -235, -238 Pu-239, Am-241 Pu-238, Oxide, Neutrons Pu-238, Pu(NO ₃) ₄ , Pu(NO ₃) ₆ , PuO ₂ , Pu-Cu, Pu(C ₂ O ₄) ₄ , Pu(O ₂).5H ₂ O, Pu(OH), PuF ₄ , PuCl ₄ , Pu-Se, Pu-Zr, H-3, Pu rare earths, Po alloys and compounds | 1948-1951 1951-1953 1956-1958 1956-1962 1959-1962 1959-1979 |
| R-127 | Po-210, Bi-210, AlCl ₃ , BiCl ₃ , Po(NO ₃) ₂ , PoCl ₂ , Po/Ag, Po/Te Fe-55, -59 H-3 PuO ₂ , PuF ₄ , Pu-MoCl ₄ , Pu-MoF ₄ H-3, Pu-239 | 1948-1951 1952-1954 1956-1961 1965-1978 1987-present |
| R-128 | Po-210, Bi-210, Po(NO ₃) ₄ , PoCl ₂ , Po/Ag, Po/Te PuO ₂ , PuF ₄ , Pu-MoCl ₄ , Pu-MoF ₄ . H-3, U(D,T) | 1948-1954 1965-1978 1987-present |
| R-129,130 | Po-210, Bi-210, P(NO ₃) ₂ , PoCl ₂ , Po/Ag, Po/Te Ac-227, AcO ₂ , Ac(NO ₃) ₄ , Ac(C ₂ O ₄) ₄ , Ra-223, -224, -226, Th-228, -229, -230 Pu-238, PuO ₂ , PuF ₄ , Pu-MoCl ₄ , Pu-MoF ₄ , PuCl ₄ (Th-232 compounds replacing Pu-238 compounds for analytical studies) H-3, Pu rare earths, Polonium alloys and compounds | 1948-1951 1951-1953 1965-1978 1990-present |
| R-131 | Po-210, Bi-210, Po(NO ₃) ₂ , PoCl ₂ , Po/Ag, Po/Te Pu-238, PuO ₂ , PuF ₄ , Pu-MoCl ₄ , Pu-MoF ₄ , PuCl ₄ , Cm-244 | 1948-1951 1965-1978 |
| R-133 | Po-210, Bi-210, Po(NO ₃) ₂ , PoCl ₂ , Po/Ag, Po/Te Ac-227, AcO ₂ , Ac(NO ₃) ₄ , Ac(C ₂ O ₄) ₄ , Ra-226, Th-228, -229, -230, AcF ₄ , AcI ₄ , Ac-227 daughters Pa-231, U-234, -235, -238, Th-230, -232; also Th-230, -232 daughters Pu-238, PuO ₂ , PuF ₄ , Pu-MoCl ₄ , Pu-MoF ₄ , PuCl ₄ , Cm-244. | 1948-1954 1951-1953 1956-1958 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 ₂ O 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 Pu-238, -239, -240, -241 (alloys, compounds and mixtures), Pu(NO ₃) ₂ , Ac-227, Am-241 | 1950-1969 1969-present |
| R-142 | Ra-226, Ra(CO ₃), Ra(NO ₃) ₂ , RaBr ₂ , Ac-227, Ac(C ₂ O ₄) ₄ , AcF ₂ , K-40, Ba(NO ₃) ₂ , Th-228, -229, -230, radon and daughters, Po-208, -209, -210 Pu-238,239, U-234,235,238, Th-230, Pa-231, Th-230 daughters PuO ₂ , (for Pu-238,239) | 1949-1953 1956-1969 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 PuO ₂ , (for Pu-238, -239) | 1948-1951 1972-1976 |
| R-145,147 | Ra-226, Ra(CO ₃), Ba(CO ₃), Ac(NO ₃) ₂ , Ra/Ba, Ac-227, Ac(C ₂ O ₄) ₄ , AcO ₂ , Th-228, -229, -230 Fe-59, Al-26, Ca-45, Co-60, Pa-231, Cu-65 Pu-239, Am-241 Pu-238 oxide, neutrons Pu-238, -239, PuO ₂ , U-234, -235, -238 | 1949-1954 1955-1956 1956-1959 1960-1962 1968-1975 |
| R-148,149 | Ra-226, Ra(CO ₃), Ba(CO ₃), Ac(NO ₃) ₂ , Ra/Ba, Ac-227, Ac(C ₂ O ₄) ₄ , AcO ₂ , Th-228, -229, -230, Po-208, Pa-231 Fe-59, Al-26, Ca-45, Co-60, Pa-231, Cu-65, Pu-238 Pu-238, Pu(C ₂ O ₄) ₄ , Pu(NO ₃) ₄ , Th-230, PuO ₂ , Pm-146->149, U(234)(NO ₃) ₄ , U(234)O ₂ , Pu/Zr | 1949-1954 1954-1958 1960-1968 1970-1980 |
| R-151 | Po-210, Bi-210, Po(NO ₃) ₂ , PoCl ₂ , Po/Ag, Po/Te Pu-238, -239, Pu(NO ₃) ₄ , Pu(NO ₃) ₆ , PuO ₂ , Pu(OH), Pu(C ₂ O ₄) ₄ , Pu(O ₂).5H ₂ O, PuCl ₄ , PuF ₄ , Pu(SO ₄) ₂ , Np-237, and EDTA, citrates, and other substances acting like chelating agents were present | 1948-1951 1958-1983 |
| R-152 | Po-210, Bi-210, AlCl ₃ , BiCl ₃ , Po(NO ₃) ₂ , PoCl ₂ , Po/Ag, Po/Te Ac-227, AcO ₂ , Ac(NO ₃) ₄ , Ac(C ₂ O ₄) ₄ , Ra-226, Th-228,229,230, AcF ₄ , AcI ₄ | 1948-1954 1951-1953 |
| R-155 | Po-210, Bi-210, AlCl ₃ , BiCl ₃ , Po(NO ₃) ₂ , PoCl ₂ , Po/Ag, Po/Te 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) | 1948-1951 1956-1969 |
| R-159 | Po-210, Bi-210, AlCl ₃ , BiCl ₃ , Po(NO ₃) ₂ , PoCl ₂ , Po/Ag, Po/Te 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) | 1948-1951 1956-1969 |
| R-160,161 | Po-210, Bi-210, AlCl ₃ , BiCl ₃ , Po(NO ₃) ₂ , PoCl ₂ , Po/Ag, Po/Te Ac-227, AcO ₂ , Ac(NO ₃) ₄ , Ac(C ₂ O ₄) ₄ , Ra-226, Th-228, -229, -230 | 1948-1951 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 Pu-238, -239 U-233, -235, -238 | 1948-1951 1950 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 Pu-238, U-234, -235, -238, I-131, Cs-137, Ce-144, Sr-90, Tc-99, Xe-133, Y-88, -90, -91 Fe-55, -59, Al-26, Ca-45, Co-60, Pa-231, Cu-65. Pu-239, Ac-227, neutrons U-233, Th-229, -230, -232 Sr-90, Y-88, -90, -91, Pa-231. Pa-231, -233, Ce-141, -144, Am-241, Cm-244, U-233, Th-230, -232, Ra-226, Ti-208 | 1948-1951 1949-1952 1954-1955 1955-1957 1958 1960-1962 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 U-235, -238, Pm-147, Ca-45 | 1960-1980 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 ₂ O ₄) ₄ , AcO ₂ , Th-228, -229, -230, Ac and Ra daughters U-235, -238 Pu-238, -239, -240, -241 (compounds, alloys and mixtures), Am-241, Ac-227, Ra-226 | 1949-1954 1961-1963 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 ₂ O ₄) ₄ , Pu(OH) ₄ , PuF ₄ | 1961-1962 |

| | | |
|--------------------|---|-----------|
| | Pu(NO ₃) ₄ .5H ₂ O, Pu(NO ₃) ₆ , PuO ₂ .XH ₂ O, PuO ₂ , Pu(C ₂ O ₄) ₄ , PuO ₂ .5H ₂ O, Pu(OH), Th(NO ₃) ₄ , ThO ₂ , Th(OH) ₄ , ThO ₂ .XH ₂ O | 1962-1967 |
| SM-2 | PuO ₂ | 1961-1967 |
| SM-3,10 | Pu(NO ₃) ₄ , PuO ₂ , Pu(C ₂ O 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 ₂ O ₄) ₄ , Pu(OH) ₄ , PuF ₄ | 1961-1967 |
| SM-27,28 | Pu(NO ₃) ₄ .5H ₂ O, Pu(NO ₃) ₆ , PuO ₂ , Pu(C ₂ O ₄) ₄ , PuO ₂ .5H ₂ O, Pu(OH), PuF ₄ , PuCl ₄ | 1961-1965 |
| | Pu(NO ₃) ₄ , Pu(NO ₃) ₄ .5H ₂ O, PuO ₂ , PuO ₂ .X H ₂ O, Pu(C ₂ O ₄) ₄ , Pu(OH) | 1965-1967 |
| SM-34 | Pu(NO ₃) ₄ .5H ₂ O, 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 ₂ O, Pu(NO ₃) ₆ , PuO ₂ , Pu(C ₂ O ₄) ₄ , Pu(O ₂).5H ₂ O, Pu(OH) ₄ , PuF ₄ , PuCl ₄ | 1961-1965 |
| | Pu(NO ₃) ₄ , Pu(NO ₃) ₄ .5H ₂ O, PuO ₂ , PuO ₂ .X H ₂ O, Pu(C ₂ O 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 ₂ O, Pu(NO ₃) ₆ , PuO ₂ , Pu(C ₂ O ₄) ₄ , PuO ₂ | 1965-1970 |
| SM-39 | Pu(NO ₃) ₄ .5H ₂ O, Pu(NO ₃) ₆ , PuO ₂ , Pu(C ₂ O ₄) ₄ , PuO ₂ .5 H ₂ O, Pu(OH) ₄ , PuF ₄ , PuCl ₄ | 1961-1965 |
| | Pu(NO ₃) ₄ , Pu(NO ₃) ₄ .5H ₂ O, PuO ₂ , PuO ₂ .X H ₂ O, Pu(C ₂ O 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, ²³⁴U 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 Aripport 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-ft² area located in the Semi-Works (SW) Building. Radium-226 and ²²⁷Ac 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 |
| SW-9 | U(238)(D,T), Li(D,T), Ba(D,T), Ti(D,T) | 1960-1985 |
| | 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 ₂ O 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), AcO ₂ . | 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 ₂ O 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 |
| SW-231 | H-3, U-238(D,T), tritides (Type F) | 1985-present |
| | 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, ²¹⁰Po 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 ₂ O 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 ₂ O, Pu(NO ₃) ₆ , PuO ₂ , Pu(C ₂ O ₄) ₄ , Pu(O ₂).5H ₂ O, 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 ₂ O, Pu(NO ₃) ₆ , PuO ₂ , Pu(C ₂ O ₄) ₄ , Pu(O ₂).5H ₂ O, 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 | Ruthenium-106 |
| Cesium-137 | Strontium-90 |
| Niobium-94 | Tellurium-121 and -127 |
| Plutonium-238 and -239 | Yttrium-88, -90, and -91 |
| Rare earths (especially cerium) | 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 | Ruthenium-106 |
| Cesium-137 | Strontium-90 |
| Niobium-94 | Tellurium-121 and -127 |
| Plutonium-238 and -239 | Yttrium-88, -90, and -91 |
| Rare earths (especially cerium) | Zirconium-93, -95 |

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

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

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

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— $\text{PuO}_2 \cdot \text{XH}_2\text{O}$
- Plutonium hydroxide, $\text{Pu}(\text{OH})_4$, Type S
- Plutonium nitrate, $\text{Pu}(\text{NO}_3)_4$, Type M; this could also take the form of plutonium nitrate pentahydrate, $\text{Pu}(\text{NO}_3)_4 \cdot 5\text{H}_2\text{O}$

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

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

Building 19

The building is a 4,800-ft² 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-ft² 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-ft² 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-ft² 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-ft² 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-ft² 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-ft² 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-ft² 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-ft² 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-ft² 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-ft² 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 ft². 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 ft². 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 Pipeline

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 pipeline 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.

REFERENCES

Cited References.

King, W., 1995, *Mound Site Radionuclides by Location*, MD-22153, EG&G Mound Applied Technologies, Miamisburg, Ohio.

NIOSH (National Institute for Occupational Safety and Health), 2002a, *External Dose Reconstruction Implementation Guideline*, OCAS-IG-001, Office of Compensation Analysis and Support, Cincinnati, Ohio.

NIOSH (National Institute for Occupational Safety and Health), 2002b, *Internal Dose Reconstruction Implementation Guideline*, OCAS-IG-002, Office of Compensation Analysis and Support, Cincinnati, Ohio.

Other References

C2MH Hill Mound, Inc., 2003, *Building 124 (Cwpf) Structural History and Process History Summary Background Document*, Environmental Compliance And Laboratories, CH2M Hill Mound, Inc., Miamisburg, Ohio.

EG&G Mound Applied Technologies, 1996, *Environmental Appraisal Report of Mound Plant*, Miamisburg, Ohio.

Gilbert, K. V., 1969, *History of the Dayton Project*, Monsanto Research Corporation, Mound Laboratory, Miamisburg Ohio.

Gill, J., 2003, *Mound Site Radionuclides and Processes*, CH2M Hill Mound Inc., Mound Laboratory, Miamisburg, Ohio.

Nancy Hurst and Associates, 1996, *Environmental Appraisal Report of the Mound Plant Volume 12*, MLM-ML-96-43-001, EG&G Mound Applied Technologies, Miamisburg, Ohio.

References to processes for the Rubb Building at Building 104 (a.k.a. rubb building 123).

Svirbely, Dr. J. L., 1948, *Monthly Health Report January 1 –31, 1948*, Monsanto Chemical Company Units III, IV, and V, Dayton, Ohio

The Brickmaker References to Processes and Waste Generation, February 2002.

Essig G., Scott D., *Annual review 1966*, MLM-ML-66-52-0001, Monsanto Research Corporation, Mound laboratory, Miamisburg, OH, 45342, United States Atomic Energy Commission

Essig G., Scott D., *Annual review 1967*, MLM-ML-67-52-0001, Monsanto Research Corporation, Mound laboratory, Miamisburg, OH, 45342, United States Atomic Energy Commission

Flitcraft R., *1971 Annual Summary report*, MLM-ML-716-52-0004, Monsanto Research Corporation, Mound laboratory, Miamisburg, OH, 45342, United States Atomic Energy Commission

Nason H., neubart R., *Annual Technical Summary report 1969*, MLM-ML-70-42-0001, Monsanto Research Corporation, February 1970, Mound laboratory, Miamisburg, OH, 45342, United States Atomic Energy Commission

Summary report 1973, MLM-ML-74-42-0001, February 1974 Monsanto Research Corporation, Mound laboratory, Miamisburg, OH, 45342

Mound Site Environmental Report for Calendar year 1995, EG&G Mound Applied Technologies, Mound laboratory, Miamisburg, OH, 45342, United States Department of Energy

Essig G., Scott D., Annual review 1964, MLM-ML-64-52-0001, Monsanto Research Corporation, Mound laboratory, Miamisburg, OH, 45342, United States Atomic Energy Commission

BWXT (BWXT Technologies Inc.), 2000, Radon Study Summary Report, Letter transmittal from Kevin Doody to Ronald Daily, Radiological Instrumentation Lab Team leader, BWXT of Ohio, June 15, 2000