EG&G MOUND-04-01----9604150056

MOUND

TECHNICAL MANUAL

MD–22153, ISSUE 1
MOUND SITE RADIONUCLIDES BY LOCATION

Section	Issue
Intro	1
1	1
2	1
3	1
Appen A	1
Appen B	1

Page	Issue
1	1
2	1
3	1

D.V. Eckman, DOE/MB

Ken Armstrong, BD–48
Dave Billing, SW–202
Clyde Gallaher, T–320
George Gartrell, OSW–213
TR– Wayne King, BD–91
Paul Lamberger, T–245
Al Ogurek, BD–91
E– M. J. Pacinda
Rob Robinson, A–22
Terry L. Vaughn. BD–91
Ray Weaver, BD–91
Drawing Control, OSW–3
Technical Manuals

CHANGES INCORPORATED

- ☐ Replace
- ☐ Insert (New Pages)
- ☐ Remove
- ☐ Complete Reprint

All appropriate reviews by senior safety committees were conducted. This issue is authorized for use by Advanced Change Order on file in Technical Manuals.

Terry L. Vaughn, Radiological Control Manager 6–22–95

IMPORTANT

VERIFY that the procedure you are using is the latest issue.

- **Check the Manuals Tracking System on PVC.**
- **Non-PVC users, call x3804 for issue information.**

PUBLICATION RECORD

ISSUE	DATE	APPLICATION	CHANGE DATE	CHANGE ACO
1	7-26-95	Radiological Control	6–22–95	950249MD–C

TABLE OF CONTENTS

Introduction

Section 1: Primary Research and Production Buildings

Section 2: Supporting Buildings

Section 3: Information on Appendix B

Section 4: Information from GIS Report--To Be Published Later

Appendix A: Major Daughter Nuclides

Appendix B: Suppliment to Section 1; located in Document Control

MOUND SITE RADIONUCLIDES BY LOCATION

INTRODUCTION

1. Purpose

There are three major objectives of this document. The first is to identify the radionuclides used in each of the rooms for each of the buildings at Mound. This will include a listing of all compound forms of each radionuclide for specific time frames because of specific programs, which are also identified.

The second objective is to determine information about a given radionuclide which would facilitate internal dose assessment. This includes the compound forms with which the radionuclides are associated, information to indicate the probable lung solubility class, the relative abundance of radioisotopes in each room for a given time frame, and the particle size.

The third objective is to compile all information about ground surveys and core sample results to indicate possible intakes at specific locations as a result of D&D and other work performed.

When doing either a historic or current internal dose assessment for an individual, the records do not always indicate the details of an incident or a chronic condition. By knowing the approximate date and location of an exposure, this document can be used to determine which radioisotopes existed in that area. Since chemical compound, temperature in processing, and particle size all can affect the lung solubility class, this information is of great help in determining the parameters used in the biokinetic model which predicts the internal dose from lung deposition. This information is also valuable for uptakes resulting from ingestion or wounds.

2. Scope

This document is a historic and current compilation, listing radionuclides at Mound by buildings, rooms, and dates. It also includes ground survey and core sample results of site.

Notes:

- Ground surveys and core sample results will not be available until the Geographical Information System (GIS) report is available October 1. The GIS report will compile that information from several sources and will have accompanying site drawings showing the site location for the data. The relevant information will be included in this document.

- A critique of this document is welcomed. Please consider the technical accuracy, format, and any other information which should be included. Address all comments to Wayne King, Building 91, X-3207.

3. Organization of Material

The information in this document is organized into four sections:

Section 1 identifies the primary buildings where research, development, and production, involving radioisotopes, were performed. Appendix A lists the daughter products of their radionuclides. The buildings include HH Building, PP Building (also called Building 38), R Building, SM Building, SW Building, T Building, and WD/WDA Buildings.

Section 2 represents supporting buildings which were, or are not directly involved in research or production. Although these buildings were, or are occupied by radionuclides in one form or another, they do NOT represent a significant location for uptakes nor incidents. These support buildings include: Warehouse #9, #13, #15, and Buildings 15, 21, 34, 50, 59, 68, B, E, H, I, M, P, RR, and SD. All information in this category is unclassified.

Section 3 is a supplement to Section 1 which presents additional information for the same rooms and buildings in a Secret Restricted Appendix (SRD), Appendix B. Appendix B gives additional information about processes and additional radionuclides which could not be presented in the unclassified Section 1. A "See Appendix B" statement is given in the unclassified document for each place this "SECRET" information is available.

Please Note: Much important information is contained in this secret appendix. It is strongly recommended that a reading of the material in Appendix B be made when looking at a section of this document where the statement "see Appendix B" is made. The material given for many rooms in R, SW, and T Buildings is vague and cannot be fully understood without using this appendix.

Section 4 gives a compilation of ground survey and core sample results taken from the GIS report. This information includes maps of where survey and survey core sample results were taken and tables of those results. This information came from four data bases which, when integrated, give a comprehensive listing. The four data bases are: The "Site Survey Data Base," "Decontamination and Decommissioning Data Base," "Environmental Monitoring Data Base," and "Construction Engineering Data Base."

4. Limitations of Biokinetic Models

The parameters for the biokinetic models are not straightforward and are subject to much experimentation for the following reasons:

- Traditionally ICRP #30 teaches that plutonium compounds should be lung solubility class W except for the oxides (dioxide, oxide hydrate, hydroxide) which should be lung solubility class Y.

- In processes where plutonium oxides (traditionally class Y) have not been subjected to any heat it may be possible to classify them as lung solubility class W, or some intermittent value such as 200 days for class Y, since they appear to be more soluble.

- In processes where plutonium nitrates and oxalate are involved in an aqueous form, the plutonium could possess a lung solubility class of a W or even D.

- After the precipitation of plutonium, the self-generating heat produced oxide solids (dioxide, oxide hydrate, hydroxide). These should be classified as a class Y, but since no process sintering was done it is more likely to possess some lesser solubility factor such as 200 days as mentioned above.

- The particle diameters of the plutonium compounds varied greatly from submicron (< 1.0 μm) conditions, which were abundant, to particulate exceeding 20 μm. Some processes involved vaporization of plutonium-containing materials or other radioisotopes which created extremely fine particulate. As a result of the abundance of fine particulate, the biological half-life time may be greatly reduced from what is recommended by the ICRP manuals.

- Some processes used complexing agents such as EDTA and citrates which cause rapid depletion of plutonium and the other radionuclides from the body if an uptake occurred. These complexes act like chelating agents which cause the excretion of abnormally large amounts of radionuclides into the urine in a relatively short time.[1]

- Polonium-210 dosimetric analysis will vary somewhat from the ICRP #30 and #54 model. A model was developed in 1989 by Dr. Ken Scrable of the University of Lowell and Dr. Cohen of New York University through the direction of Gene Runkle of DOE Albuquerque Health Protection Division. The polonium section of this Technical Basis Manual presents the details of the dosimetry model parameter recommendations.

- Other radioisotopes from the polonium work, as identified under the polonium section in T Building, will be analyzed in accordance with ICRP #30 and #54 recommendations. These analyses will include dose from internal beta and gamma photon energies.

---

[1] Don Rogers, 9/93, Senior Fellow

- Tritium gas, HTO, and metal tritides will be analyzed according to parameters and models established in the Technical Basis Manual.

5. Other Considerations

5.1 Incidents

"Incidents," with the dates and radionuclides, have been listed for the various rooms of all buildings to support claims of their presence. All incidents were listed where room number and radioisotope was given. In cases where more than one person was involved only one of the persons was identified. (The incident number and all significant data are given in the "endnote" such that further inquiries would be possible.)

Listings were not given for incidents involving Pu-238 in SM and PP Buildings since it is well documented that most all work involved Pu-238. Only incidents involving other radionuclides will be listed for those two buildings.

5.2 Rooms

The rooms are listed in numerical order for each building where radionuclides exist (or have existed). Much duplicate information exists so that each room "stands alone" in a user-friendly format. Only the "OVERVIEW" to the building being referenced should be considered along with the room number since some guidance is presented there. Other rooms associated with that room need not be considered for this reason.

5.3 Dates

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for decontamination work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides, and daughters, which MAY BE present as fixed radiation.

5.4 Radionuclide Ranking

All radionuclides are ranked according to the degree of concern for uptake and amount of activity for internal dosimetry considerations. Rooms which are referenced to Appendix B for additional radionuclides do not have a ranking in this manual since the ranking is performed in Appendix B, where all radionuclides are listed. This situation is identified as "see Appendix B for ranking." Rooms where additional information on processing or radionuclides in Appendix B does not effect the ranking are identified as "see appendix" only.

CAUTION

The room numbers listed in this document do not always agree with current building drawings. The numbers listed within this document sometimes refer to older floor plans.

TABLE OF CONTENTS FOR SECTION 1
PRIMARY RESEARCH AND PRODUCTION BUILDINGS

1. HH BUILDING 1
   1.1 OVERVIEW 1
   1.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS 3
      1.2.1. Room HH-3, 4 3
      1.2.2 Room HH-5 3
      1.2.3 Room HH-6 5
      1.2.4 Room HH-8 6
      1.2.5 Room HH-9 7
      1.2.6 Rooms HH-10, 11, and 12 7
      1.2.7 Room HH-119, 120, 121, 122 8

2. PP BUILDING 9
   2.1 OVERVIEW 9
   2.2 RADIONUCLIDES, ROOM, AND DATES ASSOCIATED WITH SPECIFIC HEAT SOURCE PROGRAMS 13
      2.2.1 PP-Corr-5A 13
      2.2.2 Room PP-6 13
      2.2.3 Room PP-6W 13
      2.2.4 PP-CORR-10 13
      2.2.5 Room PP-13 14
      2.2.6 Room PP-14 14
      2.2.7 PP-CORR-15, CORR-16, CORR-17 14
      2.2.8 Room PP-18 14
      2.2.9 Room PP-24 15
      2.2.10 Room PP-100 15
      2.2.11 Room PP-113 15
      2.2.12 PP-CORR-115 16
      2.2.13 Room PP-127 16
      2.2.14 PP-CORR-134, CORR-135, CORR-136 16
      2.2.15 PP-CORR-140, CORR-141, CORR-142 17
      2.2.16 Room PP-143 (A1) 17
      2.2.17 Rooms PP-144 (A2), 147 (B2), & 148 (B3) 17
      2.2.18 Room PP-145 (A3) 20
      2.2.19 Room PP-149 (B4) 20
      2.2.20 Rooms PP-146 (B1), 150 (C1), 151 (C2), 152 (C3), 153 (C4), 154 (D1), 156 (D3) 20
      2.2.21 Room PP-157 22
      2.2.22 Room PP-158 22
      2.2.23 Room PP-159 22
      2.2.24 Room PP-161 (Same as F-1) 22
      2.2.25 Rooms PP-162 and 163 (Same as F-2 & F-3) 23

3. R BUILDING 24
   3.1 OVERVIEW 24
   3.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS 33
      3.2.1 Room R-105, 106 33

TABLE OF CONTENTS FOR SECTION 1
PRIMARY RESEARCH AND PRODUCTION BUILDINGS

3.2.2 Room R-108 33
3.2.3 Room R-110 34
3.2.4 Room R-111 35
3.2.5 Room R-112 36
3.2.6 Rooms R-113, 114, and 115 36
3.2.7 Room R-116 (A&B) 37
3.2.8 Room R-117 38
3.2.9 Room R-118 39
3.2.10 Rooms R-120 and support rooms R-118, 119, 121, 123 40
3.2.11 Room R-127 43
3.2.12 Room R-128 45
3.2.13 Room R-129 and R-130 46
3.2.14 Room R-131 47
3.2.15 Room R-133 48
3.2.16 Room R-134 50
3.2.17 Room R-137 50
3.2.18 Room R-140 51
3.2.19 Room R-142 52
3.2.20 Rooms R-143 and 144 53
3.2.21 Rooms R-145 and 147 54
3.2.22 Room R-149 also support room R-148 56
3.2.23 Room R-151 58
3.2.24 Room R-152 59
3.2.25 Room R-155 60
3.2.26 Room R-159 62
3.2.27 Room R-160 63
3.2.28 Room R-161 64
3.2.29 Room R-162 65
3.2.30 Room R-166 66
3.2.31 Room R-167 67
3.2.32 Room R-168 69
3.2.33 Room R-169 (A,B,C) 69
3.2.34 Room R-170 70
3.2.35 Rooms R-171, 172 70
3.2.36 Room R-174, 176 71
3.2.37 Room R-197A 72
3.2.38 Room R-198 72
3.2.39 The crawl space above R Building 72
3.2.40 R-Corr 5 73

4. SM BUILDING 74
4.1 OVERVIEW 74
4.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS 78
4.2.1 Room SM-1 78
4.2.2 Room SM-2 79
4.2.3 Room SM-3, 10 79
4.2.4 Room 20 79

TABLE OF CONTENTS FOR SECTION 1
PRIMARY RESEARCH AND PRODUCTION BUILDINGS

4.2.5 Room SM-21 79
4.2.6 Room SM-26 80
4.2.7 Room SM-27,28 80
4.2.8 Room SM-34 82
4.2.9 Rooms SM-35, 35A 83
4.2.10 Room SM-38 84
4.2.11 Room SM-39 86
4.2.12 Rooms SM-58, 59A, and 59B 87
4.2.13 Room SM-60 88
4.2.14 Rooms SM-61, 62 88
4.2.15 Environmental concerns 89
4.2.16 See Appendix B for SM Building Room SM-10 89

5. SW BUILDING 90
5.1 OVERVIEW 90
5.1.1 Original SW Complex (1950) 91
5.1.2 Hot Gas Facility (1957) 92
5.1.3 Ceramics Facility (1958) 92
5.1.4 Disassembly and Surveillance (1960) 92
5.1.5 SW-1C: Second Floor Addition and Mechanical Room on first floor (1960) 92
5.1.6 Change House (1961) 92
5.1.7 North Alterations / Second Floor Addition and a Two Story Support Building (1961) 92
5.1.8 Nuclear Component Development and Pre-Production Facility (NCDPF) (1965) 93
5.1.9 Addition To Existing SW-9 (1967) 93
5.1.10 Surveillance and Environmental Test Facility (1969) 93
5.1.11 Cooling Tower and Chiller (1972) 93
5.1.12 Impact Test Facility (1975) 93
5.1.13 Thorium Facility (1976) 93
5.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC PROGRAMS IN SW BUILDING 97
5.2.1 Room SW-2 97
5.2.2 Room SW-8 97
5.2.3 Room SW-9 99
5.2.4 Room SW-10 99
5.2.5 Room SW-13 and supporting rooms SW-11, 12, 14, 15, 16 (Area SW-1B) . 99
5.2.6 Room SW-19 (Old Cave) 102
5.2.7 Room SW-20, 21 103
5.2.8 Room SW-22: "New Cave" and Laboratory Area 103
5.2.9 Room SW-128, 129, 130, 134 105
5.2.10 Room SW-132 105
5.2.11 Rooms SW-136 and SW-137 106
5.2.12 Room SW-140 107
5.2.13 Room SW-142 108
5.2.14 Rooms SW-146, 147 109
5.2.15 Room SW-149 and 149A 110

TABLE OF CONTENTS FOR SECTION 1
PRIMARY RESEARCH AND PRODUCTION BUILDINGS

5.2.16 Rooms SW-150 and 152 111
5.2.17 Room SW-200 111
5.2.18 Room SW-202 111
5.2.19 Room SW-205 112
5.2.20 Room SW-208 112
5.2.21 Room SW-210 113
5.2.22 Room SW-219 113
5.2.23 Room SW-231 114
5.2.24 Rooms SW-238, 240 115

6. T-BUILDING 116
6.1 OVERVIEW 116
6.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS 125
6.2.1 Room T-1W 125
6.2.2 Room T-2W 125
6.2.3 Room T-4E 125
6.2.4 Room T-5W 125
6.2.5 Room T-5E 125
6.2.6 Room T-8 126
6.2.7 Room T-9 or 9A 126
6.2.8 Room T-13 126
6.2.9 Room T-15B 126
6.2.10 Room T-16A 127
6.2.11 Room T-18 127
6.2.12 Room T-19, T-19A 127
6.2.13 Room T-20 128
6.2.14 Room T-22 128
6.2.15 Rooms T-25 and T-26 129
6.2.16 Room T-27 129
6.2.17 Rooms T-28, 29, 30, 31, 32, 33, 34, 35 130
6.2.18 Room T-36, T-36A 131
6.2.19 Room T-37 131
6.2.20 Room T-40 132
6.2.21 Room T-41 132
6.2.22 Room T-46 132
6.2.23 Room T-48, T-49, T-50 132
6.2.24 Room T-53 133
6.2.25 Room T-54A, 55A, 55 133
6.2.26 Room T-57 135
6.2.27 Room T-58 136
6.2.28 Room T-59 136
6.2.29 Room T-61, T-61A 137
6.2.30 Room T-63 138
6.2.31 Rooms T-72, 73, 74, 75 and T-92, 93, 96, 97, 98 138
6.2.32 Room T-99 139
6.2.33 Rooms T-100, 102, 103, 104 139
6.2.34 Room T-208A 140

TABLE OF CONTENTS FOR SECTION 1
PRIMARY RESEARCH AND PRODUCTION BUILDINGS

6.2.35 Room T-229 141
6.2.36 Room T-234 142
6.2.37 Room T-236 (dock) 142
6.2.38 Room T-237 143
6.2.39 Room T-238 144
6.2.40 Room T-242 144
6.2.41 Room T-243 145
6.2.42 Room T-245 145
6.2.43 Room T-246 145
6.2.44 Room T-247 146
6.2.45 Room T-248 --> T-259 146
6.2.46 Room T-260 147
6.2.47 Room T-266, 267, 268 148
6.2.48 Room T-270 149
6.2.49 Room T-274 149
6.2.50 Rooms T-275 and T-276 151
6.2.51 Room T-277 and T-279 151
6.2.52 Room T-300A 152
6.2.53 Room T-307 152
6.2.54 Room T-310 153
6.2.55 Rooms T-311 155
6.2.56 Room T-319 155

7. WD AND WDA BUILDINGS 157
7.1 WD OVERVIEW 157
7.2 WDA OVERVIEW 158
7.3 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS 161
7.3.1 Room WD-1 161
7.3.2 Room WD-8 164
7.3.3 Room WDA-9 166
7.3.4 Room WDA-10 167
7.3.5 Room WD-101 168
7.3.6 Room WD-104 171
7.3.7 Room 107 and basement 173
7.3.8 Room WD-108 173
7.3.9 Room WD-110 174
7.3.10 Room WDA-110 175
7.3.11 Room WDA-112 175
7.3.12 Room WDA-113 176
7.3.13 Room WDA 118 A&B 176
7.3.14 Room WD-Penthouse 177
7.3.15 Tanks/WDA 177
7.3.16 Cleaning of tanks and equipment in WD 178

8. ENDNOTES AND REFERENCES 179

MOUND SITE RADIONUCLIDES BY LOCATION

PRIMARY RESEARCH AND PRODUCTION BUILDINGS

1. HH BUILDING

1.1 OVERVIEW

HH means "Hydrolysis House," which is a name derived from its first primary function, the hydrolysis of highly radioactive bismuth chloride and aluminum chloride solutions. In 1963 HH Building was converted to stable gaseous isotope separation using thermal diffusion, liquid diffusion, and cryogenic processes. [1]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for decontamination work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

All radionuclides are ranked according to the degree of concern for uptake and internal dosimetry considerations for each room. Rooms that reference Appendix B for additional information usually will not have a ranking in this manual, since the ranking is done in Appendix B, where all radionuclides are listed.

Table 1 is a summary of the rooms, dates, and radionuclides for H-H Building.

Table 1 - HH BUILDING SUMMARY

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
HH-3, 4	H-3	1960-1990
	Xe (all isotopes), Kr-85	1964-1983
	Stable isotopes, Kr-85	1964-PRES
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), Kr-85	1964-1983
	Stable isotopes, Kr-85	1964-PRES
HH-6	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
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, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, 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, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-->134?, Hg-203	1949-1958
HH-119, 120, 121, 122	H-3	1964-1980

1.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS

1.2.1. Room HH-3, 4 These rooms had several functions:

a. (1960 - 1990) The helium-3 separation program was a gaseous thermal diffusion method initiated in SW-8 (1957-1960). In this process helium-3 was separated from aged tritium and helium-3 was used for commercial sales. A pipeline was installed which transported the tritium-containing waste gas to R-108 where it was oxidized and released to the ERS in SW Building. Radionuclides of concern and their compounds are: [2 3 4 5]

tritium

b. (1964 - 1983) Xenon gas, resulting from fission within a reactor, had its isotopes separated from each other using gaseous thermal diffusion. This was one of two methods used for isotope separation. Radioisotopes of concern and their compounds are: [6 7 8]

all xenon isotopes krypton-85

1) Krypton-85 is the major radiological concern and that is minimal.[9]

c. (1964 - PRESENT) Stable Isotope Separation - Initially carbon-12,13 and helium-3 and later neon-20,21,22, argon-36,38,40, xenon-124,126,...,131,134,136, nitrogen-14,15, oxygen-16,17,18, chlorine-35,37, bromine-79,81, and krypton-78,80,82,83,84,86, gases were separated isotopically by a thermal diffusion process. All of the isotopes are nonradioactive and are of no interest to this study. Sulfur-34,36 isotopes were later separated using a unique liquid thermal diffusion process.[10 11 12 13]

1) Krypton-85, a radionuclide, is an impurity found in some of the feed gases received for enrichment.

1.2.2 Room HH-5 This room had several functions:

a. (1955 - 1956) Initially this room was set up as a pilot plant for the separation of protactinium-231 from residues (raffinates) of a previously processed uranium substance called "Sperry Cake." Research work for processing had previously been done in R-145 & 147. This room became the actual processing room for the protactinium separation work from

the Sperry Cake substance. Radioisotopes of concern and their compounds are: [14 15 16]

iron-59	aluminum-26	calcium-45
cobalt-60	protactinium-231	copper-65

1) Protactinium-231 is the major radiological concern and all others are a distant second.[17]

2) By 1958 this area was completely decontaminated and all equipment removed. [18]

b. (1956) The Ionium (Th-230) program, developed in R-133, was a process closely related to the protactinium-231 program discussed above and also similar to the Cotter Concentrate program of the 1970's. The separation of Th-230 from "airport cake," a raffinate produced by an extraction process of uranium, required large columns for the actual separation production. The process was moved to HH Building since the large columns could be used there. Radioisotopes of concern and their compounds are: [19 20 21 22 23]

uranium-233,234,235,238	thorium-230,232
protactinium-231	thorium-230,232 daughters

1) Thorium-230 was the major radionuclide with all others being as distant second. [24]

c. (1960 - 1990) The helium-3 separation program consisted of three programs of which the gaseous thermal diffusion method initiated in SW-8 (1957-1960) is one. In this process helium-3 was separated from aged tritium and helium-3 was used for commercial sales. A pipeline was installed which transported the tritium-containing waste gas to R-108 where it was oxidized and released to the ERS in SW Building. Radionuclides of concern are: [25 26 27 28]

tritium

d. (1964 - 1983) Xenon gas, resulting from fission within a reactor, had its isotopes separated from each other using gaseous thermal diffusion. This

was one of two methods used for isotope separation. Radioisotopes of concern and their compounds are: [29 30 31]

all xenon isotopes krypton-85

1) The radioactive Xenon isotopes are the major radiological concern.[32]

e. (1964 - PRESENT) Stable Isotope Separation -Initially carbon-12,13 and helium-3 and later neon-20,21,22, argon-36,38,40, xenon-127,129,131,133, nitrogen-14,15, oxygen-16,17,18, chlorine-35,37, bromine-79,81, and krypton-78,80,82,83,84,86, gases were separated isotopically by a thermal diffusion process. All of the isotopes are nonradioactive and are of no interest to this study. Sulfur-34,36 isotopes were later separated using a unique liquid thermal diffusion process. [3334 35 36]

1) Krypton-85, a radionuclide, is an impurity found in some of the feed gases received for enrichment.

1.2.3 Room HH-6 This room had two functions:

a. (1955 - 1956) Initially this room was set up as a pilot plant for the separation of protactinium-231 from residues (raffinates) of a previously processed uranium substance called "Sperry Cake." Research work for processing had previously been done in R-145 & 147. This room became the actual processing room for the protactinium separation work from the Sperry Cake substance. Radioisotopes of concern and their compounds are: [37 38 39]

iron-59	aluminum-26	calcium-45
cobalt-60	protactinium-231	copper-65

1) Protactinium-231 is the major radiological concern and all others are a distant second.[40]

2) By 1958 this area was completely decontaminated and all equipment removed. [41]

b. (1956) The Ionium (Th-230) program, developed in R-133, was a process closely related to the protactinium-231 program discussed above and also similar to the Cotter Concentrate program of the 1970's. The separation of Th-230 from "airport cake," a raffinate produced by an extraction

process of uranium, required large columns for the actual separation production. The process was moved to HH Building since the large columns could be used there. Radionuclides of concern and their compounds are: [42 43 44 45 46]

uranium-233,234,235,238	thorium-230,232
protactinium-231	thorium-230,232 daughters

1) Thorium-230 was the major radionuclide with all others being as distant second. [47]

1.2.4 Room HH-8 This room had two functions:

a. (1949 - 1958) Hydrolysis for Po-210 Program - Radioactive aluminum chloride and bismuth chloride waste were received from the processing of the aluminum cans and bismuth in T-Building. Hydrolysis of these compounds produced a gelatinous bismuth oxychloride sludge which was stored in a quonset hut for possible recovery of the bismuth and re-irradiation at Hanford. The bismuth sludge was shipped off site in April of 1954. The aluminum sludge was solidified and shipped off site as it was produced. [48 49]

1) The sludge possessed high levels of radioactivity at 0.02 Ci/L of alpha, 0.002 Ci/L of beta, and 100 mrem of gamma at a distance of 1.0 foot. Radioisotopes of concern and their compounds are: [50 51 52]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a) Polonium-210 is the major radionuclide of concern with zinc-65 being the second. All others are a distant third.[53]

2) The bismuth chloride aqueous wastes and aluminum chloride aqueous wastes were transferred from T Building to HH Building via two separate 4 inch diameter Pyrex lines. These two waste streams were received and processed in the HH building until 1959 when all polonium operations ceased in the HH building. The hydrolysis of these wastes was done in T-54 after 1958. [54 55 56]

b. (1961 - 1963) Xenon, resulting from fission within a reactor, had its isotopes separated from each other using a "still" to separate the isotopes of xenon and the krypton-85. This was done on an experimental basis. Radioisotopes of concern and their compounds are: [57]

all xenon isotopes krypton-85

1) The radioactive xenon isotopes are the major radiological concern.[58]

1.2.5 Room HH-9

(1964 - 1985) In this room one of three methods was used to obtain helium-3 from a tritium/helium mixture. A charcoal process was used in combination with cryogenics in separating the tritium from helium-3. The tritium was the waste and the helium-3 was the desired product. Radioisotope of concern is: [59]

tritium

1.2.6 Rooms HH-10, 11, and 12

(1949 - 1958) Hydrolysis for Po-210 Program - Radioactive aluminum chloride and bismuth chloride waste were received from the processing of the aluminum cans and bismuth in T-Building. Hydrolysis of these compounds produced a gelatinous bismuth oxychloride sludge which was stored in a quonset hut for possible recovery of the bismuth and re-irradiation at Hanford. It was shipped off site in April 1954. The aluminum sludge was solidified and shipped off site as it was produced. [60 61]

a. The sludge possessed high levels of radiation at 0.02 Ci/L of alpha, 0.002 Ci/L of beta, and 100 mrem of gamma at a distance of 1.0 foot. Radioisotopes of concern and their compounds are: [62 63 64]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being the second. All others are a distant third.[65]

b. The bismuth chloride aqueous wastes and aluminum chloride aqueous wastes were transferred from T Building to HH Building via two separate 4-inch diameter Pyrex lines. These two waste streams were received and processed in the HH building until 1959, when all polonium operations ceased in the HH building. The hydrolysis of these wastes were done in T-54 after 1958. [66 67 68]

1.2.7 Room HH-119, 120, 121, 122

(1964 - 1980) The cryogenic process for the separation of helium-3 from tritium was used in this area. Radioisotope of concern is: [69]

tritium

2. PP BUILDING

2.1 OVERVIEW

Plutonium Processing (PP) Building (Building 38) was completed in December of 1967. The Special Metallurgical (SM) Building processes, fabrication operations, and recovery processes were transferred to PP Building along with waste treatment facilities, research and development, which included material research, and analytical laboratory support activities. This building was used primarily for processing plutonium-238 dioxide, received from 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 MLM-1564 (AEC Research and Development Report), page 31.

(1 ppm)-->1E-4% Pu-236
80.2% Pu-238
15.9% Pu-239
3.0% Pu-240
0.6% Pu-241
0.1% Pu-242

Note: MLM-1564 also makes reference to other mixtures.

All reference to plutonium-238 in PP Building was a composite of the mixture identified above. This mixture also included trace amounts of americium-241, neptunium-237, and uranium-234. [70]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

Thorium-232 was often substituted for Pu-238 compounds for modeling purposes in research and development, since this isotope was less expensive, less hazardous, and had physical characteristics similar to Pu-

238. It is therefore possible to find Th-232 compounds identical to the Pu-238 compounds. [71] [72]

The term "high-fired" is sometimes used, which implies that the plutonium compound has been heated in a plasma torch process such that the lung solubility class is definitely a "Y" or perhaps even a "YY." The term "non-high-fired" implies an absence of such heating and in extreme cases, where indicated, a lung solubility class of "W" or even a "D" may exist where there is high solubility.

Although a multitude of incidents occurred in the PP Building, only a few were listed because they were all from plutonium-238. It was already mentioned in the introduction to the document that only radioisotopes other than plutonium-238 would be listed for incidents in PP and SM Buildings.

A ranking of radionuclides according to the degree of concern for uptake and internal dosimetry consideration, as was done in HH and R Building, was NOT done in PP Building since all radionuclides were plutonium. The mixture of plutonium isotopes as shown above will dictate the ranking of radionuclides to be concerned with in all incidents and internal dosimetry dose calculations.

Table 2 is a summary of rooms, dates, and radioisotopes for PP Building.

Table 2 - BUILDING 38 AND PP BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	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	PuO2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967-PRES
PP-CORR-10	PuO_2	1967-PRES
PP-13	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967-1980
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	PuO2, $Pu(NO_3)_4$	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 orphan sources	1975-1989 1988-PRES
PP-CORR-115	Pu(238,239)O2	1967-PRES
PP-127	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967-PRES
PP-CORR-134, CORR-135, CORR-136	PuO_2	1967-PRES
PP-CORR-140, CORR-141, CORR-142	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, Th-232, $Th(NO_3)_4$, ThO_2, $Th(C_2O_4)_4$, $Th(OH)_4$	1967-PRES
PP-143 (A1)	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, Th-232, $Th(NO_3)_4$, ThO_2, $Th(C_2O_4)_4$, $Th(OH)_4$	1967-1980

Table 2 - BUILDING 38 AND PP BUILDING

PP-144 (A2),	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC, Th-232, $Th(NO_3)_4$, ThO_2, $Th(C_2O_4)_4$, $Th(OH)_4$, ThF_4	1967-1980
PP-145 (A3)	PuO_2	1967-1982
PP-146 (B1)	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC	1967-1980
147 (B2), 148 (B3)	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC, Th-232, $Th(NO_3)_4$, ThO_2, $Th(C_2O_4)_4$, $Th(OH)_4$, ThF_4	1967-1980
PP-149 (B4)	PuO_2	1967-1982
PP-150-->156 (C1->C4, D1->D3)	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC	1967-1980
PP-157 (E1)	PuO_2	1967-1980
PP-158 (E2)	PuO_2	1967-1980
PP-159 (E3)	PuO_2, $Pu(NO_3)_4$, $Pu(OH)_4$, PuF_4	1967-1980
PP-162, 163	PuO_2	1967-1980

Note: Pu-238 was the designated radioisotope in every room unless otherwise specified. Other isotopes of plutonium were also present in the mixture identified in the introduction along with small amounts of americium-241, neptunium-237, and uranium-234. Th-232 was sometimes used as a "stand-in" for the plutonium.

2.2 RADIONUCLIDES, ROOM, AND DATES ASSOCIATED WITH SPECIFIC HEAT SOURCE PROGRAMS

2.2.1 PP-Corr-5A

(1967 - 1974) Function and location is uncertain. Radionuclides of concern are probably the plutonium dioxides. [73] .

2.2.2 Room PP-6

(1967 - 1980) This room contains the PP Building filter bank and controls the negative air pressure with respect to the outside. Radioisotopes of concern and their compounds are: [74]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.3 Room PP-6W

(1967 - PRESENT) This room contains the corrosive vaporization filtering system to support the north analytical lab (room PP-113). Radioisotopes of concern and their compounds are: [75]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

a. Incident - (Pu-238 and Pu-239, 1/10/89)

2.2.4 PP-CORR-10

(1967 - PRESENT) This is a corridor/aisle on the first floor of PP Building. Radioisotope of concern and the compound is: [76]

plutonium oxide

2.2.5 Room PP-13

(1967 - 1980) The corrosive vaporization filtering system is located in this area which is used to support the analytical labs. A caustic scrubber system is used to remove caustic vapors from the air and transport to the liquid waste system. Radioisotopes of concern and their compounds are: [77]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.6 Room PP-14

(1967 - 1980) The PP Building vacuum system is contained in this room. This system enabled specific process systems, housed in gloveboxes, to operate under vacuum conditions when procedures dictated that environment. Radioisotopes of concern and their compounds are: [78]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.7 PP-CORR-15, CORR-16, CORR-17

(1967 - 1974) These corridors supported the glovebox lines located on the floor above. Radioisotopes of concern and their compounds are: [79]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.8 Room PP-18

(1967 - PRESENT) This room is the "cold" side of the basement where reagents are made for scrubbing. It is believed that room PP-154 had a spill which leaked down into this room. Radioisotopes of concern and their compounds are: [80]

plutonium oxide plutonium nitrate

2.2.9 Room PP-24

(1967 - PRESENT) This room is an air-lock between PP-13 and PP-14. Radioisotopes of concern and their compounds are: [81]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.10 Room PP-100

(1967 - PRESENT) Function of this room is uncertain. Radionuclides of concern are probably the plutonium dioxides. [82]

plutonium oxide

2.2.11 Room PP-113

(1975 - PRESENT) Often called North Line, this room has been used for a variety of programs as discussed below.[83] [84]

a. (1975 - 1989) This room was an analytical lab used in the "Sample Exchange" program. Samples containing Pu-239 were monitored for total percent plutonium along with other measurements. Radionuclides of concern are:

plutonium-238,239

1) Plutonium-239 was the major radionuclide of concern with plutonium-238 being second. [85]

b. (1988 - PRESENT) The "orphan source" program is used to determine which radioisotopes are contained in unknown sources. Some characterization studies are also being done on these unknown sources. Support for the decontamination work is also conducted in this lab. Radioisotopes of concern are varied.

c. (1995 - FUTURE) This lab may be used for the repackaging of Pu-239 contained in vaults in T Building but this is uncertain at this time. Radioisotopes of concern will be Pu-239.

d. Incident - (Pu-239, 240, 4/6/87)[86]

2.2.12 PP-CORR-115

(1967 - PRESENT) This is an access corridor for the north line gloveboxes used for a variety of purposes as discussed under PP-113. Radionuclides of concern are:

plutonium-238,239 orphan sources

a. Plutonium-239 was the major radionuclide of concern with plutonium-238 being second until 1988. Since that time orphan sources may be found here. [87]

2.2.13 Room PP-127

(1967 - PRESENT) This is an airlock supporting corridor 141. Radioisotopes of concern and their compounds are: [88]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.14 PP-CORR-134, CORR-135, CORR-136

(1967 - PRESENT) These are access corridors to the various rooms for rooms containing glovebox lines A-->E. [89]

a. (1967 - 1974) These corridors possessed minimal contamination, usually in the form of plutonium dioxide. Radionuclides of concern are:

plutonium dioxide

b. (1975 - PRESENT) Only CORR-136 was used for support to PP-113. Radionuclides of concern are:

plutonium-238,239 orphan sources

2.2.15 PP-CORR-140, CORR-141, CORR-142

(1967 - 1985) This corridor supports the glovebox lines, A-->F. Radioisotopes of concern and their compounds are: [90]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate

plutonium nitrate	plutonium hydroxide
thorium nitrate	thorium hydroxide
thorium dioxide	thorium oxide hydrate

a. Actual processing work ceased in 1974. These corridors and rooms associated with them were essentially idle until D&D work in 1985. Some use was made for packaging during this time. [91]

2.2.16 Room PP-143 (A1)

(1967 - 1980) Analytical lab for determining plutonium concentrations and acidity of solutions. Also prepared samples for impurity determination. [92]

a. Radioisotopes of concern and their compounds are:

plutonium nitrate pentahydrate $Pu(NO_3)_4.5H_2O$

plutonium hexanitrate	plutonium nitrate
plutonium dioxide	plutonium oxide hydrate
(high fired and non)	plutonium hydroxide
thorium nitrate	thorium hydroxide
thorium dioxide	thorium oxide hydrate

2.2.17 Rooms PP-144 (A2), 147 (B2), & 148 (B3)

(1967 - 1980) These rooms were the primary ones used for all major operations in PP Building as discussed below.

a. Plutonium-Molybdenum Cermet (PMC) Process - From 1969 - 1973 the (PMC) program took precipitated, dried plutonium dioxide, crushed and sized, sintered in pure oxygen, sieved and sized again to 43 - 250 micron, coated the particles with molybdenum, and vacuum HOT PRESSED into right circular cylinders. The molybdenum coating produces pathways for even heat transfer. The plutonium disks were machined to a required

dimension and assembled into heat source capsules. Radioisotopes of concern and their compounds are: [93] [94]

plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$
plutonium hexanitrate
plutonium nitrate
plutonium dioxide
(high fired and non)
plutonium oxide hydrate
plutonium-hydroxide

b. Pressed Plutonium Oxide (PPO) - This method was the longest lived of the plutonium programs extending from 1970 to the late 1970's when encapsulated heat sources were then received from SRP. The process was similar to the PMC process except that there was no particulate molybdenum coating. The material was transferred to a hot press facility where a sphere was fabricated in a die body. The spheres were then sent to PP-161 for encapsulation. Compounds and mixtures which may be encountered in PP-144, 147, 148 from the PPO process: [95] [96]

plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$
plutonium hexanitrate
plutonium nitrate
plutonium carbide
plutonium oxide hydrate
plutonium dioxide
plutonium hydroxide
(high-fired and non-high-fired)

c. Milliwatt Generator Program - This program existed from 1974 - 1979 and followed the same initial steps up to the sizing as was done in the PMC and the PPO process. The 105 - 500 micron shards were poured loosely into a heat source capsule with yttrium chips and sealed. [97]

Note: The compounds and mixtures were the same as for PPO program discussed above.

d. Solid Solution Process - Sporadically from 1970 - 1974 (probably only one year total) a process was developed which kept the plutonium-238 in solution for most of the process. Thorium nitrate was added to the solution in a 9 part plutonium to 1 part thorium nitrate, with the goal to raise the melting point. Precipitation, crushing, sieving, hot pressing were then performed. Radioisotopes of concern and their compounds are: [98] [99]

plutonium-238
thorium-232
plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$

plutonium hexanitrate
plutonium dioxide
(high fired and non)
plutonium thorium nitrate
thorium homolog (to each of the above plutonium counterpart)

plutonium nitrate
plutonium oxide hydrate
plutonium hydroxide

e. Sol-Gel Process - Sporadically from 1969 - 1971 plutonium-238 nitrate, with the same isotopic mixture as was discussed in the overview, was suspended in a gelatinous organic solvent solution (EDTA complexes) to form a plutonium polymer 10 - 20 angstroms in diameter. No heat, vaporization, crushing, or grinding existed which made it a much safer operation in regards to inhalation. [100]

1) If an uptake occurred with the polymerized Pu-238 nitrate in organic solvent solution it reacted quite different from typical plutonium solutions. 100% would go to the liver and be hydrolyzed. It would act as a class W solubility class. [101]

2) The EDTA complexes made the Pu-238 very soluble in the lung and gut.

f. Microsphere Process - (1967 - 1970) There was a continuation of the microsphere process developed in the SM Building where plutonium dioxide spheres with a diameter of 50 to 250 μm were produced. There are two phases to this process where were carried out in two different areas.

1) Rooms PP-144, 147, and 148: The precursor material was chemically processed through several steps and then was crushed, sieved, and sintered. There is a large quantity of very fine particulate material produced from the crushing and sifting process with much airborne material submicron in size. Compounds and mixtures which may have been encountered are: [102] [103]

plutonium dioxide
plutonium hydroxide
plutonium oxide hydrate
plutonium nitrate
plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$
plutonium oxalate--------{ $Pu(C_2O_4)_4$ }
plutonium peroxide
plutonium fluoride

2) The second phase of the process was done in rooms PP-162 and 163. These rooms are discussed in their proper numerical order.

3) The lung solubility class varied greatly during the procedure. In PP-144, 147, 148 there was a class D or W for the first few steps where nitrates and oxalate are involved with little heating. A weak class Y developed where oxides were formed but prior to the plasma processing. In PP-162 and 163 a definite class Y emerged after the plasma process since the heated plutonium dioxide was much less soluble in tissue fluids after this high-temperature sintering step.[104] [105]

2.2.18 Room PP-145 (A3)

(1967 - 1980) Lab for plutonium support work. Also an access to elevator for the building conveyor system. Radionuclides of concern are: [106]

plutonium dioxides

2.2.19 Room PP-149 (B4)

This room contained a gamma scanning assay well under the floor. Radionuclides of concern are: [107]

plutonium dioxides

2.2.20 Rooms PP-146 (B1), 150 (C1), 151 (C2), 152 (C3), 153 (C4), 154 (D1), 156 (D3)

(1967 - 1980) These rooms were designated for recovery operations using ultrasonic cleaners and other recovery techniques from both solid and liquid waste: [108]

a. Aqueous wastes consisted of plutonium-bearing acidic solutions which included nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. Caustic waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Recoverable aqueous waste was sent back to the processing lines.

1) In the recovery process an organic resin, DOWEX-1, was used as an anion-exchange column to recover the plutonium. The plutonium was dissolved in various solutions such as nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, sodium hydroxide, or complexing agents such as EDTA and citrates which made the plutonium extremely soluble. This accentuates the statement made about being a class W or even class D at certain times. The solutions contained nitrate, sulfate, and fluoride ions, and as such formed various compounds with the available plutonium, americium-241, neptunium-237 and uranium isotopes. These other elements were minuscule in quantity, as compared to the plutonium dioxide. Radionuclide of concern and its compounds are: [109 110 111]

plutonium	plutonium oxide
americium-241	neptunium-237
uranium-238	uranium-238 nitrate
plutonium nitrate	uranium-238 fluoride
americium-241 nitrate	neptunium-237 nitrate
plutonium fluoride	plutonium fluoride
americium-241 fluoride	neptunium-237 fluoride
uranium-238 sulfate	neptunium-237 sulfate
plutonium sulfate	plutonium oxide sulfate
americium-241 sulfate	neptunium-237 hydroxide
plutonium hydroxide	uranium-238 hydroxide
americium-241 hydroxide	

2) Plutonium radionuclides were the major radionuclides of concern. [112]

b. Solid waste processing consisted of washing and leaching of the glove box residue material with the aid of ultrasonic cleaning equipment. Combustible wastes generated in glove boxes were put into an incinerator located in one of the glove boxes.

1) Materials containing recoverable plutonium were dissolved in a mixture of nitric and hydrofluoric acid or underwent fusion with pyrosulfate. Glass fiber filters were dissolved in a hydrofluorinator and the acidic solutions containing plutonium were sent to the plutonium recovery process. Recovery precipitation procedures used oxalic acid. Compounds from recovery procedures include the following: [113]

plutonium nitrate pentahydrate $Pu(NO_3)_4.5H_2O$
plutonium hexanitrate plutonium nitrate
plutonium dioxide plutonium oxide hydrate
plutonium fluoride plutonium hydroxide

Note: Th-232 which was often substituted for Pu-238 for modeling purposes but was NEVER put into recovery operations since it was not desirable to mix the Pu-238 and the Th-232. [114] [115]

2.2.21 Room PP-157

(Same as PP-E1), (1967 - 1980) Analytical lab. Probable radioisotope of concern is: [116]

plutonium dioxide

2.2.22 Room PP-158

(Same as PP-E2), (1967 - 1980) - Analytical lab used for determining density and gas rack analysis. Radionuclides of concern is: [117]

plutonium dioxide

2.2.23 Room PP-159

(Same as PP-E3), (1967 - 1980) - Received PuO_2 shipments and transferred to production area. Dissolving of plutonium in nitric acid was also done in this area. Radioisotopes of concern and their compounds are: [118]

plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$
plutonium hexanitrate plutonium nitrate
plutonium dioxide plutonium oxide hydrate
plutonium hydroxide plutonium fluoride

2.2.24 Room PP-161 (Same as F-1)

(1970 - 1978) The plutonium-238 PPOs were received from PP-144, 147, 148. In PP-161 they were encapsulated into iridium hemispheres and welded. Radioisotopes of concern and their compounds are: [119]

plutonium-238 dioxide

2.2.25 Rooms PP-162 and 163 (Same as F-2 & F-3)

Microsphere Process - (1967 - 1970) Plutonium dioxide spheres with a diameter of 50 to 250 μm were produced in a previous operation. The second phase of this process took the sintered plutonium oxide compound from the above process and performed a plasma torch process which formed "microspheres." The ceramic spheres were chemically stable and essentially free from loose contamination. Significant quantities of plutonium dioxide were vaporized during the plasma process which resulted in extremely fine particulates, most of it submicron in diameter. The only radionuclide compound of concern is: [120] [121]

plutonium-238 dioxide

3. R BUILDING

3.1 OVERVIEW

"R" (for RESEARCH) Building was built in 1948 and has had a multitude of programs involving radionuclides over the years. A brief description of some of the major programs are listed below. Also included are the elemental radionuclides and radioisotopic compounds resulting from those processes.

Beginning in the fall of 1948 research and development for the polonium-210 program began. This was all pilot scale work for the actual production processing done in T Building. Later R&D work with polonium extended into the early 1970's.

Plutonium-238 research began in R Building in about 1959 and continued through the 1960's. The following plutonium isotope concentration was typical for the material received at Mound from the Savannah River Plant.[122]

1E-4% Pu-236	3.0% Pu-240
80.2% Pu-238	0.6% Pu-241
15.9% Pu-239	0.1% Pu-242[123]

Starting in the early 1980's, tritium research and development was conducted in the following rooms: Rooms R-105, 106, 108, 110, 113, 114, 120, 127, 128, 130, 134. Experimentation with metal tritides and deuterides such as uranium tritide and lithium tritide was done. Developmental studies with tritiated water and its handling were also done.

Some tritides and tritiated solvents were so poorly metabolized that the biological half-times were in the order of hours. This was not true for uranium tritides.[124 125 126]

Nickel Carbonyl has been identified in several incident reports. This gas mixture is NOT radioactive but it is highly toxic. It should be disregarded in internal dosimetry analysis.

In regards to the particle sizes of the radionuclides the following general rules can be applied.

a. Polonium would typically be of submicron (<1.0 μm AMAD) because of its very high specific activity. This factor explains why it vaporizes easily yielding a high vapor pressure for a metal.

b. For plutonium, americium, actinium, and the other alpha emitters it is reasonable to expect a typical particle size of around 1.0 μm. This of course depends on the processes involved. Much of the plutonium particle sizes would follow the general rules discussed in the SM and PP Building discussions.

All references to plutonium-238 was of the mixture ratio identified in the introduction to R Building (above). This mixture also included trace amounts of americium-241 and neptunium-237. Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240 and 241.[127]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for decontamination work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

All radionuclides are ranked according to the degree of concern for uptake and amount of activity for internal dosimetry considerations. Rooms which are referenced to Appendix B for additional radionuclides do not have a ranking in this manual since the ranking is done in Appendix B where all radionuclides are listed. This situation is identified as "see Appendix B for ranking." Rooms where additional information on processing or radionuclides in Appendix B does not effect the ranking are identified as "see Appendix B" only.

Table 3 is a summary of rooms, dates, and radioisotopes for R Building. Please observe that the first block going across in Table 3 is designated for the early polonium program. All "probable" rooms associated with that program are lumped together. The proper word is probable since little information is available as to which rooms were all involved. This arrangement is a deviation from the pattern used for the rest of the table,

and all other tables in this document, where the tables are arranged according to rooms and not a process or program.

** The first block in the table identifies rooms and radionuclides involved in the early polonium program. This listing deviates from the organization used in the remainder of this table and in other tables used in this document.

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
Early work in polonium: **(See previous page) Rooms: R-117 120 127 128 129 130 131 133 143 144 151 152 155 159 160 161 162 167	$AlCl_3$, $BiCl_4$, 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, See Appendix B ..... H-3, Li(D,T), U-238(D,T), Ti(D,T), See Appendix B	1948-1965 1975-PRES
R-110	Po-208,210, ... H-3	1955-1972 1972-PRES
R-111.	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-223, 224,226, Th-228,229,230, Ac & Ra daughters Po-208,210, H-3	1951-1955 1955-1965
R-112	H-3, Li(D,T), U-238(D,T), See Appendix B	1973-1993

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
R-113, 114, 115	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-223, 224,226, Th-228,229,230, (Ac & 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-PRES
R-116	Po-210, Pu-238,239, Po/Be, PoF_2, Po/B, Pu/Be, PuF_2, Pu/B	1956-1961
	Pu-238,239, Pu/Be, 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 & Ra daughters)	1955
	U-234,235,238, Pa-231, Th-230,232 and (Th-232 daughters)	1956-1958
R-120 and (support rooms 119, 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, See Appendix B	1951-1953
	Pa-231, Th-230,232 and (Th-232 daughters), U-234,235,238	1956-1958
	Pu-239, Am-241	1956-1962
	See Appendix B	1960-1962
	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, polonium alloys and compounds .	1959-1979

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
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-PRES
R-128	Po-210, Bi-210, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1954
	PuO_2, PuF_4, Pu-$MoCl_4$, Pu-MoF_4	1965-1978
	H-3, U-238(D,T)	1987-PRES
R-129, 130	Po-210, Bi-210, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1951
	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-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
	See Appendix B	1990-PRES
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 daught., See Appendix B	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-3, U-238, U-238(D,T)	1986-PRES

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
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, mixtures), $Pu(NO_3)_2$, Ac-227, Am-241 . . .	~1969-PRES
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
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)	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
	See Appendix B	1960-1962
	Pu-238,239, PuO_2, U-234,235,238	1968-1975
R-148, 149	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, Po-208, Pa-231	1949-1954
	Fe-59, Al-26, Ca-45, Co-60, Pa-231, Cu-65 Pu-238	1954-1958
	Pu-238, $Pu(C_2O_4)_4$, $Pu(NO_3)_4$,	1960-1968
	Th-230, PuO_2, Pm-146-->149, $U(234)(NO_3)_4$, $U(234)O_2$, Pu/Zr	1970-1980

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
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, See Appendix B	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, Zn-65, Bi-210, Pb-210, Zr-95, Al-26 rare earth elements)	1956-1969
R-159	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, Zn-65, Bi-210, Pb-210, Zr-95, Al-26 rare earth elements)	1956-1969
R-160	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, See Appendix B	1951-1953
R-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, See Appendix B	1951-1953

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
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 & 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 & 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
	See Appendix B	1955-1957
	U-233, Th-229,230,232	1958
	Sr-90, Y88,90,91, Pa-231	1960-1962
	Pa-231,233, Ce-141,144, Am-241, Cm-244, U-233, Th-230,232, Ra-226, Tl-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-PRES
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 & Ra daughters	1949-1954
	U-235,238, See Appendix B	1961-1963
	Pu-238,239,240,241 (compounds, alloys, mixtures), Am-241, Ac-227, Ra-226	1965-1991
R-174, 176	H-3	1970-PRES

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
R-197A	Pu-238,239, PuO_2, Cm-244	1970-PRES
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
Crawl Space above R-Bldg	Pu-238,239, Ra-226, Ac-227, Po-210, Th-228, 229,230	1948-PRES
R-CORR-5	Ac-222	1948-1984

Note: All references to plutonium-238 was of the mixture ratio identified in the introduction to R Building. This mixture also included trace amounts of americium-241, neptunium-237, and uranium-234. [128]

Plutonium-239 was over 95% pure with trace amounts of plutonium-240,241.

3.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS

3.2.1 Room R-105, 106 This area had two major programs:

a. (1958 - 1965) This area was used as an unloading station for tanker trucks bringing "stack gas" (helium and tritium) to the site. Other hardware for tritium was also unloaded on that dock. Room R-105 is known as the tank truck unloading station.[129 130]

The gas was pumped into tanks and taken to SW-8 for recovery processing. Processes were also performed to purify the helium of tritium and deuterium. Radioisotopes of concern and their compounds are: [131 132]

tritium	tritiated water (HTO)

Note:
- Tritium gas is the major radiological concern.[133]
- Incident - (Tritium, 4/10/58, 8/8/60, 6/11/62)[134]

b. (1965 - 1978) Functioned as an analytical laboratory for the analysis of the metal tritides and the effects of long term storage. A gas synthesis system was used to prepare metal deuteride and tritide salts for X-ray diffraction and other forms of analyses. Operations are similar to R-105. Radioisotopes of concern and their compounds are: [135 136 137]

tritium	lithium tritide	uranium-238 tritide

Note: Tritium is the major radionuclide of concern with uranium-238 being second.[138]

3.2.2 Room R-108 These rooms were used in two separate programs.

a. (1948 - 1965) This room was used as a calorimetry research and assay lab to support the Po-208,210 research and development work. Radioisotopes of concern and their compounds are:[139 140]

polonium-208,210	tritium

1) See Appendix B.

b. (1975 - PRESENT) This room (R-108) has facilities for a tritium recovery including solid tritiated metal compounds, gas recovery, and purification from other tritium handling processes. A "heat-up reactor" is used to drive off tritium. Radioisotopes of concern and their compounds are: [141] [142] [143] [144]

tritium	lithium tritide
uranium-238 tritide	titanium tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[145]

2) Note: R-108 was a consolidation of rooms R-107, R-108, and R-109 in 1973. [146]

3) See Appendix B.

3.2.3 Room R-110 This room was used for two separate programs.

a. (1955 - 1972) This was a support lab giving calorimetry support. Radioisotopes of concern and their compounds are: [147] [148]

polonium-208,210

1) Polonium-210 is the major radionuclide of concern.[149]

b. (1972 - PRESENT) This room is used for preparation of hydrogen and helium mixtures for analytical standards used in mass spectrometry, gas chromatograph, etc.. Radioisotopes of concern and their compounds are: [150] [151] [152]

tritium

3.2.4 Room R-111

a. (1951 - 1955) This room was used for support work to the actinium-227/radium-226 work. The precipitate was processed further in rooms such as this. Radioisotopes of concern and their compounds are: [153] [154] [155] [156]

actinium-227	radium-223,224,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium-227 daughters	radium daughters

1) Actinium-227 was the major radionuclide of concern with radium-226 and thorium-228 both being a close second. All compounds of actinium-227 were highly soluble.[157]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[158] Previous discussions/interviews indicated that only actinium-227 and the related compounds were there.

3) Incident - A chemist was contaminated with actinium-227 and a urine analysis revealed radium-223 in his body. [159]

4) Decontamination work was begun in June, 1953 and extended until 1955 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 were scrubbed twice. [160] [161] [162]

b. (1955 - 1965) Calorimetry, research, and assay work was done to support the polonium-208,210 R&D program. Radioisotopes of concern and their compounds are: [163]

polonium-208,210	tritium

1) Polonium-210 was the major radionuclide of concern with tritium being second.[164]

3.2.5 Room R-112

(1973 - 1993) Nuclear Magnetic Resonance Spectroscopy (NMR)- NMR is used to measure the amounts of deuterium, tritium, and He-3 in liquids and solids for retention and diffusion characteristics in metal tritides. Radioisotopes of concern and their compounds are: [165 166 167]

tritium	lithium tritide	uranium-238 tritide (actually natural uranium)

a. This was a cold lab previous to 1973.[168]

b. See Appendix B.

3.2.6 Rooms R-113, 114, and 115

This area was used in three separate programs.

a. (1951 - 1955) This room was used for support of radium-226/actinium-227 work in the cave (SW-19). The precipitate was taken to rooms such as this for further processing. Radioisotopes of concern and their compounds are:[169 170 171 172 173]

actinium-227	radium-223,224,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium-227 daughters	radium daughters

1) Actinium-227 was the major radionuclide of concern with radium-226 and thorium-228 both being a close second. All compounds of actinium-227 were highly soluble.[174]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[175] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Incident - (Actinium-227 7/22/52)[176]

4) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [177] [178]

b. (1956 - 1961) Neutron Source Program - This program was similar to that in R-116 where research and development was directed at various alternatives for neutron sources. Typically polonium and plutonium-238,239 was used in combination with other elements such as beryllium, fluorine, boron, etc. [179] [180]

polonium-210	plutonium-238,239
polonium-beryllium	plutonium-beryllium
polonium fluoride	plutonium fluoride
polonium-boron	plutonium-boron

1) Polonium-210 was the major radionuclide of concern with plutonium-238 second and plutonium-239 third.[181]

c. (1978 - PRESENT) This area is used for analytical support to research, development, and recovery. Calorimetry was used after 1990 as an evaluation technique in monitoring contamination of equipment with low level tritium. Radionuclide of concern is: [182] [183] [184] [185]

tritium

3.2.7 Room R-116 (A&B)

This area was used for several distinct programs as discussed below.

a. (1956 - 1961) This room was used to produce plutonium/beryllium neutron sources such as those used in "well logging" operations. Pu-238 and Pu-239 was used in conjunction with beryllium as evidenced by the two incidents involving plutonium/beryllium. This process was moved to the Monsanto Plant on Nicholas Road along with the polonium-210 neutron sources. Radioisotopes of concern and their compounds are: [186] [187]

polonium-210	plutonium-238,239
polonium-beryllium	plutonium-beryllium
polonium fluoride	plutonium fluoride
polonium-boron	plutonium-boron

1) Polonium-210 was the major radionuclide of concern with plutonium-238 second and plutonium-239 third.[188]

2) Incidents - (Plutonium/beryllium, 8/19/60, 7/19/61) [189]

3) Pu-238 was used on 3/22/56[190]

b. (1956 - 1962) This room was also used to produce alpha sources by plating various metal substrates. These alpha sources were used as sources for calibration of alpha monitors. This operation was expanded to a section of R-120. It was later moved to SW-219. Radioisotopes of concern and their compounds are: [191]

americium-241	plutonium-239

1) Americium-241 was the major radionuclide of concern with plutonium-239 second.[192]

c. (1960 - 1965) This area is used for analytical support to research, development, and recovery. Calorimetry was the primary evaluation technique used in this area to analyze various aspects of tritium and metal tritides. Radioisotopes of concern and their compounds are: [193] [194] See Appendix B for details.

tritium	lithium tritide	uranium-238 tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[195]

d. (1965 - PRESENT) This area was a "cold" lab. There are no radionuclides of concern. [196] [197] [198]

3.2.8 Room R-117

(1948 - 1990) This was a vault containing radionuclides in both packaged materials form and sealed sources. Radioisotopes of concern and their compounds are: [199] [200]

plutonium-238 dioxide	plutonium-238 metal
plutonium-238/zirconium alloy	thorium-230
plutonium-238,239 / Be	plutonium-239 metal

polonium-210 / beryllium protactinium-231

a. The ranking of radionuclides are time dependent:[201]

1) Before 1955 protactinium-231 was the major radionuclide of concern.

2) From 1955 - 1965 polonium-210 was the major radionuclide of concern.

3) After 1965 plutonium-238 was the major radionuclide of concern.

3.2.9 Room R-118

This room was used for several projects as discussed below.

a. (1955) This room has been designated as the storage area for all the radioactive materials from the radium and actinium program. Radioisotopes of concern and their compounds are: [202]

actinium-227	radium-223,224,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium-227 daughters	radium daughters

1) Actinium-227 was the major radionuclide of concern with radium-226 and thorium-228 both being a close second. All compounds of actinium-227 were highly soluble.[203]

b. (1956 - 1958) Ionium Work - Starting in 1956 a major effort was underway to separate Th-230 (Ionium) from "airport cake," a raffinate produced by an extraction process of uranium. The "airport cake" was the similar to the Cotter Concentrate used in the 1970's except that it had fewer uranium isotopes and thorium daughter isotopes. Radioisotopes of concern and their compounds are:[204] [205] [206]

uranium-234,235,238	thorium-230,232
protactinium-231	thorium-230,232 daughters

1) Thorium-230 was the major radionuclide of concern with all others a distant second.[207]

3.2.10 Rooms R-120 and support rooms R-118, 119, 121, 123

These rooms were used for a variety of programs:

a. (1948 - 1951) In support for the polonium project a pilot program was developed. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried.[208] [209]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [210]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[211]

b. (1951 - 1953) This room is used for the reduction of actinium-227 from the precipitate in the old cave. Radioisotopes of concern and their compounds are: [212] [213] [214] [215] [216]

actinium-227	actinium nitrate
actinium oxide	actinium oxalate
radium-226	thorium-228,229,230
actinium fluoride	actinium iodide
actinium-227 daughters	

1) Actinium-227 was the major radionuclide of concern with actinium-227 daughters being a close second. Both radium-226 and thorium-228 are a distant third.[217]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[218] Previous discussions/interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [219] [220]

4) See Appendix B.

c. (1956 - 1958) Ionium Work - Starting in 1956 an effort was underway to separate Th-230 (Ionium) from "airport cake," a raffinate produced by an extraction process of uranium. The "airport cake" was the similar to the Cotter Concentrate used in the 1970's except that it had fewer uranium isotopes and thorium daughter isotopes. Radioisotopes of concern and their compounds are:[221] [222] [223]

uranium-234,235,238	thorium-230,232
protactinium-231	thorium-230,232 daughters

1) Thorium-230 was the major radionuclide of concern with all others a distant second.[224]

2) A memo discusses Th-230 on 3/22/56 [225]

3) The Health Physics Quarterly discusses the cleaning up of rooms R-119 and R-121. [226]

d. (1956 - 1962) This room was also used to produce alpha sources by plating various metal substrates. These alpha sources were used as sources for calibration of alpha monitors. This operation was started in R-16 and expanded to a section of R-120. It was later moved to SW-219. Radioisotopes of concern and their compounds are: [227]

americium-241	plutonium-239

1) Americium-241 was the major radionuclide of concern with plutonium-239 second.[228]

e. (1959 - 1979) Metallurgical Analysis of Plutonium Compounds -Work was done primarily with Pu-238, Pu-239, and some Po-210 early in the program, especially in conjunction with the heat source programs. The highly corrosive plutonium-238 compounds demanded alternative exploration. These materials were very fine oxide particles possessing

class Y characteristics since they are retained in the body for long periods of time. Radioisotopes of concern and their compounds are: [229] [230]

plutonium oxalate-------{ $Pu(C_2O_4)_4$ }
plutonium hexanitrate
plutonium nitrate
plutonium dioxide
(high-fired and non-high-fired)
plutonium oxide hydrate
plutonium hydroxide
plutonium tetrachloride
plutonium tetrafluoride--(high neutron flux)
metallic plutonium (elemental)
plutonium/copper
plutonium/selenium
plutonium/zirconium
plutonium/rare earths
vaporized plutonium dioxide
polonium alloys and compounds
tritium-(not normally expected to be there)

1) The ranking of radionuclides are time dependent:[231]

   a) 1959 - 1969 polonium-210 was the major radionuclide of concern. All others are a distant second.

   b) After 1969 plutonium-238 was the major radionuclide of concern. All others are a distant second.

2) Incident - (Pu-238, 7/6/60, 7/3/63, 1/28/71, 8/3/73)[232]

3) Incident - (Tritium, 1/9/63) - radioactivity in water in an air hose.)[233]

f. (1960 - 1962) See Appendix B.

g. (1988 - PRESENT) Room R-120 was decontaminated in 1984-1987 and has been a cold lab since that time. Room R-118 and R-123A were decontaminated from 1985-1990. There are no radionuclides of concern used during that time. [234] [235] [236]

Note: Rooms R-127, 128, 130, 131 (128A, 128B, 128C): These rooms were used for several major programs as discussed below. [237] [238] [239] [240]

a. R-127,128,129,130 were separate rooms as discussed under the respective room number.

b. In the fall of 1954 these four rooms were decontaminated and formed one large room, R-128.

c. From 1965 - 1978 these rooms were used in support of the heat source programs using plutonium-238 as the primary radioisotope.

d. From 1978 - 1988 these rooms were decontaminated and R-130 and R-131 were converted into 128A, 128B, 128C.

e. Since the late 1980's these rooms are used as analytical laboratories performing various analyses on tritiated samples.

3.2.11 Room R-127

This room had several programs as discussed below.

a. (1948 - 1951) In support for the polonium project a pilot program was developed. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried. [241] [242]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [243]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[244]

b. (1952 - 1954) This room was used for an iron sulfide process which was radioactive (gamma). Radionuclide of concern is:

iron-55,59

1) Incident - A chemist left a flask with a saturated salt solution on a hot plate overnight and it shattered. Contamination spread over a 15 foot area. [245]

c. (1956 - 1961) This room contained thermal diffusion columns and was used for helium-3 separation from helium-4 gas. Also involved in the separation process was tritium. The process was moved to HH Building. Radioisotopes of concern are: [246 247 248]

tritium

d. (1965 - 1978) Plutonium-Molybdenum Cermet (PMC) program (Heat Source Program). The 43 - 250 μm plutonium dioxide shards were processed and sintered at 1600° in PP Building before being received in R-127. In R-127 the shards were coated with molybdenum by using a molybdenum hexafluoride compound. (The hexafluoride on the plutonium was the source of a huge neutron flux.) Radioisotopes of concern and their compounds are: [249 250 251]

plutonium dioxide (heat-treated)
plutonium fluoride
plutonium molybdenum-tetrachloride
plutonium molybdenum-tetrafluoride
(high neutron flux)

1) Plutonium-238 was the major radionuclide of concern with other plutonium radionuclides ranked in order as given in R Building overview.[252]

e. Decontaminated 1981-1983 [253]

f. (1987 - PRESENT) After a renovation program from 1983 - 1987 this room was used as a facility where components would be monitored for radiation. Radioisotopes of concern and their compounds are: [254]

tritium plutonium-239

1) See Appendix B for more information and ranking of radionuclides of concern.

3.2.12 Room R-128

This room had two phases of operations as discussed below.

a. (1948 - 1954) In support for the polonium project a pilot program was developed. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried. [255] [256]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [257]

silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[258]

b. (1965 - 1978) This was an analytical lab supporting the heat source program. Radioisotopes of concern and their compounds were: [259] [260]

plutonium-238 oxide other radionuclides
plutonium-238 compounds and mixtures (fluorides, molybdenum, chlorides, etc.)

1) Plutonium-238 was the major radionuclide of concern. All others are a distant second.[261]

c. Actually decontaminated 1985-1987. [262]

d. (1987 - PRESENT) This room is an analytical laboratory used to perform contaminant and surface area analysis, differential analysis, infrared spectrometry, ion chromatography, etc.. Radioisotopes of concern and their compounds are: [263] [264]

tritium	uranium-238 tritide

Note: Other tritides may have been there but only rarely.

1) Tritium is the major radionuclide of concern with uranium-238 being second.[265]

3.2.13 Room R-129 and R-130

This room was used for a variety of programs as discussed below.

a. (1948 - 1951) In support for the polonium project a pilot program was developed. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried. [266] [267]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [268]

silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[269]

b. (1951 - 1953) This room was used for actinium-227 processing. Radioisotopes of concern and their compounds are: [270] [271] [272] [273]

actinium-227	radium-223,224,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium-227 daughters	radium daughters

1) Actinium-227 was the major radionuclide of concern with radium-226 and thorium-228 both being a close second. All compounds of actinium-227 were highly soluble.[274]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[275] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [276277]

c. (1965 - 1978) This was an analytical lab supporting the heat source program. Th-232 was sometimes used to simulate Pu-238 fuel. Radioisotopes of concern and their compounds were: [278 279 280 281]

plutonium-238 oxide
plutonium-238 compounds and mixtures (fluorides, molybdenum, chlorides, etc.)
plutonium-238 dioxide (cermet and pressed oxide)
thorium-232 (associated with the same compounds and mixtures as the plutonium)

other radionuclides

1) Plutonium-238 was the major radionuclide of concern with thorium-232 being a distant second.[282]

d. Decontaminated 1982-1985. [283]

e. (1990 - PRESENT)

1) See Appendix B for ranking.

3.2.14 Room R-131 This room had two programs:

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried. [284285]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [286]

silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[287]

b. (1965 - 1978) This was an analytical lab supporting the heat source program. Special consideration was given to Pu-238 oxygen exchange processing. The desired goal was to remove O-17 and O-18 which resulted in a lower neutron count for the plutonium-oxide. Some heat source support work was also done as evidenced by curium-244 according to the Technical Manual MD-10050. Radioisotopes of concern and their compounds are: [288] [289] [290]

plutonium-238 dioxide
plutonium-238 compounds and mixtures (fluorides, molybdenum, chlorides, etc.)
curium-244
other possible radionuclides

1) Plutonium-238 was the major radionuclide of concern. All others are a distant second.[291]

c. Decontaminated 1983-1985. [292]

3.2.15 Room R-133

This room was used for a variety of programs as discussed below.

a. (1948 - 1954) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried. [293][294]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [295]

silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[296]

b. (1951 - 1953) This room is used for the reduction of actinium-227 from the precipitate in the old cave. Radioisotopes of concern and their compounds are: [297 298 299 300 301]

actinium-227	actinium nitrate
actinium oxide	actinium oxalate
radium-226	thorium-228,229,230
actinium fluoride	actinium iodide
actinium-227 daughters	

1) Actinium-227 was the major radionuclide of concern with actinium-227 daughters being a close second. Both radium-226 and thorium-228 are a distant third.[302]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[303] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [304 305]

4) See Appendix B.

c. (1956 - 1958) Ionium Work - Starting in 1956 a major effort was underway to separate Th-230 (Ionium) from "airport cake," a raffinate produced by an extraction process of uranium. The "airport cake" was the similar to the Cotter Concentrate used in the 1970's except that it had fewer uranium isotopes and thorium daughter isotopes. Radioisotopes of concern and their compounds are:[306 307 308]

uranium-234,235,238	thorium-230,232
protactinium-231	thorium-230,232 daughters

1) Thorium-230 was the major radionuclide of concern with all others a distant second.[309]

d. (1965 - 1978) This was an analytical lab supporting the heat source program. Radioisotopes of concern and their compounds were: [310 311 312]

plutonium-238 dioxide
plutonium-238 compounds and mixtures (fluorides, molybdenum, chlorides, etc.)
curium-244
other possible radionuclides

1) Plutonium-238 was the major radionuclide of concern. All others are a distant second.[313]

3.2.16 Room R-134 This room had two major programs:

a. This area was a cold lab up to 1983. [314]

b. (1986 - PRESENT) This room is an analytical lab used to analyze various aspects of tritium and deuterium gas and metal tritides and deuterides. The primary means of analysis are various spectrometric procedures such as thermal probe mass and Fourier transform infrared spectrometry. It was not until 1988 that radioisotopes were brought into the lab. Radioisotopes of concern and their compounds are: [315 316]

tritium uranium-238 uranium tritide

Note: Very small amounts of these isotopes.

1) Tritium is the major radionuclide of concern with uranium-238 being second.[317]

3.2.17 Room R-137

This room was used for a variety of programs as discussed below.

a. (1951 - 1953) This room is used for the reduction of actinium-227 from the precipitate in the old cave. Radioisotopes of concern and their compounds are: [318 319 320 321 322]

actinium-227 actinium nitrate
actinium oxide actinium oxalate

radium-226
actinium fluoride
actinium-227 daughters
thorium-228,229,230
actinium iodide

1) Actinium-227 was the major radionuclide of concern with actinium-227 daughters being a close second. Both radium-226 and thorium-228 are a distant third.[323]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[324] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [325] [326]

4) No "hot work" was done since decontamination was performed.[327]

3.2.18 Room R-140 This room had two major functions:

a. (1950's to the late 1960's) - Early programs consisted of analytical support for the work in R-120 and other production and development areas in R Building. There was an emissions spectrograph using a carbon arc built into a glovebox. Vaporization of all samples results in possibility for uptakes. Radioisotopes of concern and their compounds are the following: [328]

thorium-228,230,232
plutonium-238,239
cesium-137
actinium-227
strontium-90
uranium-234,235,238
polonium-208,209,210
protactinium-231
radium-223,224,226

1) Polonium-210, protactinium-231, radium-226 are equally important with plutonium-238 being a secondary concern.[329]

2) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [330][331]

b. (The late 1960's to the present) - Renovation work was done making ready for the second analytical program.[332] Analysis of plutonium compounds, alloys, and mixtures along with related radionuclide compounds were studied by chemical analysis and emission spectroscopy. A variety of solutions of oxide samples were commonly prepared for these analyses. Vaporization of the compounds from arcing could be the source of some small diameter particulate. [333] [334]

plutonium-238,239,240,241	plutonium nitrates
plutonium alloys and mixtures	
americium-241	actinium-227

1) Plutonium-238 was the major radionuclide of concern with americium-241 and actinium-227 equally being a secondary concern.[335]

2) Incident - (Pu-238 - 9/27/74)[336]

3.2.19 Room R-142

This room was used for a variety of programs which are discussed below.

a. (1949 - 1953) Radium-Actinium Separation - Radium bromide-226 was off-site irradiated to produce actinium-227 and then a separation process was performed to obtain the desired Ac-227. This was a pilot program for the work done in the Old Cave (SW-19). Radioisotopes of concern and their compounds are: [337]

radium-226	radium carbonate
actinium-227	radium nitrate
radium bromide	actinium oxalate
actinium fluoride	potassium-40
barium nitrate	radon and daughters
thorium-228,229,230	polonium-208,209,210

1) Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a close second. The polonium-208, 209, 210 are all a distant third.[338]

2) Incident - (Radium - 5/4/50)[339]

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [340341]

b. (1956 - 1969) A program was conducted to develop methods to reduce the fissile material content in solutions at both Hanford and Oak Ridge. An optical emissions spectrometer using a carbon arc would vaporize samples of plutonium-238,239 dioxide for analysis. Radioisotopes of concern and their compounds are: [342 343 344]

plutonium-238,239	uranium-234,235,238 (natural uranium)
protactinium-231	thorium-230
thorium-230 daughters	

1) Plutonium-239 was the major radionuclide of concern with uranium-234 being the secondary concern.[345 346]

c. (1966 - 1979) This lab provided support for the radioisotopic fuels program. An optical emissions spectrometer using a carbon arc would vaporize samples of plutonium-238,239 dioxide for analysis. Radioisotopes of concern and their compounds are: [347]

plutonium-238,239 dioxide

1) Emphasis changed to plutonium-238 as the major radionuclide of concern with plutonium-239 being secondary.

3.2.20 Rooms R-143 and 144

These rooms have several functions as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [348]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [349]

aluminum chloride	bismuth chloride

silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[350]

b. (1955) These rooms were decontaminated and made a part of R-142.[351]

c. (1972 - 1976) This was the room where the fabrication of the PMC heat source capsules was completed. In PP-144, 147, and 148 the plutonium-238 particles were coated with molybdenum and formed into disks. The PMC disks were encapsulated in R-143 and used for the Pioneer, Viking, and other such heat source programs. Radioisotopes of concern and their compounds are: [352] [353]

plutonium-238 dioxide (fuel forms)

d. This area was D&D'd in 1979-1981. [354]

3.2.21 Rooms R-145 and 147

These rooms were used for a variety of programs including separation programs, heat source programs, and heat source disassembly .

a. (1949 - 1954) This area was used for the initial R&D work for the separation of radium-226 from the K-65 ore. This radium-226 was then irradiated off-site to make the actinium-227. The room was also used to reduce the precipitate from the old cave processing. This room was also used to store crucibles from the reduction of actinium-227. They were stored in a fumehood in R-145. Radionuclide of concern is:[355] [356] [357] [358]

actinium-227	actinium oxalate
actinium oxide	actinium nitrate
radium-226	thorium-228,229,230
barium/radium	barium/radium carbonate[359]

1) Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a close second. [360]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[361] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [362363]

b. (1955 - 1956) Procedures were developed in R-167 to separate protactinium-231 from residues (referred to as raffinates) of previous uranium processing called "Sperry cake." The process was done in both R-145 and also in HH-5 where the separation was done on a larger scale. Radioisotopes of concern were: [364 365 366]

iron-59	aluminum-26	calcium-45
cobalt-60	protactinium-231	copper-65

1) Protactinium-231 was the major radionuclide of concern with all others being a distant second.[367]

2) A memo on 3/22/56 confirmed that Pa-231 work was being done in Room R-145. [368]

c. (1956 - 1959) Chemistry studies of reactor fuels were conducted in this laboratory. Plutonium compounds were studied in thermal processes. Radioisotopes of concern were:[369 370]

plutonium-239 americium-241.

1) Plutonium-239 is the major radionuclide of concern with americium-241 being a distant second.[371]

d. (1960 - 1962) See Appendix B for ranking.

e. (1968 - 1975) This room was used for the Heat Source Program where plutonium molybdenum shards (PMC) were hot pressed into disks and machined to required dimension. This room was also used for the hot pressing of the plutonium dioxide shards into spheres for the Pressed

Plutonium Oxide (PPO) program. Compatibility studies involving assembly and disassembly of heat sources units and "hot" metalographic analysis. Container welding was also done in this area. Radioisotopes of concern are: [372 373 374]

plutonium-238,239 plutonium dioxide
plutonium coated particles, cermet, shards)
uranium-234,235,238

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second and uranium-234 being a third.[375]

2) Incident - (Pu-238, 5/11/61, 6/5/62)[376]

3) Incident - (Pu-238, Pu-239, U-234, 8/26/65)[377]

4) This area was decontaminated from 1979-1981.[378 379]

f. (1982 - PRESENT) These rooms were used for thermal analysis of pyrophoric materials. No radionuclides are used in this area. [380]

3.2.22 Room R-149, also support room R-148

Three phases of work with two renovation programs separating them.

a. (1949 - 1954) These rooms were used for the reduction of actinium-227 compounds from R-145,147 which was part of the old cave work. It was also used for other R&D programs and separation work. Radioisotopes of concern and their compounds are: [381 382 383 384]

actinium-227
actinium oxide
thorium-228,229,230
polonium-208 <---[385]
barium/radium
radium-226
actinium nitrate
protactinium-231
actinium oxalate
barium/radium carbonate[386]

1) Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a distant second because of it being a reduction process. [387]

2) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [388389]

b. (1954 - 1958) Procedures were developed to separate protactinium-231 from residues of previous uranium processing called "Sperry cake." Radioisotopes of concern were: [390 391]

iron-59	aluminum-26
calcium-45	cobalt-60
protactinium-231	copper-65.

1) Protactinium-231 was the major radionuclide of concern with all others being a distant second.[392]

2) (3/22/56) A memo confirming the separation of Pa-231 as the primary goal of this program. [393]

c. In the early 1960's decontamination work was done which made ready for the heat source and the U-234 separation program work. Heat source welding was also done in this area. [394]

d. (1960 - 1968) - Research and development work was done for the Pu-238 heat source program. A whole line of gloveboxes was used for all processes of heat sources research and production. Welding operations for encapsulation in support of the heat source program was done in room R-137. The plutonium-238 used was in the form of Pu-238 metal and Pu-238 dioxide cermets which came from SM-35, 35A, 39 and 60. Radioisotopes of concern and their compounds are: [395 396]

plutonium-238

1) Incidents - (Pu-238, 5/19/60, 6/2/60, 1/16/63, 4/19/65)[397]

a) The incident of 6/2/60 resulted in crawl space contamination.[398]

2) (1961 - 1968) Various SNAP programs and other heat source programs were all supported from this room. All radioisotopes were encapsulated and of no concern to this study. [399]

e. (1970 - 1980) U-234 Separation - U-234 separation from aged Pu-238 (approximately 20 years) was done. A homogeneous oxalate precipitation technique was used along with two cycles of ion exchange on resins. The U-234 was sold to Oak Ridge National Laboratories. The following compounds and isotopes were encountered.[400 401 402 403]

plutonium oxalate--------{ $Pu(C_2O_4)_4$ }
plutonium hexanitrate
plutonium nitrate
thorium-230
promethium-146-->149
uranium-234 oxide
plutonium-238 metal
plutonium-238 dioxide
plutonium/zirconium alloys
nitrate solutions of Pu-238 and U-234

1) Plutonium-238 was the major radionuclide of concern with uranium-234 being secondary.[404]

f. This room was renovated in 1985-1988. [405 406] This area was no longer used as a "hot" area. Analytical equipment was moved in to support "cold" analyses.[407]

3.2.23 Room R-151

This room had a variety of programs as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [408 409]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [410]

silver/polonium
tellurium/polonium
polonium-210
bismuth-210
polonium nitrate
polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[411]

b. (1958 - 1983) Analytical chemistry lab supporting most Pu-238 and Pu-239 work including the Heat Source Program. Aqueous wastes consisted of plutonium-bearing acidic solutions which included nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, hydrochloric and sulfuric acid, and sodium hydroxide were used in leaching and dissolution processes. Radioisotopes of concern and their compounds are: [412 413 414 415]

plutonium-238,239 metal	plutonium-238,239 dioxide
neptunium-237	plutonium hydroxide
plutonium nitrate	plutonium oxalate
plutonium sulfate	plutonium chloride
plutonium fluoride	

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary.[416]

2) EDTA, citrates, ion exchange resins, and other complexing agents were used which acted like chelating agents, causing rapid removal of the plutonium from the uptake compartment.[417]

3) Incident - (Pu-238, 2/11/74)[418]

3.2.24 Room R-152

This room was used for a variety of programs as discussed below.

a. (1948 - 1954) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [419 420]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [421]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[422]

b. (1951 - 1953) This room is used for the reduction of actinium-227 from the precipitate in the old cave. Radioisotopes of concern and their compounds are: [423 424 425 426 427]

actinium-227	actinium nitrate
actinium oxide	actinium oxalate
radium-226	thorium-228,229,230
actinium fluoride	actinium iodide
actinium-227 daughters	

1) Actinium-227 was the major radionuclide of concern with actinium-227 daughters being a close second. Both radium-226 and thorium-228 are a distant third.[428]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[429] Previous discussions/interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [430 431]

4) See Appendix B.

3.2.25 Room R-155

This room was used for a variety of programs as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [432 433]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [434]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[435]

b. (1956-1969) Research lab for the support of the reactor fuels programs conducted in R-159. The Electron Microprobe was used to help characterize materials through a vaporization technique. The plutonium reactor fuel group explored a variety of uranium and later Pu-239 metal and Pu-239 dioxide compounds for possible application into the fuel program. Also used were Np-237, Am-241, Cm-244 in the metal and oxide form. At least 89 ternary compounds, especially those using cerium, and a multitude of binary compounds/alloys were investigated. Also explored were zirconium compounds. Radioisotopes of concern and their compounds are: [436 437 438 439]

plutonium-239	uranium-235,238
neptunium-237	americium-241
curium-244	

1) Uranium-238 was the major radionuclide of concern with plutonium-239 a secondary concern.[440]

2) Some of the elements combined with the above radionuclides were:

cerium	boron	nickel	cobalt
silicon	aluminum	magnesium	zinc
manganese	copper	gallium	lead
carbon	bismuth	rare earths	zirconium
lithium/beryllium			

Note: The samples used in analyses were small in quantity and activity.

3) This room was renovated in the early 1980's and has not been used since for any radionuclide operation. [441]

Note: R-157, 158, 159, 160, 161 were formerly separate rooms as discussed under the specific room number. However, in the spring of 1955 these rooms were combined into one large room R-159.

3.2.26 Room R-159

This room was used for a variety of programs as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [442] [443]

1) Radioisotopic compounds or alloys resulting from the irradiation process and the R&D work includes: [444]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[445]

b. (1956-1969) The plutonium reactor fuel group explored a variety of uranium and later Pu-239 metal and Pu-239 dioxide compounds for possible application into the fuel program. Also used were Np-237, Am-241, Cm-244 in the metal and oxide form. At least 89 ternary compounds, especially those using cerium, and a multitude of binary compounds/alloys were investigated. Also explored were zirconium compounds. These metal alloys were measured for physical properties including phase diagrams of molten plutonium alloys as potential fuels. Radioisotopes of concern and their compounds are: [446] [447] [448] [449]

plutonium-239	uranium-235,238
neptunium-237	americium-241
curium-244	

1) Uranium-238 was the major radionuclide of concern with plutonium-239 a secondary concern.[450]

2) Some of the elements combined with the above radionuclides were:

cerium	boron	nickel	cobalt
silicon	aluminum	magnesium	zinc
manganese	copper	gallium	lead
carbon	bismuth	rare earths	zirconium
lithium-beryllium			

3) This program also designed the first glass containing plutonium-239 dioxide as a constituent. [451]

4) This room was renovated from 1985 - 1988 and became room 159 A&B. R-159 A is an analytical support room for "cold" analysis only. 159 B is the calcium isotope research room for "cold" analysis only.[452 453 454 455]

3.2.27 Room R-160

This room is used for a variety of programs as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [456 457]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [458]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[459]

b. (1951 - 1953) This room was part of the actinium area. It contained the primary filter for the hoods in R-161.[460 461 462 463]

actinium-227	actinium oxalate

actinium oxide	actinium nitrate
thorium-228,229,230	radium-226

1) Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a close second. [464]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[465] Previous discussions/interviews indicated that only actinium-227 and the related compounds were there.

3) Incident - a chemist wearing an airline mask and protective clothing was found contaminated from an alpha source. The actual source is unknown.[466]

4) See Appendix B.

d. Decontamination work was begun in 1954 and was continuing in 1955. It was difficult to get air contamination levels low enough to reclassify the room. A new concrete floor was put in, several scrubbings, etc. [467]

3.2.28 Room R-161

This room was used for a variety of programs as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [468] [469]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [470]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[471]

b. (1951 - 1953) This room was used for the purification of actinium resulting from the old cave work. It was major lab used for a variety of chemical analysis studies. Radioisotopes of concern and their compounds are: [472 473 474 475 476]

actinium-227	radium-226
actinium oxide	actinium nitrate
thorium-228,229,230	polonium-208,209,210

1) Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a close second. [477]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[478] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Health Physics Report mentioned waste solutions and resins which were high gamma emitters. [479]

4) R-161 was mentioned in several Health Physics Monthly Reports for actinium work. There is also mention of beta/gamma besides the alpha contamination. Only MLM-821 (2/28/53) will be listed for a reference as a typical example for this time period. [480]

5) See Appendix B.

3.2.29 Room R-162

This was an analytical lab used primarily for cold work supporting several programs in R Building. However, three exceptions are discussed below where radionuclides were used in analysis.

a. (1948 - 1951) Decontamination of Bismuth Phosphate Materials - Five shipments of bismuth phosphate materials were received from Hanford which included crib materials and samples from two other stages of the process in the plutonium separation program from irradiated

uranium-238. Purex and Tributyl Phosphate materials from Oak Ridge National Laboratory were also received from a similar program and contained the same radionuclides. A study was done to determine the best procedure for removing the radioactive contaminates. Radioisotopes of concern are: [481] [482] [483]

ruthenium-106	cesium-137
tellurium-121,127	zirconium-93,95
strontium-90	plutonium-238,239
antimony-125	niobium-94
yttrium-88,90,91	rare earths (especially cerium)

1) All were present and were of equal concern.[484]

2) This was the same as the program in R-167 and R-168 except that this room received the residue from that process and monitored for remaining activity, developed methodology for further decontamination for that study. [485]

b. (1950) Separation work with plutonium-238 and 239 was done for only a short time with some materials source from Hanford. Radioisotopes of concern are: [486]

plutonium-238,239

1) Both were present and were of equal concern.[487]

c. 1958 - 1959) This analytical lab was used for studies in uranium-233, 235 and 238. No production or processing work was done other than analytical work. Radionuclides of concern are: [488] [489]

uranium-233,235,238

1) All were present and were of equal concern.[490]

3.2.30 Room R-166

(1961 - 1968) This was a radiochemical analytical lab for bench top work using polonium-210. Radionuclides of concern are: [491]

polonium-210

3.2.31 Room R-167

(1949-1987) Research and development of separation techniques and characterization studies for various radioisotopes were done over the years. The specific programs are discussed below.

a. (1948 - 1951) Decontamination of Bismuth Phosphate Materials -Five shipments of bismuth phosphate materials were received from Hanford which included crib materials and samples from two other stages of the process in the plutonium separation program from irradiated uranium-238. Purex and Tributyl Phosphate materials from Oak Ridge National Laboratory were also received from a similar program and contained the same radionuclides. A study was done to determine the best procedure for removing the radioactive contaminates. The actual production program was performed in SW-13 (SW-1B) the following year. Radioisotopes of concern are: [492] [493] [494]

ruthenium-106	cesium-137
tellurium-121,127	zirconium-93,95
strontium-90	plutonium-238,239
yttrium-88,90,91	antimony-125
rare earths (especially cerium)	niobium-94

1) All were present and were of equal concern.[495]

2) It was a ferrous sulfide process and used adsorption and/or coprecipitation followed by clarification of fission products with ferrous sulfide, ferrous hydroxide and calcium phosphate.

b. (1949 - 1952) A bench-scale process for the separation and recovery of Pu-239 was made by neutron irradiation of uranium metal in production reactors at other DOE sites. Fission products of concern are:

iodine-131	cesium-137
cerium-144	strontium-90
technetium-99	xenon-133
yttrium-88,90,91	plutonium-239
uranium-234,235,238	

1) Plutonium-239 was the major radionuclide of concern with natural uranium (234,235,238) being secondary.

c. (1954 - 1955) Procedures were developed to separate protactinium-231 from residues (referred to as raffinates) of previous uranium processing called "Sperry cake." The actual process was done in R-145 and in HH-5. Radioisotopes of concern were: [496] [497]

iron-55,59	aluminum-26
calcium-45	cobalt-60
protactinium-231	copper-65

1) Protactinium-231 was the major radionuclide of concern with all others being a distant second.[498]

2) This work was similar to that done in R-145 and R-147.[499]

d. (1955 - 1957) See Appendix B for ranking.

e. (1958) Uranium-233 and daughters were received and divided into small lots for research use. No description of actual lab procedures were discussed for this lab. Radioisotopes of concern and their compounds are:[500]

uranium-233	thorium-229,230,232

1) Uranium-233 was the major radionuclide of concern with all others being a distant second.[501]

f. (1960 - 1962) This room was used for the isotopic separation of strontium-90 and yttrium-90 through a variety of techniques. Radioisotopes of concern are: [502] [503]

strontium-90	yttrium-88,90,91
protactinium-231	

1) Strontium-90 was the major radionuclide of concern with yttrium-90 being a secondary concern.[504]

g. (1956 - 1987) This lab was used for additional work with the isotopic separation of protactinium-231,233 giving the purest possible end

product. Characterization and analysis of cerium 141 and 144, americium-241 and protactinium-231 was also done. Radioisotopes of concern are: [505] [506] [507]

protactinium-231,233	cerium-141,144
americium-241	curium-244
uranium-233	thorium-230,232
radium-226	thallium-208

1) Protactinium-231 was the major radionuclide of concern with all others being a close second. Minimal quantities were used and the risk was considered low for all radionuclides.[508]

2) A memo on 3/22/56 discusses the Pa-231 work in R-167.[509]

3) Incident - (Cm-244, 7/8/83)[510]

3.2.32 Room R-168

(1958) This room was used for the study of physical properties of aqueous uranium-238 salts such as uranium fluoride and uranium oxide. After this function it was never again used for radionuclide work. Radioisotopes of concern and their compounds are: [511]

uranium-238 fluoride	uranium-238 oxide

3.2.33 Room R-169 (A,B,C)

This room also had two major programs.

a. (1960 - 1980) - This area was used as a radio-counting room to determine the activities of the various radioisotopes used in R Building. Radioisotopes of concern are: [512]

thorium-230,232	uranium-234,235,238
plutonium-238,239	polonium-208,209,210
cesium-137	protactinium-231
actinium-227	radium-223,224,226

1) Polonium-210 was the major radionuclide of concern with plutonium-238 being secondary.[513]

2) These are low level analytical samples.

b. (1980 - PRESENT) The isotopic separation of uranium radioisotopes, especially U-235 and U-238, using a chloride complex separation technique has been conducted. Much work also was done on promethium-147. Currently ion exchange resins are being used with calcium-45 for calcium separation analysis. [514515]

uranium-235,238	promethium-147
calcium-45	

1) Uranium-238 was the major radionuclide of concern with uranium-235 being secondary.[516]

3.2.34 Room R-170

(1960 - 1964) This room was used for mass spectrometry using uranium-238 and calcium. This was also used as a health physics counting room. After 1964 this room was a cold laboratory. Radioisotopes of concern and their compounds are: [517]

uranium-238	calcium-45

1) Uranium-238 was the major radionuclide of concern.[518]

3.2.35 Rooms R-171, 172

These rooms housed a variety of programs which are as follows:

a. (1949 - 1954) This room was used in support of the radium-226 and actinium-227 work done in SW-19 (old cave). See rooms R-145, 147, and 149. Radionuclide of concern is: [519 520 521 522 523]

actinium-227	radium-223,224,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium-227 daughters	radium daughters

1) Actinium-227 was the major radionuclide of concern with radium-226 and thorium-228 both being a close second. All compounds of actinium-227 were highly soluble.[524]

2) Incident - (Radium, 6/27/51)[525]

b. (1955 - 1960) This area was a cold laboratory doing differential thermal analysis for phase diagram work. There are no radionuclides of concern.[526] [527]

c. (1961 - 1963) This room was used for research and development involving welding and brazing containers. Radioisotopes of concern and their compounds are: [528]

uranium-235,238

1) See Appendix B for ranking.

d. Mass Spectroscopy Lab - (1965 - 1991) These rooms were used for the analysis of Pu-238 compounds, alloys, and mixtures. A variety of solutions of oxide samples were commonly prepared for these analyses. Vaporization of the compounds from arcing could be the source of small diameter particulate. [529] [530]

plutonium-238,239,240,241 (compounds and mixtures/alloys)
americium-241 actinium-227 radium-226

1) Plutonium-238 was the major radionuclide of concern with all others being a distant second.[531]

3.2.36 Room R-174, 176

(1970 - PRESENT) Analytical support laboratory for cold work. The tritium incident, indicating the presence of tritium, would have been a rare occurrence. Radioisotope of concern is:[532]

tritium

a. Incident - (Tritium, 9/8/78)[533]

3.2.37 Room R-197A

(1970 - PRESENT) This room is used for the packaging of radionuclides for shipment. Radioisotopes of concern are: [534] [535]

plutonium-238,239
curium-244
plutonium dioxide

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary.[536]

3.2.38 Room R-198

(1956 - 1982) This room was called the Decontamination "A" lab and was used to clean contaminated equipment from R-Building including respirators. Radioisotopes of concern and their compounds are: [537]

plutonium-238,239
uranium-234,235,238
lithium tritide
polonium-210
plutonium oxide
uranium tritide
americium-241
promethium-146-->149
tritium
plutonium fluoride
polonium fluoride
tritiated organics
plutonium nitrate
curium-244
actinium-227
neptunium-237

a. Plutonium-238 was the major radionuclide of concern with actinium-227 being a secondary concern.[538]

b. This room was decontaminated from 1985-1990. [539]

3.2.39 The crawl space above R Building has been contaminated with many of the isotopes used and studied in this building. In the latter 1970's/early 1980's the loose material was covered/encapsulated with plastic.[540] Some believe the radioisotopic contamination was removed in the crawl space above each lab which was renovated. The crawl space above R-140 was never decontaminated. Radioisotopes of concern and their compounds are:[541] [542]

plutonium-238,239
actinium-227
radium-226
polonium-210

thorium-228,229,230

a. Plutonium-238 was the major radionuclide of concern with actinium-227 being a secondary concern and radium-226 being tertiary.[543]

3.2.40 R-Corr 5

This was the operational access corridor for the hotside of R-Building. This area was decontaminated from 1985 - 1988. [544]Incident - (Ac-227, 1/31/89)[545]

3.2.41 See Appendix B A for R Building rooms **R-108, 111, 112, 120, 127, 129, 130, 133, 137, 145, 149, 152, 160, 161, 167, 171, 172**.

4. SM BUILDING

4.1 OVERVIEW

Special Metallurgical (SM) Building was constructed in 1960 and became operational in 1961. It was originally designed for the reception of a liquid plutonium nitrate mixture from the Savannah River Plant (SRP) which was used in a variety of programs, mainly the heat source projects. SM Building also housed recovery processing, waste treatment facilities, research and development, and analytical laboratory support activities.

Solutions of plutonium nitrate mixture [$Pu(NO_3)_4$] were received for use in SM Building until about 1964 when powdered plutonium dioxide [PuO_2] was received. The mixture shown below accounted for 99.9% plutonium received from SRP according to MLM-1564 (AEC Research and Development Report), page 31.

1E-4% Pu-236
80.2% Pu-238
15.9% Pu-239
3.0% Pu-240
0.6% Pu-241
0.1% Pu-242

Note: MLM-1564 also makes reference to other mixtures.

All references to plutonium-238 was of the mixture ratio identified in the introduction above. This mixture also included trace amounts of americium-241 and neptunium-237. [546]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

Extremely high neutron flux from Pu-238 in its association with water and fluorine compounds in SM Building will necessitate its consideration and perhaps inclusion in the internal dose assessments.

The term "high-fired" is sometimes used which implies that the plutonium compound has been heated in a plasma torch process such that the lung solubility class is definitely a "Y" or perhaps even a "YY." The term "non-high-fired" implies an absence of such heating and in extreme cases, where indicated, a lung solubility class of "W" or even a "D" may exist where there is high solubility.

Although a multitude of incidents occurred in the SM Building, none were listed because they were all from plutonium-238. It was already mentioned in the introduction to the document that only radioisotopes, other than plutonium-238, would be listed for PP and SM Buildings.

A ranking of radionuclides according to the degree of concern for uptake and internal dosimetry consideration, as was done in HH and R Building, was NOT done in PP Building since all radionuclides were plutonium. The mixture of plutonium isotopes as shown above will dictate the ranking of radionuclides to be concerned with in all incidents and internal dosimetry dose calculations.

Table 4 is a summary of rooms, dates, and radioisotopes for SM Building.

Table 4 - SM BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE 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, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, 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, $Pu(C_2O_4)_4$, See Appendix B	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, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, Pu(OH), PuF_4, $PuCl_4$	1961-1965
	$Pu(NO_3)_4$, $Pu(NO_3)_4.5H_2O$, PuO_2, $PuO_2.Xh_2O$, $Pu(C_2O_4)_4$, Pu(OH)	1965-1967
SM-34	$Pu(NO_3)_4$, 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, $Np(SO_4)_2$, PuF_4, $Np(NO_3)_4$, UO_2, $U(SO_4)_2$, UF_4	1963-1967
SM-35,35A	$Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, 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, $PuO_2.Xh_2O$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1965-1967
SM-38 (SM-1)	$Pu(NO_3)_4$, 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, $Np(SO_4)_2$, PuF_4, $Np(NO_3)_4$, UO_2, $U(SO_4)_2$, UF_4 $Pu(NO_3)_4.5H_2O$,	1963-1967
	$Pu(NO_3)_6$, PuO_2, $Pu(C_2O_4)_4$, $Pu(O_2)$	1965-1970
SM-39	$Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, 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, $PuO_2.Xh_2O$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1965-1967

Table 4 - SM BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
SM-58, 59(A&B)	$Pu(NO_3)_4$, 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, $Np(SO_4)_2$, PuF_4, $Np(NO_3)_4$, 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

Note: All references to plutonium was of the mixture ratio identified in the introduction above. This mixture also included trace amounts of americium-241, neptunium-237, and uranium-234. [547]

4.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS

4.2.1 Room SM-1: This room had a double function.

a. (1961 - 1962) This was the original Pu-238 liquid waste treatment facility for both high and low risk waste water. The high-risk aqueous wastes were processed for possible plutonium recovery but this procedure was terminated in late 1962. The plutonium aqueous high-risk waste recovery operations was moved into the processing area of SM Building. The low-risk waste water was treated similar to the processes used in WD Building. The low-risk waste water was precipitated, coagulated, filtered, and the sludge is solidified so it can be shipped off-site for disposal. The supernatant from the clarifier was filtered, neutralized to the proper Ph and released into a drainage ditch. Radioisotopes of concern and their compounds are:

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide
plutonium fluoride

b. (1962 - 1967) Removal of the high-risk waste treatment equipment enabled the establishment of a support lab for the operations in SM Building. The treatment of low-risk waste as discussed above and the preparation of off site packaging for low-risk waste precipitate and high-risk liquid waste were all done in this area. Radioisotopes of concern and their compounds are:

plutonium nitrate pentahydrate
plutonium hexanitrate plutonium nitrate
plutonium dioxide plutonium oxide hydrate
(high-fired and non-high-fired) plutonium hydroxide
plutonium oxide hydrate and oxalate
thorium nitrate thorium hydroxide
thorium dioxide thorium oxide hydrate

4.2.2 Room SM-2

(1961 - 1967) Maintenance lab where tools are used for opening containers with radioactive materials. Radioisotopes of concern and their compounds are:

plutonium dioxide.

4.2.3 Room SM-3, 10

(1961-1967) These were special research and development labs where plutonium in various sizes (sub micron to over 20 microns) were used. The compounds of plutonium were diverse as is illustrated by the listing which follows. The solubility states also varied from a very soluble class "w," almost a class "d," up to the traditional class "Y" for the plutonium oxides. Radioisotopes of concern and their compounds are:

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate

a. See Appendix B.

4.2.4 Room 20

(1961 - 1967) This was a measurement and counting lab and contained only sealed sources which emitted neutron and gamma radiation. Only external dose would be acquired in this room. There are no radionuclides of concern.

4.2.5 Room SM-21

(1961 - 1967) This room had two functions which were carried on simultaneously. They are as follows:

a. This room was an analytical lab for physical measurements and studies of plutonium and related heat source activities. Thorium-232 was often used to simulate plutonium because the physical characteristics are similar. Complexing agents such as EDTA and citrates were used which caused rapid depletion of plutonium from the body. They acted like chelating agents. Radioisotopes of concern and their compounds are: [548]

plutonium dioxide thorium-232 dioxide

b. This room also was operated as a storage area for radioactive materials.

4.2.6 Room SM-26

(1961 - 1968) The SM Building vacuum system is contained in this room. This system enabled equipment housed within gloveboxes to operate under vacuum conditions when procedures dictated that environment. Radioisotopes of concern and their compounds are: [549]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide
plutonium fluoride

4.2.7 Room SM-27, 28

These were research and development rooms supporting the activities of SM-35 and 39. Two programs were supported by SM-27,28 which are as follows:[550]

a. (1961 - 1965) Plutonium Metal Production - A process which converted the plutonium nitrate into metallic plutonium. Metallic plutonium was used in the SNAP (Space Nuclear Auxiliary Power) units during the early 1960's. This process was terminated in the mid-1960's in favor of the microsphere process which had a more stable product and was less susceptible to contamination. The steps in the process resulted in the following possible exposures: [551]

plutonium oxalate
plutonium nitrate pentahydrate
plutonium hexanitrate
plutonium dioxide
(high fired and non)
plutonium tetrafluoride--(high neutron flux)
plutonium (elemental)
plutonium tetrachloride
plutonium nitrate
plutonium oxide hydrate
plutonium hydroxide

1) The airborne plutonium particulate was of varied sizes (submicron to 20 μm) with much of it being less than 1.0 μm.

2) Highly soluble, low heat non-oxide compounds resulted from the first several steps in the process. This equates to a lung solubility class of "W" or even a "D." Only small quantities of plutonium dioxide (Class Y) were inadvertently formed as a result of the breakdown of plutonium oxalate by its own heat generation. The lung solubility was on the W side of the class Y for the plutonium oxides since little sintering was involved. Midway through the process a reduction bomb was used with the charge attaining 1,200°C. Metallic plutonium resulted with the residue going to waste or recovery streams. It is concluded that there could have been small quantities of class Y materials arising from this program. [552 553]

3) In addition to the traditional plutonium concerns there is the extremely high neutron flux resulting from plutonium tetrafluoride. This must not be overlooked as a dosimetry calculation for plutonium incidents from 1963 - 1965.

b. (1965 - 1967) Microsphere Process - The "microsphere" process was developed which produced plutonium dioxide spheres with a diameter of 50 to 250 microns. This process circumvented the neutron problem with PuF_4 by using plutonium dioxide. The material went through several steps including being crushed, sieved, sintered, and then entered a plasma torch process forming "microspheres." The ceramic spheres were chemically and thermally stable and essentially free from loose contamination. The steps in the process resulted in the following possible exposures: [554 555]

plutonium dioxide
plutonium hydroxide
plutonium nitrate pentahydrate
plutonium oxalate
plutonium oxide hydrate
plutonium nitrate

1) There was a quantity of very fine particulate material produced from the crushing and sizing process. Much airborne material was submicron in size. [556]

2) The plasma torch process was used to make the microspheres. Significant quantities of plutonium dioxide were vaporized from this process which produced extremely fine particulates. [557]

3) The lung solubility class was varied since there would be class D or W for the first few steps where nitrates and oxalate are involved, a weak class Y where oxides are formed but no heating, and then definite class Y after the heating processes since the plutonium dioxide was much less soluble in tissue fluids after sintering. [558]

4.2.8 Room SM-34

(1963 - 1967) This was a recovery process room where solid and liquid recoverable wastes were processed. Aqueous wastes consisted of plutonium-bearing acidic solutions which included nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. These were accumulated in holding tanks in SM-1. Caustic wastes were generated when ammonium hydroxide was used to precipitate plutonium from the solution. The solutions contained nitrate, sulfate, and fluoride ions, and as such formed various compounds with the available plutonium, americium, neptunium and uranium. These waste compounds were minuscule in quantity, as compared to the plutonium dioxide. Recoverable aqueous wastes were sent back to the processing lines and the nonrecoverable wastes were treated in SM-1 as discussed above. Radioisotopes of concern and their compounds are: [559] [560]

plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

a. Solid waste processing consisted of washing and leaching of the glove box wastes with the aid of ultrasonic cleaning equipment. Combustible wastes generated in glove boxes were incinerated. Materials containing recoverable plutonium were dissolved in a mixture of nitric and hydrofluoric acid or underwent fusion with pyrosulfate. Glass fiber filters were dissolved in a hydrofluorinator and the acidic solutions containing plutonium were sent to the plutonium recovery process. The above list of radionuclide compounds were likely.

4.2.9 Rooms SM-35, 35A

These were the major rooms, along with SM-39, for the production processes in the SM Building. Two programs are discussed below: [561]

a. (1961 - 1965) Plutonium Metal Production - A process which converted the plutonium nitrate into metallic plutonium. Metallic plutonium was used in the SNAP (Space Nuclear Auxiliary Power) units during the early 1960's. This process was terminated in the mid-1960's in favor of the microsphere process which had a more stable product and was less susceptible to contamination. The steps in the process resulted in the following possible exposures: [562]

plutonium oxalate	plutonium hydroxide
plutonium nitrate pentahydrate	plutonium (elemental)
plutonium hexanitrate	plutonium nitrate
plutonium dioxide	plutonium oxide hydrate
(high fired and non)	plutonium tetrachloride

plutonium tetrafluoride--(high neutron flux)

1) The airborne plutonium particulate was of varied sizes (submicron to 20 μm) with much of it being less than 1.0 μm.

2) Highly soluble, low heat non-oxide compounds resulted from the first several steps in the process. This equates to a lung solubility class of "W" or even a "D." Only small quantities of plutonium dioxide (Class Y) was inadvertently formed as a result of the breakdown of plutonium oxalate by its own heat generation. The lung solubility was on the W side of the class Y for the plutonium oxides since little sintering was involved. Midway through the process a reduction bomb was used with the charge attaining 1,200°C. Metallic plutonium resulted with the residue going to waste or recovery streams. It is concluded that there could have been small quantities of class Y materials arising from this program. [563] [564]

3) In addition to the traditional plutonium concerns there is the extremely high neutron flux resulting from plutonium tetrafluoride. This must not be overlooked as a dosimetry calculation for plutonium incidents from 1963 - 1965.

b. (1965 - 1967) Microsphere Process - The "microsphere" process was developed which produced plutonium dioxide spheres with a diameter of 50 to 250 microns. This process circumvented the neutron problem with PuF_4 by using plutonium dioxide. The material went through several steps including being crushed, sieved, sintered, and then entered a plasma torch process forming "microspheres." The ceramic spheres were chemically and thermally stable and essentially free from loose contamination. The Microsphere Process did not terminate in 1967 but was moved to the PP Building where it continued. Radioisotopes of concern and their compounds are the following: [565] [566]

plutonium dioxide
plutonium hydroxide
plutonium nitrate pentahydrate
plutonium oxalate
plutonium oxide hydrate
plutonium nitrate

1) There was a quantity of very fine particulate material produced from the crushing and sizing process. Much airborne material was submicron in size. [567]

2) The plasma torch process was used to make the microspheres. Significant quantities of plutonium dioxide was vaporized from this process which produced extremely fine particulates. [568]

3) The lung solubility class was varied since there would be class D or W for the first few steps where nitrates and oxalate are involved, a weak class Y where oxides are formed but no heating, and then definite class Y after the heating processes since the plutonium dioxide was much less soluble in tissue fluids after sintering. [569]

4.2.10 Room SM-38

This room was used for two major functions as discussed below:

a. (1963 - 1967) Recovery process room where solid and liquid recoverable wastes were processed. Aqueous wastes consisted of plutonium-bearing acidic solutions which included nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. These were accumulated in holding tanks in SM-1. Caustic wastes were generated when ammonium hydroxide was used to precipitate plutonium from the

solution. The solutions contained nitrate, sulfate, and fluoride ions, and as such formed various compounds with the available plutonium, americium-241, neptunium-237 and uranium-234. These waste compounds were minuscule in quantity, as compared to the plutonium dioxide. Recoverable aqueous wastes were sent back to the processing lines and the nonrecoverable wastes were treated in SM-1 as discussed above. Radioisotopes of concern and their compounds are: [570] [571]

plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

1) Solid waste processing consisted of washing and leaching of the glove box wastes with the aid of ultrasonic cleaning equipment. Combustible wastes generated in glove boxes were incinerated. Materials containing recoverable plutonium were dissolved in a mixture of nitric and hydrofluoric acid or underwent fusion with pyrosulfate. Glass fiber filters were dissolved in a hydrofluorinator and the acidic solutions containing plutonium were sent to the plutonium recovery process. The above list of radionuclide compounds were likely.

b. (1965 - 1970) U-234 Separation - A pilot program was developed for the initial separation of U-234 <u>only</u> from aged Pu-238. A tri-butyl solvent extraction and ion exchange method was used. This was an isotope sold to Oak Ridge National Laboratory. The following compounds and isotopes were encountered. [572] [573] [574]

plutonium oxalate	plutonium-238 oxide
plutonium hexanitrate	plutonium nitrate
uranium oxide	

1) This whole process was moved to R-149 for the actual production.

4.2.11 Room SM-39

This was the major room, along with SM-35 and 35A, for the production processes in the SM Building. Two major programs are discussed below:[575]

a. (1961 - 1965) Plutonium Metal Production - A process which converted the plutonium nitrate into metallic plutonium. Metallic plutonium was used in the SNAP (Space Nuclear Auxiliary Power) units during the early 1960's. This process was terminated in the mid-1960's in favor of the microsphere process which had a more stable product and was less susceptible to contamination. The steps in the process resulted in the following possible exposures: [576]

plutonium oxalate	plutonium hydroxide
plutonium nitrate pentahydrate	plutonium (elemental)
plutonium hexanitrate	plutonium nitrate
plutonium dioxide	plutonium oxide hydrate
(high fired and non)	plutonium tetrachloride

plutonium tetrafluoride--(high neutron flux)

1) The airborne plutonium particulate was of varied sizes (submicron to 20 μm) with much of it being less than 1.0 μm.

2) Highly soluble, low heat non-oxide compounds resulted from the first several steps in the process. This equates to a lung solubility class of "W" or even a."D." Only small quantities of plutonium dioxide (Class Y) was inadvertently formed as a result of the breakdown of plutonium oxalate by its own heat generation. The lung solubility was on the W side of the class Y for the plutonium oxides since little sintering was involved. Midway through the process a reduction bomb was used with the charge attaining 1,200°C. Metallic plutonium resulted with the residue going to waste or recovery streams. It is concluded that there could have been small quantities of class Y materials arising from this program. [577] [578]

3) In addition to the traditional plutonium concerns there is the extremely high neutron flux resulting from plutonium tetrafluoride. This must not be overlooked as a dosimetry calculation for plutonium incidents from 1963 - 1965.

b. (1965 - 1967) Microsphere Process - The "microsphere" process was developed which produced plutonium dioxide spheres with a diameter of 50 to 250 microns. This process circumvented the neutron problem with PuF_4 by using plutonium dioxide. The material went through several steps including being crushed, sieved, sintered, and then entered a plasma torch process forming "microspheres." The ceramic spheres were chemically and thermally stable and essentially free from loose contamination. The Microsphere Process did not terminate in 1967 but was moved to the PP Building where it continued. Radioisotopes of concern and their compounds are the following: [579] [580]

plutonium dioxide
plutonium hydroxide
plutonium nitrate pentahydrate
plutonium oxalate
plutonium oxide hydrate
plutonium nitrate

1) There was a quantity of very fine particulate material produced from the crushing and sizing process. Much airborne material was submicron in size. [581]

2) The actual plasma torch process used to make the microspheres was not performed in these rooms but was located in SM-60. Significant quantities of plutonium dioxide was vaporized from this process which produced extremely fine particulates. [582]

3) The lung solubility class was varied since there would be class D or W for the first few steps where nitrates and oxalate are involved, a weak class Y where oxides are formed but no heating, and then definite class Y after the heating processes since the plutonium dioxide was much less soluble in tissue fluids after sintering. [583]

4.2.12 Rooms SM-58, 59A, and 59B

(1963 - 1967) These were recovery process rooms where solid and liquid recoverable wastes were processed. Aqueous wastes consisted of plutonium-bearing acidic solutions which included nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. These were accumulated in holding tanks in SM-1. Caustic wastes were generated when ammonium hydroxide was used to precipitate plutonium from the solution. The solutions contained nitrate, sulfate, and fluoride ions, and as such formed

various compounds with the available plutonium, americium-241, neptunium-237 and uranium-234. These waste compounds were minuscule in quantity, as compared to the plutonium dioxide. Recoverable aqueous wastes were sent back to the processing lines and the nonrecoverable wastes were treated in SM-1 as discussed above. Radioisotopes of concern and their compounds are: [584] [585]

plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

b. Solid waste processing consisted of washing and leaching of the glove box wastes with the aid of ultrasonic cleaning equipment. Combustible wastes generated in glove boxes were incinerated. Materials containing recoverable plutonium were dissolved in a mixture of nitric and hydrofluoric acid or underwent fusion with pyrosulfate. Glass fiber filters were dissolved in a hydrofluorinator and the acidic solutions containing plutonium were sent to the plutonium recovery process. The above list of radionuclide compounds were likely.

c. Room 59B was also used for waste treatment where some of the process discussed under SM-1 were done.

4.2.13 Room SM-60

(1965 - 1967) This room had only one important function and that was to perform the actual plasma torch process used to make the microspheres. Significant quantities of plutonium dioxide was vaporized from this process which produced extremely fine particulates. Most all particle size was submicron with a class "y" solubility. Radionuclide of concern is: [586]

plutonium dioxide

4.2.14 Rooms SM-61, 62

(1961 - 1967) These rooms were analytical labs for physical measurements and studies of plutonium and related heat source activities. Thorium-232

was often used to simulate plutonium because the physical characteristics are similar. Complexing agents such as EDTA and citrates were used which caused rapid depletion of plutonium from the body. They acted like chelating agents. Radioisotopes of concern and their compounds are: [587]

plutonium dioxide Thorium-232 dioxide

4.2.15 Environmental concerns include the area under and surrounding the SM building which is contaminated with Pu-238 from the storage of plutonium materials in tanks which leaked. Thorium and radium concentrations were also reported for surface soil readings.

4.2.16 See Appendix B for SM Building **Room SM-10**.

5. SW BUILDING

5.1 OVERVIEW

SW Building is similar to R Building in that it consists of many laboratories engaged in a variety of research, development, analytical, recovery, enrichment, 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, uranium-234 separation program, and the tritium programs. The tritium programs include the tritium enrichment, effluent capture, process development, component evaluation, scrap recovery and tritium waste solidification. [588]

All references to plutonium-238 was of the mixture ratio identified below. This mixture also included trace amounts of americium-241 and neptunium-237.[589] This information was obtained from MLM-1564 (AEC Research and Development Report), page 31.

1E-4% Pu-236
80.2% Pu-238
15.9% Pu-239
3.0% Pu-240
0.6% Pu-241
0.1% Pu-242

Note: MLM-1564 also makes reference to other mixtures.

Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241. [590]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

With the completion of the NCDPF Building in 1967/1968 the Tritium Research, Development, and Testing Program was undertaken which extends to the present time. Most of the NCDPF building is part of the SW Building complex and contains rooms designated for the Tritium program. [591] [592]

Tritiated water and vacuum pump oil were found in most all SW Building rooms. It is also known that some tritides and tritiated solvents were so poorly metabolized that the biological half-times were in the order of hours. This was not true for uranium tritides. [593] [594] [595]

Tritiated ammonia (NH_3) is to be expected in boxlines, piping systems, and gas storage tanks. The biological half-times could be in terms of hours. [596]

All radionuclides are ranked according to the degree of concern for uptake and amount of activity for internal dosimetry considerations. Rooms which are referenced to Appendix B for additional radionuclides do not have a ranking in this manual since the ranking is done in Appendix B where all radionuclides are listed. This situation is identified as "see Appendix B for ranking." Rooms where additional information on processing or radionuclides in Appendix B does not effect the ranking are identified as "see Appendix B" only.

Nickel carbonyl has been identified in several incident reports. This gas mixture is NOT radioactive but it is highly toxic. It should be disregarded in internal dosimetry analysis.

The following listing of rooms with construction dates will enable the reader to match rooms with dates and rooms which have more than one room number. For example SW-1A is an area number which could refer to several rooms as listed below. To gain an overview of these rooms in SW Building and to correlate the dates of "reported programs" with construction dates the following list of rooms and dates is provided:[597]

5.1.1 Original SW Complex (1950): [598]

a. SW-1A: This includes SW-19 (Old Cave), also 19A, 19B, 18, 17.

b. SW-1B: This includes SW-13, also 14, 15, 16, 16A, 16B.

c. SW-142, also 136, 137, 138, 139, 140.

d. SW-20 and SW-22 (New Cave), also 20A, 20B, 20D, 20E, 22A

e. SW-2, also 2A, 3, 4, 5.

5.1.2 Hot Gas Facility (1957): [599]

a. SW-8, also 6, 6A, 7, 9.

5.1.3 Ceramics Facility (1958): [600]

a. SW-205, also 202(A-->G), 203, 204

5.1.4 Disassembly and Surveillance (1960): [601]

a. SW-208

5.1.5 SW-1C: Second Floor Addition and Mechanical Room on first floor (1960):[602]

a. SW-210, also support rooms 201A, 209, 210A, 210B.

b. SW-23 (mechanical equipment room)

5.1.6 Change House (1961): [603]

a. SW-108, also SW-105, 106, 107, 108, 109, 110, 111, 112, 113, 115, 117, 118, 122, 124, 125, and 127.

5.1.7 North Alterations / Second Floor Addition and a Two Story Support Building (1961): [604]

a. SW-129, 130, 131, 132, 133, 134, 135.

b. SW-211 and SW-219, also support rooms Sw-212, 213, 214, 215, 217, 218, and 220.

5.1.8 Nuclear Component Development and Pre-Production Facility (NCDPF) (1965): [605]

a. SW-147, 148, 150, and 152, also support rooms SW-146, 147A, 149, 151, 153, 153(A-C), 154, 155, and 156.

b. SW-238 and SW-240, also SW-225, 226, 227, 228, 229(A-D), 230, 231, 232, 233, 234, 235, 236, 237, and 241.

5.1.9 Addition To Existing SW-9 (1967): [606]

a. SW-10

5.1.10 Surveillance and Environmental Test Facility (1969): [607]

a. SW-20C and SW-21 and 21A

5.1.11 Cooling Tower and Chiller (1972): [608]

a. SW-242 and SW-243

5.1.12 Impact Test Facility (1975): [609]

a. SW-21 and SW-21A

b. SW-200

5.1.13 Thorium Facility (1976): [610]

a. SW-128 and SW-128A

Table 5 is a summary of rooms, dates, and radioisotopes for SW Building.

Table 5 - SW BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
SW-2	H-3	1973-PRES
SW-8	H-3, Xe (all isotopes)	1957-1960
	H-3	1958-PRES
	H-3, U(238)(D,T), Li(D,T), Ba(D,T), Ti(D,T)	1960-1985
	H-3	1963-PRES
SW-9	See Appendix B	1965-PRES
	U(D,T), Li(D,T), U/Al(D,T) See Appendix B	1989-PRES
SW-10	H-3	1967-1972
SW-13, 11, 12, 14, 15, 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
	See Appendix B.	1959-1965
	H-3, U(D,T), LI(D,T), LiO(D,T), See Appendix B	1959-1978
	See Appendix B.	1964-1967
	H-3, U-238, U(D,T), See Appendix B. .	1968-PRES
	See Appendix B.	1969-1975
	See Appendix B.	1975-1978
SW-19	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, radon and daughters	1951-1953
	See Appendix B.	1962-1988
	H-3, Ra daughters, See Appendix B . .	1973-PRES
SW-20, 21	H-3	1961-1973

Table 5 - SW BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
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
	See Appendix B	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, AcO_2, $Ac(NO_3)_2$, ...	1964-1968
	Th-230,232, U-234,235,238, Pa-231, Ac-227, Ra-223,224,226, $Ac(NO_3)$, AcO_2.	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
	See Appendix B	1959-1969
	See Appendix B	1962-1967
	H-3, U-238, U(D,T), See Appendix B .	1969-1985
SW-146, 147	H-3, U-238, U(D,T)	1967-1985
	Tritiated stainless steel.	1985-PRES

Table 5 - SW BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
SW-149, 149A	All radionuclides in SW Building . . . . H-3, HTO, tritiated organics . . . . . . H-3, HTO, tritiated organics	1965-1968 1969-PRES 1980-PRES
SW-150, 152	H-3, U-238(D,T), See Appendix B. . . . See Appendix B	1968-PRES 1973-PRES
SW-200	H-3.	1958-PRES
SW-202	Po-210 . . . . . . H-3.	1958-1962 1963-PRES
SW-205	H-3.	1958-PRES
SW-208	H-3, U-238(D,T), See Appendix B . . . . H-3, U-238(D,T), See Appendix B	1965-1989 1989-PRES
SW-210	H-3, U(238)(D,T), See Appendix B . . .	1968-1989
SW-219	Pu-238/Be, Pu-239/Be, Am-241, Pu-239 . . . . . . Po-210, Pu-238,239 . . . . . . H-3. . . . . . See Appendix B . . . . . . H-3, U-238(D,T), See Appendix B. . . .	 1962-1965 1966-1971 1968-1978 1968-1980 1985-PRES
SW-231	H-3, HTO	1970-PRES
SW-238,240	H-3, U-238(D,T), U-238, See Appendix B	1968-PRES

Note: All references to plutonium-238 was of the mixture ratio identified in the introduction to SW Building above. This mixture also included trace amounts of americium-241, neptunium-237, and uranium-234. Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241. [611]

5.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC PROGRAMS IN SW BUILDING

5.2.1 Room SW-2

This area had two major functions as discussed below.

a. (1950 - 1972) This was an equipment support room containing a ventilation system. It was a "cold" area with no possibility of uptakes. [612]

b. (1973 - PRESENT) Mass spectrometry often associated with the Tritium Analysis Meter (TAM). Radionuclide of concern is: [613]

tritium

5.2.2 Room SW-8

This room has been involved in a variety of programs as discussed below.

a. (1957 - 1960) Isotope separation of various gases such as xenon, helium, tritium, and carbon. This process was moved to HH Building. Radioisotopes of concern and their compounds are: [614] [615]

xenon (all isotopes) tritium

1) Tritium was the major radionuclide of concern with xenon radionuclides being secondary.[616]

b. (1958 - PRESENT) This area has been involved in tritium enrichment, recovery process technology, and the processing and containment of tritium-contaminated scrap from all of Mound and also scrap generated by other DOE sites. Radionuclide of concern is: [617] [618] [619]

tritium

c. (1960 - 1985) Enrichment of tritium was accomplished through a thermal diffusion process where hydrogen isotopes were separated into protium, deuterium, and tritium. This process was discontinued in 1985. The solid scrap recovery line was established for tritium recovery. This was discontinued in 1978 because an improved recovery system was

established in R-108. The thermal diffusion columns still remain but are partially decontaminated and are awaiting further decontamination operations. The solid recovery equipment was removed by 1980. Radioisotopes of concern and their compounds are: [620] [621]

tritium	uranium-238 tritide
lithium tritide	titanium tritide
barium tritide	calcium tritide

(many other metal tritides possibly tried.)

1) Tritium was the major radionuclide with uranium-238 being second. All others are a distant third. [622]

2) See Appendix B.

d. (1963 - PRESENT) In 1963 experimentation with the Effluent Removal System (ERS) began, which became operational in 1965. Purged gas from gloveboxes, fumehoods, and room air from maintenance operations were subjected to a process which removed all particulates and liquid droplets of mercury and pump oil. The remaining effluent is oxidized to form HTO from the tritiated gas and tritiated organics. The HTO vapor went through a dryer (molecular sieve) where a water/gas separation occurred.

1) In theory the reclaimed HTO water is sent to the Tritium Aqueous Waste Recovery System (TAWRS) in room T-63 of T Building. However, TAWRS has only operated for one year, as discussed under room T-63.

2) For all but one year (1989-1990) the condensed HTO effluent is taken to SW-149 where it is packaged for burial.

3) Radionuclide of concern is: [623] [624]

tritium

4) Incidents - (Tritium, 6/7/61, 7/23/72, 3/13/73, 7/18/73)[625]

5.2.3 Room SW-9

This room was used for two functions as discussed below.

a. (1965 - PRESENT) The Hydraulic Pressing System was used for pressing filters, powders, and explosive actuators. Energetic materials are involved along with some radionuclides. [626] [627] Early work also used an Electron Beam (EB) welder to seal containers holding tritium. [628]

1) See Appendix B for ranking.

b. (1989 - PRESENT) This area was remodeled to provide gloveboxes for storing tritiated materials. See Appendix B of additional information. Radioisotopes of concern and their compounds are the following:[629] [630]

uranium tritide
uranium aluminum tritide
lithium oxide tritide
lithium tritide
lithium hydroxide tritide

1) Tritium was the major radionuclide with uranium-238 being second. All others are a distant third. [631]

2) See Appendix B.

5.2.4 Room SW-10

(1967 - 1972) A research lab doing characterization studies of vanadium, uranium-238, palladium in a tritide form. The metals were NOT radioactive with only tritium being a concern from an internal dosimetry perspective. Radionuclide of concern is: [632]

tritium

5.2.5 Room SW-13 and supporting rooms SW-11, 12, 14, 15, 16 (Area SW-1B)

a. (1951 - 1953) Decontamination of Bismuth Phosphate Materials -Five shipments of bismuth phosphate materials were received from Hanford which included crib materials and samples from two other stages of the process in the plutonium separation program from irradiated uranium-238. Purex and Tributyl Phosphate materials from Oak Ridge National

Laboratory were also received from a similar program and contained the same radionuclides. A study had been done in R-162 and R-167 for the best process to use, and a pilot plant was tested in HH building before the actual decontamination production process in SW-13 (SW-1B). Radioisotopes of concern are: [633 634 635 636]

ruthenium-106	cesium-137	antimony-125
tellurium-121,127	zirconium-93,95	niobium-94
strontium-90	plutonium-238,239	
yttrium-88,90,91	rare earths (especially cerium)	

1) All radionuclides were of equal concern.[637]

2) It was a ferrous sulfide process and used adsorption and/or coprecipitation followed by clarification of fission products with ferrous sulfide, ferrous hydroxide and calcium phosphate. Feed lines would often break spilling solution with high gamma activity. [638]

b. (1955) Thorium-232 Refinery Program (Monex) - In 1955 A pilot program for the extraction of Th-232 from Brazilian Monazite sludge, thorium oxalate, and sulfate sludge residues was begun in room SW-1B. However, the research was canceled after four months.[639 640]

1) Warehouse #15 stored 1,650 tons of this material which was already received. It was highly corrosive and continually leaked through the barrels causing much contamination. In 1961 Building 21 stored the material in silo form until 1975.

2) Over 34 isotopes were identified from the feedstock of this program with most being nonradioactive. Radioisotopes of concern and their compounds are: [641 642]

thorium-232,228	radium-228,224
uranium-238	thorium-232 daughters (especially thallium-208)

a) Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. However, when considering the quantity of radionuclides, and not activity, 99% of the mass of radionuclides are thorium-232.[643]

c. (1956) The protactinium-231 purification process which was begun in HH Building was moved to this area in the spring of 1956 to take advantage of the existing equipment from the thorium project discussed above. It uses the residues (referred to as raffinates) from a previous uranium processing called "Sperry cake." The work was completed by June of the same year. Radioisotopes of concern were: [644] [645]

iron-55,59	aluminum-26	calcium-45
cobalt-60	protactinium-231	copper-65

1) Protactinium-231 was the major radionuclide of concern with all others a distant second.[646]

d. (1959 - 1978) Gas Synthesis System - Tritium and deuterium research and development was conducted with gas synthesis systems in association with various metals. Research and characterization of metal tritides such as depleted uranium tritide, lithium tritide. The characterizations included pressure-composition-temperature relationships between the isotopes of hydrogen and various metals. (i.e. how much hydrogen a metal will hold at various temperatures and pressures.) Radioisotopes of concern and their compounds are: [647]

uranium tritide	lithium tritide
tritium	lithium hydroxide tritide
uranium-238	

1) Tritium is the major radionuclide of concern with uranium-238 being second.[648]

2) Incident - (tritium, 8/27/64)[649]

3) See Appendix B.

e. (1959 - 1965) See Appendix B for ranking.

f. (1964 - 1967) See Appendix B for ranking.

g. (1969 - 1975) See Appendix B for ranking.

h. (1975 - 1978) See Appendix B for ranking.

i. (1968 - PRESENT) Metallurgical analysis is used to analyze radionuclides and metal tritide samples by cutting items into sections and examining using a variety of techniques. Radioisotopes of concern and their compounds are: [650] [651]

tritium uranium-238 uranium tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[652]

2) Incident - (Tritium, 8/28/85)[653]

3) See Appendix B.

5.2.6 Room SW-19 (Old Cave) - This area had a variety of programs as discussed below.

a. (1951 - 1953) Radium-Actinium Separation - Radium-226 bromide was irradiated at another facility to produce actinium-227 and then a separation process was done in SW-19 to obtain the desired Ac-227 in a compound form. The actinium-227 compound was then taken to R-Building for further processing. High and low risk materials were drained in a concrete channel with a sump at each end which pumped to a treatment facility in an adjoining room. This area was so hot with radium and radon residue that it has been filled over with several feet of gravel and concrete. By 1957 the area was filled over with concrete for radioactive protection purposes. Some of the radionuclides and compounds encountered would be: [654] [655] [656]

radium-226	radium carbonate
actinium-227	radium nitrate
radium bromide	actinium oxalate
actinium fluoride	potassium-40
radon and daughters	thorium-228,229,230

1) Actinium-227, radium-226, and thorium-228 were the major radionuclides of concern. All compounds of actinium-227 were highly soluble.[657]

2) Large quantities of particulate were generated in the area of the evaporator especially during drumming operations. [658]

3) MLM-736 (7/31/52) discusses some of the decontamination problems they encountered. [659]

4) Initial discussion / interviews with previous workers indicated that work went on from about 1950 to 1955 but Health Physics Monthly Information Reports from the spring of 1953 onward indicate that cleanup and decontamination operations were being done. Clean up operations were completed by the first quarter of 1959. [660][661] [662]

b. (1962 - 1988) See Appendix B for ranking.

c. (1973 - PRESENT) This laboratory was then used to store tritium contaminated metal specimens left over from previous operations. At present this area still used for storage although decontamination operations are being planned. A high radon and daughters background exists as a result of the earlier work. Radioisotopes of concern and their compounds are: [663]

tritium radon and daughters

1) See Appendix B for ranking.

5.2.7 Room SW-20, 21

(1961-1973) Component evaluation and environmental testing which includes thermal and shock testing. Radioisotopes of concern and their compounds are: [664]

tritium

1) Incident -(Tritium, 9/24/86)[665]

5.2.8 Room SW-22: "New Cave" and Laboratory Area

This area was used for several research projects relating to plutonium, uranium, thorium, protactinium, and other elements staring in 1960 and extending through to about 1988. See SW-140 for similar work. A variety of programs were conducted which included the following: [666]

a. (1966 - 1975) Thorium-229 Separation Program - Part of "rare isotope program" where thorium-229 was separated from aged uranium-233 and

its daughters. A chloride complex separation technique was used in the process. Radioisotopes of concern are: [667 668 669 670]

uranium-232,233	thorium-228,229
radium-224,225	actinium-225
francium-221	astatine-217

thorium-228 daughters (especially thallium-208)

1) (1975 - 1981) The process was altered where U-233 was the precursor of the process. [671]

2) Uranium-232,233 and thorium-228 daughters, especially thallium-208 are all equally major radiological concerns.[672]

b. (1970 - 1979) Support of Cotter Concentrate program - The processing of pitchblende ore to recover uranium, at another site, left a residue which contained many isotopes, some of which were of value to DOE. This concentrate was processed by a repeating cycle of dissolution in acids and precipitating to obtain small quantities of Pa-231 and Th-230. The cycle included an organic-phosphate extraction and an aqueous stage which implies that uptakes might be processed in the body like a chelating agent. Radioisotopes of concern and their compounds are: [673 674 675 676 677]

thorium-230,232	uranium-234,235,238
actinium-227	protactinium-231
radium-223,224,226	actinium nitrate
actinium oxide	

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity. [678]

2) Fourteen elements besides those isotopes listed above are also contained in the Cotter Concentrate as listed on page 2-71 of CERCLA, VOL. 7, July 1992. There is no indication that these fourteen additional elements are radioactive.

c. (1976 - 1979) A process was done to retrieve the polonium-209 and lead-206 from the old polonium work done earlier on the Mound site. Radionuclides of concern include the following:

polonium-208,209,210 polonium-210 daughters

1) Polonium-210 daughters are the major radionuclide of concern.[679]

d. (1984 - 1986) See Appendix B for ranking.

5.2.9 Room SW-128, 129, 130, 134

These rooms are support rooms for SW-22 and SW-140 (New Cave). They have been "cold" areas throughout their existence. No processing was ever done in these rooms.

a. (1970 - 1979) These rooms were a staging area for the 55 gallon drums of Cotter Concentrate in the 1970's. Because spills and leaks from the drums were possible the radionuclides of concern would be all that existed in the Cotter Concentrate as listed below. [680 681 682 683]

thorium-230,232 uranium-234,235,238
actinium-227 protactinium-231
radium-223,224,226

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity.[684]

2) Fourteen elements besides those isotopes listed above are also contained in the Cotter Concentrate as listed on page 2-71 of CERCLA, VOL. 7, July 1992. There is no indication that these fourteen additional elements are radioactive.

5.2.10 Room SW-132: This room had the following functions:

a. (1970 - 1979) Support of Cotter Concentrate program. SW-132 allowed personnel to get behind the fumehoods in SW-140 and give support to the programs in that room. The Cotter Concentrate was processed by a repeating cycle of dissolution in acids and precipitating to obtain small quantities of Pa-231 and Th-230. The cycle included an organic-phosphate extraction and an aqueous stage which implies that uptakes might be processed in the body like a chelating agent. Radioisotopes of concern and their compounds are: [685 686 687]

thorium-230,232 uranium-234,235,238

actinium-227	protactinium-231
radium-223,224,226	actinium nitrate
actinium oxide	

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity.[688]

2) Fourteen elements besides those isotopes listed above are also contained in the Cotter Concentrate as listed on page 2-71 of CERCLA, VOL. 7, July 1992. There is no indication that these fourteen additional elements are radioactive.

3) Incident - (Ac-227, 10/30/78)[689]

b. (1976 - 1979) A process was done to retrieve the polonium-209 and lead-206 from the old polonium work done earlier on the Mound site. Radionuclides of concern include the following:

polonium-208,209,210	polonium-210 daughters

1) Polonium-210 daughters are the major radionuclide of concern.[690]

c. Room SW-132 was cleaned up after this and no longer used for hot work.[691]

5.2.11 Rooms SW-136 and SW-137

(1964 - 1979) These rooms were used to get materials into the hot cell which was part of SW-140. Although these rooms were not used for production they did possess the capabilities of contamination and spills. Radioisotopes of concern and their compounds are: [692] [693] [694]

thorium-230,232	uranium-234,235,238
actinium nitrate	protactinium-231
radium-223,224,226	actinium-227
actinium oxide	

a. The radionuclides of major concern are time dependent since the time span include several major programs with diverse emphasis on radionuclides.[695]

1) Early radiological concerns included thorium-228, radium-226, and actinium-227.

2) Later programs made thorium-228, protactinium-231, and natural uranium (234, 235, 238) the major radionuclide concerns.

5.2.12 Room SW-140

"New Cave" and Laboratory Area - (Includes HOT CELL and ANALYTICAL) along with supporting rooms SW-132, 136, 137: SW-140 was the primary room consisting of a "hot" side with fumehoods and two ion exchange columns. The "analytical" side was used to obtain disintegration counts using alpha, gamma, proportional counters, etc See SW-22 for similar work. This room was used for a variety of programs as discussed below.

a. (1964 - 1968) Actinium-227 as both an oxide and nitrate was processed in a separation procedure to acquire a pure radionuclide. It was a much smaller operation than was done in the "old cave" area (SW-19) where Ac-227 was separated from irradiated Radium-226. No radium was involved in this operation. Radioisotopes of concern and their compounds are: [696] [697]

actinium-227	actinium oxide	actinium nitrate

1) Actinium-227 was the major radionuclide. It is very soluble and could be found in varied chemical compounds.[698]

b. (1970 - 1979) This room was used to support the Cotter Concentrate program which was similar to the activities done in SW-22. This concentrate was processed by a repeating cycle of dissolution in acids and precipitating to obtain small quantities of Pa-231 and Th-230. The cycle included an organic-phosphate extraction and an aqueous stage which implies that uptakes might be processed in the body like a chelating agent. Radioisotopes of concern and their compounds are:[699] [700] [701] [702]

thorium-230,232	uranium-234,235,238
actinium-227	protactinium-231
radium-223,224,226	actinium nitrate
actinium oxide	

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity.[703]

2) Fourteen elements besides those isotopes listed above are also contained in the Cotter Concentrate as listed on page 2-71 of CERCLA, VOL. 7, July 1992. There is no indication that these fourteen additional elements are radioactive.

c. (1976 - 1979) A process was done to retrieve the polonium-209 and lead-206 from the old polonium work done earlier on the Mound site. Radionuclides of concern include the following:

polonium-208,209,210	polonium-210 daughters

1) Polonium-210 daughters are the major radionuclide of concern.[704]

5.2.13 Room SW-142: - Several programs as discussed below.

a. (1950 - 1961) Analytical lab used to support the polonium program. Also supported the "Old Cave" program. Radioisotopes of concern and their compounds are:[705] [706]

radium-226	radium carbonate
actinium-227	radium nitrate
radium bromide	actinium oxalate
actinium fluoride	potassium-40
polonium-208,209,210	radon and daughters
thorium-228,229,230	

1) Probable major radionuclides of concern are radium-226, actinium-227, thorium-228, and polonium-210 which can all be considered equally. This ranking is only assumed and is based upon ranking of programs contemporary with this period of time.

b. (1959 - 1969) See Appendix B for ranking.

c. (1962 - 1967) See Appendix B for ranking.

d. (1969 - 1985) Metallurgical analysis is used to analyze radionuclides and metal tritide samples by cutting item into sections and examining using

a variety of techniques. The mercury used for pumping often became contaminated with tritium. Radioisotopes of concern and their compounds are: [707 708 709 710]

tritium	uranium-238
uranium tritides	tritiated mercury oxide

1) See Appendix B for ranking.

2) Incidents - (Tritium, 11/20/64, 8/28/85)[711]

3) Incident - (Mercury, 1/25/65)[712]

a) The mercury was used in pumping/transferring tritium. [713]

e. (1985 - 1988) Decontamination work in preparation for a new lab which never became operational.

5.2.14 Rooms SW-146, 147 - The following functions were done in these rooms.

a. (1967 - 1985) This was a metrology lab used for the inspection of materials, measurement, and smoothness determination. SW-146 was also an X-ray room which used cobalt-60 as it source. Radionuclides of concern and their compounds are:[714]

tritium	uranium-238
uranium-238 tritide	

1) Tritium was the major radionuclide of concern with uranium-238 being secondary.[715]

b. (1985 - PRESENT) A surveillance program consisting of pressure burst testing systems. Radioisotopes of concern and their compounds are: [716] [717]

tritiated stainless steel (contaminated)

1) tritiated stainless steel is very stable in the body.[718]

5.2.15 Room SW-149 and 149A

This area has always been involved in the handling of radionuclides as discussed below.

a. (1965 - 1968) This was a decontamination lab used to decontaminate parts. Surface contamination consisted of the following possible radionuclides: [719]

all radionuclides contained in SW Building

1) Tritium was the major radionuclide of concern with all other radionuclides a distant second.[720]

b. (1969 - PRESENT) SW-149 (only) was used to receive, store, analyze, and solidify waste water and oil which were contaminated with tritium. Monitoring of liquid waste through calorimetry was a common procedure. Radioisotopes of concern and their compounds are: [721]

tritium
tritiated water (HTO)
tritiated organics (oils)

1) Tritium was the major radionuclide of concern.[722]

c. (~1980 - PRESENT) SW-149A (only) was built to receive, assay, and package waste tritiated oil and water. After the development of a practical method to recover tritium from water the FWCU (Feedwater Cleanup System) was installed in SW-149A. Its purpose was to remove chemical impurities from water before it was fed into the recovery process in T-63. Radioisotopes of concern and their compounds are: [723] [724] [725]

tritium
tritiated water (HTO)
tritiated organics (oils)

1) Tritium was the major radionuclide of concern.[726]

5.2.16 Rooms SW-150 and 152

These are the major labs used for the following program:

a. (1968 - PRESENT) Gas Synthesis System - Tritium and deuterium research and development was conducted with gas synthesis systems in association with various metals. Research and characterization of metal tritides such as depleted uranium tritide. The characterizations included pressure-composition-temperature relationships between the isotopes of hydrogen and various metals. (i.e. how much hydrogen a metal will hold at various temperatures and pressures.) Similar to the work done in SW-13 during this period of time. Radioisotopes of concern and their compounds are: [727] [728]

tritium uranium-238 tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[729]

2) See Appendix B.

b. (1973 - PRESENT) See Appendix B for ranking.

5.2.17 Room SW-200

1958 - PRESENT) This has been an environmental testing lab. It also contains a mechanical convection (oven system), hydraulic burst testing, and storage. Radioisotopes of concern and their compounds are: [730] [731]

tritium

5.2.18 Room SW-202

Large counting room used to support two phases of operations at Mound.

a. (1958 - 1962) Large counting room supporting polonium operations. Radioisotopes of concern and their compounds are: [732] [733]

polonium-210

1) Incident - (Po-210, 8/11/61)[734]

b. (1963 - PRESENT) This room has been used to support many operations in the SW Building. All counting in recent years has been low level counting such as for Health Physics work. There is low probability of any radiological uptake with the only radionuclide of concern being: [735] [736]

tritium

5.2.19 Room SW-205

1958 - PRESENT) Analytical lab using mass spectrometry often associated with the Tritium Analysis Meter (TAM). Radionuclide of concern is:[737] [738]

tritium

5.2.20 Room SW-208

This room had a variety of programs as discussed below.

a. Room SW-208: (1965 - 1989) This room contained a walk-in hood system where tritium containing units were received and the tritium was removed. The tritium was transported to SW-8 where it entered the thermal diffusion columns for processing.

   1) Function testing on the tritium containing units was also done in this room (1965 - 1968). [739] [740] [741]

   tritium uranium-238 tritide

   2) See Appendix B for ranking.

b. Room SW-208: (1989 - PRESENT) This room diminished its activities and only operated a glovebox line which was used for function testing of components. Walk-in-hood has not been used since 1989. The components sometimes become contaminated with tritium. Radioisotopes of concern and their compounds are: [742] [743]

   tritium uranium-238 tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[744]

2) See Appendix B.

5.2.21 Room SW-210

This room had two programs as discussed below.

a. Room SW-210: (1960 - 1968) This room was a plastics room where a plastics potting program existed. Radionuclide work in this room did not begin until 1969. [745]

b. Room SW-208, 210: (1968 - 1989) These labs contained a "walk-in-hood" system which was used for extensive function and component testing of systems. Radioisotopes of concern and their compounds are: [746] [747]

tritium	uranium-238 tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[748]

2) Room SW-210: After 1989 this room shut down completely. [749]

3) See Appendix B.

5.2.22 Room SW-219

Several programs were conducted in this room as discussed below.

a. (1962 - 1965) This was a plutonium-238,239 neutron source production area used to manufacture neutron sources. These sources were then sent to T-61 and later to T-227 for calibration. Done during this same time was the alpha source plating on various metal substrates which were used as sources for calibration. This operation was moved to this room from R-116 and R-120 where it was first done. Radioisotopes of concern and their compounds are: [750] [751] [752]

plutonium-238/beryllium	plutonium-239/beryllium
americium-241	plutonium-239

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 second and americium-241 being third.[753]

b. (1966 - 1971) This area was used for a neutron source verification program. Polonium-210 beryllium, plutonium-238 and 239 beryllium neutron sources were monitored for conformance to specification. Radioisotopes of concern and their compounds are: [754]

polonium-210 plutonium-238,239

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 secondary.[755]

c. (1968 - 1978) This was an analytical lab for hydride and tritide analysis. Radioisotopes of concern and their compounds are: [756]

tritium

d. (1968 - 1980) See Appendix B for ranking.

e. (1980 - 1984) Decontamination work included equipment tear-out and new equipment installation.

f. (1985 - PRESENT) A boxline system was installed to perform stockpile evaluation of gas transfer systems. This area does the same tasks as SW-208. Radionuclide of concern: [757]

tritium uranium-238 tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[758]

2) See Appendix B.

5.2.23 Room SW-231

(1970 - PRESENT) Initially a staging area for waste drums, it became a support room for SW-150. This room contains dryers to collect the tritiated condensate. Radioisotopes of concern and their compounds are: [759] [760]

tritium tritiated water (HTO)

a. Incident - (Tritium, 7/28/72)[761]

5.2.24 Rooms SW-238, 240

(1968 - PRESENT) These are labs for the development of system prototypes, component testing, welding operations, and calorimetry. Simulation testing of long term storage and environmental concerns are also done. Radioisotopes of concern and their compounds are: [762] [763]

uranium tritide	tritium
uranium-238	

a. Tritium is the major radionuclide of concern with uranium-238 being second.[764]

b. See Appendix B.

5.2.25 There is contaminated soil under the SW building. Radionuclides of concern are:[765]

tritium	radium-226
radon-22	thorium-230,232
cesium-137	strontium-90
plutonium-238	

5.2.26 Recent inquiries into the degree of contamination of **crawl spaces above SW Building** have revealed very little contamination and radioactivity in those areas.[766]

5.2.27 See Appendix B for SW Building rooms: SW-8, 9, 13, 19, 22, 142, 150, 152, 208, 210, 219, 238, 240.

6. T-BUILDING

6.1 OVERVIEW

T-Building was host to a multitude of research, development, and production programs with various radioisotopes. The two major radionuclide programs are the polonium and the tritium programs. From 1949 to 1973 polonium-210 programs included a processing and separation program, a fuels research and development program, neutron source program, and a variety of other research, development, and production programs with polonium. This work was all done on the first and second floors of T-Building.

An extensive renovation program from 1966 through 1968 prepared the way for additional polonium fuels research and development.[767] However, government funding was radically reduced and most all renovations were not used as anticipated. T-Building was essentially dormant from 1969 till about 1972 because of a loss of this funding. Decontamination work was done from 1971 through 1973 on the polonium-210 processing area.[768] Activity resumed with the tritium programs in the mid 1970's.[769]

A variety of other activities have been done in T-Building such as nondestructive testing, environmental testing, gamma and mass spectroscopy, calorimetry, neutron activation analysis, and safeguards R&D.

All references to plutonium-238 was of the mixture ratio identified below. This mixture also included trace amounts of americium-241 and neptunium-237.[770] This information was obtained from MLM-1564 (AEC Research and Development Report), page 31.

1E-4% Pu-236
80.2% Pu-238
15.9% Pu-239
3.0% Pu-240
0.6% Pu-241
0.1% Pu-242

Note: MLM-1564 also makes reference to other mixtures.

Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241. [771]

All analytical labs and support rooms for the polonium-210 program from 1949 to about 1973 probably had the following radionuclides and compounds which were common to the polonium processing: [772]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
aluminum chloride	bismuth chloride
polonium chloride	polonium nitrate

1) Exceptions to this would have been T-248 through T-259 which had very pure polonium handled in this area.

The abundant use of tritium in T-Building and the reactivity of tritium with other materials makes tritium an isotope of concern.

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

All radionuclides are ranked according to the degree of concern for uptake and amount of activity for internal dosimetry considerations. Rooms which are referenced to Appendix B for additional radionuclides do not have a ranking in this manual since the ranking is done in Appendix B where all radionuclides are listed. This situation is identified as "see Appendix B for ranking." Rooms where additional information on processing or

radionuclides in Appendix B does not effect the ranking are identified as "see Appendix B" only.

Nickel Carbonyl has been identified in several incident reports. It is a highly poisonous gas mixture but is NOT radioactive. It should be disregarded in internal dosimetry analysis.

Table 6 is a summary of rooms, dates, and radioisotopes for T-Building.

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
T-1W, 2W, 4E	See Appendix B	1965-1987
T-5W	H-3, HTO . . . . . . 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: All were encapsulated	1955-PRES
T-8	Po-210.	1949-1965
T-9, 9A	H-3, Pu-238(encapsulated)	1987-PRES
T-13	Po-210.	1949-1953
T-15B	Neutron generator producing many possible radionuclides from surface of materials present	1963-PRES
T-16A	H-3, tritiated organics	1984-PRES
T-18	Neutron generator producing many possible radionuclides from surface of materials present	1963-PRES
T-19, 19A	Pu-238,239, H-3, Co-60, Ir-192, Fe-55, Ra-226, Am-241, Cd-109: All were encapsulated. . . . . . H-3, tritiated organics	1985-PRES 1985-PRES
T-20	Never went hot.	1985-PRES
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, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-->134?, Hg-203 . . . . . . Pu-238,239 (encapsulated)	1949-1969 1979-PRES

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
T-25, 26	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-PRES
T-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-PRES
T-28,29,30,31, 32,33,34,35	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
	See Appendix B.	1985-PRES
T-37	H-3, U-238(D,T), Pu-238(encapsulated), tritiated organics.	1985-PRES
T-40	H-3, Pu-238(encapsulated)	1985-PRES
T-41	H-3	1985-PRES
T-46	Po-210.	1949-1969
T-48, 49, 50	H-3, U-238(D,T), See Appendix B	1983-PRES

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
T-53	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-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-PRES
T-58	H-3, ...	1985-PRES
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-238(D,T)	1985-PRES
	H-3, ...	1985-PRES
T-61, 61A	Po-210, Pu-238,239.	1960-1963
	Po-210.	1964-1966
	H-3, U-238(D,T)	1973-PRES
T-63	H-3, HTO.	1973-PRES

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
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-PRES
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-PRES
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-PRES
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-PRES
T-234	H-3, See Appendix B	1988-PRES

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
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-PRES
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, Pu238,239(encapsulated).	1985-PRES
T-238	H-3, Pu-238(encapsulated)	1985-PRES
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, See Appendix B.	1949-1958
	Po-208,209,210, rare earth polonides, See Appendix B.	1966-1969
T-248-->T-259	Po-210.See Appendix B	1949-1965
	(T-257 only) - Orphan sources	1993-PRES
T-260	Po-210, See Appendix B.	1949-1969
	Po-208,209,210, rare earth polonides, See Appendix B.	1966-1969

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
T-266, 267	Po-210, Bi-209,210, See Appendix B. . . . . Po-208,209,210, rare earth polonides, See Appendix B. . . . . . H-3, U-238(D,T)	1949-1969 1963-1966 1988-PRES
T-270	Po-210, Bi-209,210, See Appendix B.	1949-1963
T-274	External dose only . . . . . . 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 . . . . . . H-3, U-238(D,T)	1948-1971 1966-1969 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	Po-210, Am-241.See Appendix B . . . . . . Po-210 . . . . . . Po-210, Bi-209,210	1949-1964 1962-1969 1964-1969
T-300A	Orphan Sources; sources left in containers.	
T-307	Po-210 . . . . . . H-3, ...	1949-1964 1972-PRES
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 . . . . . . Pu-238,239,240,241, Pm-147, U-233,235, Am-241, H-3 . . . . . . Pu-238,239(encapsulated).	1949-1969 1969-1983 1986-PRES

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
T-311	Po-210. . . . . . Pu-238,239 (encapsulated)	1949-1969 1986-PRES
T-319	Pu-238,239,240,241, Pm-147, U-233,235, Am-241, H-3, HTO	1949-PRES
Please Note: T-43,44,48,50, 57,58,59, Corridor-51	These rooms have high fixed radiation from the old polonium program. Radioisotopes of concern are: Co-60, Cs-137, Sr-90.	

Note: All references to plutonium-238 was of the mixture ratio identified in the introduction to T-Building above. This mixture also included trace amounts of americium-241,neptunium-237, and uranium-234. Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241. [773]

6.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS

6.2.1 Room T-1W: (1965 - 1987) See Appendix B for ranking.

6.2.2 Room T-2W: (1965 - 1987) See Appendix B for ranking.

6.2.3 Room T-4E: (1965 - 1987) See Appendix B for ranking.

6.2.4 Room T-5W: This room had several functions as discussed below.

a. (1956 - 1962) This room was used to store heavy water (D_2O). Radioisotopes of concern and their compounds are: [774]

tritium	tritiated water (HTO)

1) Tritium gas was the major radionuclide of concern. [775]

b. (1963 - 1974) This was a file storage area. There were no radioisotopes of concern. [776]

c. (1975 - 1982) This room was used to house the early catalytic exchange column for enriching HTO. Radioisotopes of concern and their compounds are: [777]

tritium	tritiated water (HTO)

1) Tritium gas was the major radionuclide of concern. [778]

d. (1987 - FUTURE) The Tritium Effluent Reduction Facility (TERF) is part of the "Tritium Recycle and Enrichment System." It will replace ERS in SW-8 which will no longer function when TERF is fully on line. However, they will both operate until TERF is fully checked out. To date it has never had tritium in TERF system. [779]

1) Other support rooms for TERF are T-2W, T-241, and T-242. [780]

6.2.5 Room T-5E: (1955 - PRESENT) This room is used for non destructive testing using X-ray techniques and radiography techniques. Radioisotopes of concern and their compounds are: [781] [782]

plutonium-238,239	tritium

cobalt-60	iridium-192
iron-55,59	radium-226
americium-241	cadmium-109

(Note: These radioisotopes are all encapsulated or doubly contained.)

a. Tritium was the major radionuclide of concern with plutonium-238 being second and plutonium-239 third.[783]

6.2.6 Room T-8: (1949 - 1965) This room was used for hot side maintenance in the "low risk" section of T-Building. This should not be confused with the "hot maintenance" in the "high risk" section (T-53). Radioisotopes of concern and their compounds are: [784]

polonium-210

6.2.7 Room T-9 or 9A: (1987 - PRESENT) The Nuclear Measurement Laboratory provides the Final Leak Check and Calorimetry of tritium containing vessels. Doubly encapsulated plutonium-238 heat standards are used for calorimetry calibration. This is a support room to the activities in room T-40. Minimum standards must be met for radiation and contamination before items are permitted in the room such that it provides a man-safe environment. Radioisotopes of concern and their compounds are.[785] [786] [787]

tritium	plutonium-238 (encapsulated)

a. Tritium was the major radionuclide of concern with plutonium-238 being second.[788]

6.2.8 Room T-13: (1949 - 1953) This room is used as a decontamination room for polonium-210 contaminated equipment. Radionuclides of concern are: [789]

polonium-210

a. Health Physics report discussed the decontamination work which was done in making ready for other programs. [790]

6.2.9 Room T-15B: (1963 - PRESENT) This room is used for neutron irradiation of materials with a neutron accelerator source. Although most materials are nonradioactive, the effects of using neutron radiation in the analyses may

produce radionuclides on the surfaces of materials and equipment in the room. Therefore, it is uncertain what radionuclides may exist in this room.[791 792 793]

6.2.10 Room T-16A: (1984 - PRESENT) This room is used for the compaction of LSA waste collected from change rooms, shoe covers, general work areas, etc This trash does not contain off gassing materials. Radioisotopes of concern and their compounds are: [794]

tritium	tritiated organics

a. Tritium gas was the major radionuclide of concern. [795]

6.2.11 Room T-18: (1963 - PRESENT) This room is used as a counting lab for neutron and gamma radiation from the neutron activation analysis done in room T-15B.[796 797 798]

6.2.12 Room T-19, T-19A: These room have two functions as discussed below.

a. (1985 - PRESENT) These rooms are used for X-ray and non-destructive inspection and testing in support of production, process engineering, and R&D efforts. Radioisotopes of concern and their compounds are:[799 800]

plutonium-238,239	tritium
cobalt-60	iridium-192
iron-55	radium-226
americium-241	cadmium-109

(**Note:** These radioisotopes are all encapsulated)

1) Tritium was the major radionuclide of concern with plutonium-238 being second and plutonium-239 third.[801]

b. Room T-19: (1985 - PRESENT) This room is also used to package the LSA waste and hold until it was transferred out of T-Building. The abundant use of tritium in T-Building and the extreme reactivity of tritium with other materials makes tritium an isotope of great concern. Most forms of tritium resulting in an uptake are HT, HTO, and tritiated contaminants of water, oils, and alcohols (methanol and ethanol), and other solvents. Radioisotopes of concern and their compounds are: [802 803]

tritium tritiated organics

1) Tritium gas was the major radionuclide of concern. [804]

6.2.13 Room T-20: (1985 - PRESENT) There are no radionuclides of concern.[805 806 807]

6.2.14 Room T-22: The following functions were done in this room.

a. (1949 - 1969) This room is part of the east filter bank system (E-31A and 41) supporting the polonium operations contained in the gloveboxes. This would also include the radionuclide impurities from the dissolving operation. Radioisotopes of concern and their compounds are:[808 809 810 811]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[812]

b. (1979 - PRESENT) This room is a Safeguards verification facility lab containing calorimetric, thermal neutron, and gamma-ray spectroscopy systems. The operations include assay of nuclear materials for heat emissions by calorimetry and isotopic composition using gamma-ray spectroscopy. The results of these analysis gives the gram-value and isotope identification of the assays. R&D is also done for improvements of measurement techniques. Radioisotopes of concern and their compounds are: [813 814]

plutonium-238,239 (encapsulated)

1) Plutonium-239 was the major radionuclide of concern with plutonium-238 being second. [815]

6.2.15 Rooms T-25 and T-26: These rooms had two functions as discussed below.

a. (1949 - 1969) This area is part of the east filter bank system (E-31A and 41) supporting the polonium operations which would also include the radionuclide impurities in the air from the dissolving operation. Radioisotopes of concern and their compounds are: [816 817 818 819]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[820]

b. (1979 - PRESENT) These areas are counting rooms in support of the lab in T-22. Radioisotopes of concern and their compounds are: [821]

plutonium-238,239 (encapsulated)

1) Plutonium-239 was the major radionuclide of concern with plutonium-238 being second. [822]

6.2.16 Room T-27: This room had two functions as discussed below.

a. (1949 - 1969) This room is part of the east filter bank system (E-31A and 41) supporting the polonium operations which would also include the radionuclide impurities in the air from the dissolving operation. Radioisotopes of concern and their compounds are: [823 824 825 826]

iron-55,59	silicon-31

cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[827]

b. (1979 - PRESENT) This room is used for unpackaging of radionuclides for use in T-22. Radioisotopes of concern and their compounds are: [828]

plutonium-238,239 (encapsulated)

1) Plutonium-239 was the major radionuclide of concern with plutonium-238 being second. [829]

6.2.17 Rooms T-28, 29, 30, 31, 32, 33, 34, 35

(1949 - 1969) These rooms are part of the east filter bank system (E-31A and 41) supporting the glovebox operations. This would also include the radionuclide impurities from the dissolving operation. Radioisotopes of concern and their compounds are: [830 831 832 833]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[834]

6.2.18 Room T-36, T-36A: These rooms have two functions as discussed below.

a. (1949 - 1969) These rooms are part of the east filter bank system supporting the polonium operations which would also include the radionuclide impurities in the air from the dissolving operation. Radioisotopes of concern and their compounds are: [835 836 837 838]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-12	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[839]

b. (1985 - PRESENT) See Appendix B for ranking.

6.2.19 Room T-37

(1985 - PRESENT) This room is an alternate route for tritium entry into and out of T-Building. It is also used for special packaging and unpackaging when procedures, other than those in T-237,238, are normally done. This room is also used as a decontamination laboratory for decontamination equipment which becomes contaminated with tritium. Radioisotopes of concern and their compounds are: [840 841]

tritium	plutonium-238 (encapsulated)
uranium-238 tritide	tritiated organic solvents such as oil and alcohol (methanol and ethanol)

a. Tritium was the major radionuclide of concern with uranium-238 being second and plutonium-238 third.[842]

6.2.20 Room T-40

(1985 - PRESENT) The Nuclear Measurement Laboratory provides the final leak check and Calorimetry of tritium containing vessels. Doubly encapsulated plutonium-238 heat standards are used for calorimetry calibration. This room also has bubblers, scintillation counters, and electronic equipment to collect and do a final check on the tritium containers. Minimum standards must be met for contamination before items are permitted in the room such that it provides a man-safe environment. Radioisotopes of concern and their compounds are.[843 844 845]

tritium plutonium-238 (encapsulated)

a. Tritium was the major radionuclide of concern with plutonium-238 being second.[846]

6.2.21 Room T-41

(1985 - PRESENT) This room is a lab used for mass spectrometry for inventory purposes and impurity analysis. This room has similar functions as room T-58. Radioisotopes of concern and their compounds are:[847 848 849]

tritium

6.2.22 Room T-46

(1949 - 1969) This was a decontamination laboratory. Radioisotopes of concern and their compounds are:[850]

polonium-210

6.2.23 Room T-48, T-49, T-50

(1983 - PRESENT) T-48 and T-50 are glovebox labs and T-49 is an access corridor to both T-48 and T-50. T-48 and T-50 contain gas preparation systems used to handle large quantities of tritium. Room T-49 is an access

corridor for equipment maintenance. Radioisotopes of concern and their compounds are: [851 852 853 854 855]

tritium (tritiated pump oil)	uranium-238 tritide

a. Tritium was the major radionuclide of concern with uranium-238 being second.[856]

b. See Appendix B.

6.2.24 Room T-53

(1949 - 1969) This was a "hot maintenance" room which functioned as a machine and repair shop servicing the hot polonium areas in T-Building. Radioisotopes of concern and their compounds are: [857 858 859]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[860]

6.2.25 Room T-54A, 55A, 55: This area had two functions as discussed below.

a. (1949 - 1958) This area took the dissolved aluminum can residue, which was in a aqueous chloride acid solution form, and sent it to HH Building for processing through a 4-inch pyrex line contained within a 6-foot diameter concrete tunnel. The dissolved bismuth slug residue (also in an aqueous chloride acid solution form) was also sent to HH Building for processing through a separate 4-inch pyrex line contained within the same 6-foot diameter concrete tunnel. Both waste streams had high

degrees of beta and gamma radiation from the irradiated impurities in the aluminum can and in the bismuth metal. Gamma and beta emitting radioisotopes resulting from irradiated impurities in the aluminum can and bismuth include: [861 862 863]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[864]

b. (1958 - 1969) Pumping of the acidic solutions of the aluminum can residue and bismuth slug residue to HH Building was discontinued in 1958. Room 54A contained two large vats which were used for the hydrolysis process exactly like that previously done in HH Building. The sludge was solidified, placed in barrels, and packaged for an off-site burial ground. The aqueous remains were sent to WD Building. Radioisotopes of concern and their compounds are: [865 866 867]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[868]

6.2.26 Room T-57: This room was used for two programs as discussed below.

a. (1949 - 1971) This room was used for the dissolving of the aluminum can with hydrochloric acid. The impurities in the can resulted in gamma and beta emitting radioisotopes. This HCl was drained away and new hydrochloric acid along with nitric acid was used to dissolve the bismuth slug containing polonium-210. Denitration and scrubbing of gases were also done in this room. Radioisotopes of concern and their compounds are: [869 870 871 872 873]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[874]

2) Incident - T-57 (8/28/68, Po-210) [875]

b. (1985 - PRESENT) Hydrogen Isotope Separation System (HISS) is part of the "Tritium Recycle and Enrichment System." Because of the size of the equipment the system extends through the floors up into T-274. It is a tritium enrichment system that employs low-temperature distillation as the separation process. The HISS enriches the tritium and the tritium enriched stream is transferred to the Thermal Diffusion Facility (TDF) in T-59. The distillate is returned to the ERS (later TERF). No waste stream is generated by the HISS. Radioisotopes of concern and their compounds are: [876 877 878]

tritium

6.2.27 Room T-58: This room was used for two programs as discussed below.

a. (1949 - 1969) This is the "basement" to the chemical operations room which is only five feet high. It had no real function except providing access to pipes. There were no radionuclides of concern. [879]

b. (1985 - PRESENT) This room is a lab used for mass spectrometry for inventory purposes, impurity analysis, and high accuracy analysis in support of the tritium program. This room has similar functions as T-41. Radioisotopes of concern and their compounds are: [880 881 882]

tritium

6.2.28 Room T-59: This room has had a variety of functions as discussed below.

a. (1949 - 1969) This room was used for the dissolving of the aluminum can with hydrochloric acid. The impurities in the can resulted in gamma and beta emitting radioisotopes. This Hcl was drained away and new hydrochloric acid along with nitric acid was used to dissolve the bismuth slug containing polonium-210. Denitration and scrubbing were also done in this room. These functions were identical to those done in T-57 during the period 1949-1964. T-59 was emptied and decontaminated in 1971. It was not put back into operation with polonium. Radioisotopes of concern and their compounds are: [883 884 885 886 887]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[888]

b. (1985 - PRESENT) Thermal Diffusion Facility (TDF) is part of the "Tritium Recycle and Enrichment System." No waste stream is generated by this process although raffinate gas is sent to ERS. The radionuclide of concern are: [889 890 891]

tritium uranium-238 tritide

1) Tritium was the major radionuclide of concern with uranium-238 being a distant second.[892]

c. (1985 - PRESENT) This room is also used to open welded containers by a laser operation. [893 894]

tritium

6.2.29 Room T-61, T-61A: This room had two programs as discussed below.

a. (1960 - 1963) This area was used to calibrate the various neutron sources which included polonium-210/beryllium, plutonium-238/beryllium, and plutonium-239/beryllium. Radioisotopes of concern and their compounds include: [895]

polonium-210 plutonium-238,239

a. Polonium-210 was the major radionuclide of concern with plutonium-238 being second and plutonium-239 third.[896]

b. (1964 - 1966) This area was used to store and test the assembled DART and Poodle Thrusters. The polonium-210 was all encapsulated so there was little likelihood of uptakes. Radioisotopes of concern and their compounds are: [897 898 899]

polonium-210

c. (1973 - PRESENT) Tritium Recovery Column (TRC) is part of the "Tritium Recycle and Enrichment System." Low concentrations of tritium mixed with hydrogen gas are sent from TAWRS to a single column cryogenic distillation system. The gas is stored on uranium beds resulting in UT_3 formation. The distillate from the TRC is returned to the TAWRS, and the still bottom is the feedstock to the HISS. There is

no waste stream generated by the TRC system. Radioisotopes of concern and their compounds are: [900 901 902 903]

tritium uranium-238 tritide

1) Tritium was the major radionuclide of concern with uranium-238 being a distant second.[904]

6.2.30 Room T-63

(1973 - PRESENT) Tritium Aqueous Waste Recovery System (TAWRS) is part of the "Tritium Recycle and Enrichment System." It was on line in 1989, but was shut down after 6 months. It has not been in operation since. Since HTO is abundant in this system it represents an area of high uptake possibility. The tritium gas from this process was transferred to the Tritium Recovery Column (TRC). Radioisotopes of concern and their compounds are:[905 906 907 908]

tritium tritiated water

a. Tritiated water was the major radionuclide of concern with tritium gas being secondary.[909]

6.2.31 Rooms T-72, 73, 74, 75 and T-92, 93, 96, 97, 98

(1949 - 1969) These rooms are part of the west filter bank system (E-21 and 22) supporting the polonium operations. Radioisotopes of concern and their compounds are: [910 911 912 913]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a. Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[914]

6.2.32 Room T-99: This room has two functions as discussed below.

a. (1947 - PRESENT) This room houses exhaust fans for a major portion of T-Building. This was part of the original design of the building. Radioisotopes of concern is:[915]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[916]

b. (1984 - PRESENT) Effluent Removal System (ERS), part of the "Tritium Recycle and Enrichment System," is actually located in SW-8 Building but has pipes entering T-Building through T-99 which connect to all tritium processing gloveboxes, vacuum pumps, etc. in T-Building. Radioisotope of concern is: [917] [918] [919]

tritium

6.2.33 Rooms T-100, 102, 103, 104

(1949 - 1969) These rooms are an extension of the west filter bank system (E-31B) supporting the process area on the hot side. This would also include the radionuclide impurities in the air from the dissolving operation. Radioisotopes of concern and their compounds are: [920] [921] [922] [923]

iron-55,59	silicon-31
cobalt-60	lead-209

tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a. Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[924]

b. Rooms T-100 and T-102 are actually used for the exhausting system. T-103 and T-104 are not used but only have the exhausting system passing through these rooms.

c. (1962 - 1972) These rooms were cleaned up and D&D.

d. (1972 - PRESENT) These rooms are support areas for T-61 and T-63. Radionuclide of concern is: [925]

tritium

6.2.34 Room T-208A

(1947 - PRESENT) All of these rooms were used for X-ray and non-destructive inspection and testing in support of production, process engineering, and R&D efforts. [926] [927]

plutonium-238,239	tritium
cobalt-60	iridium-192
iron-55	radium-226
americium-241	cadmium-109
polonium-210	

Note: All these radioisotopes are encapsulated.

a. Tritium was the major radionuclide of concern with plutonium-238 being second and plutonium-239 third.[928]

6.2.35 Room T-229

This room is used for the following functions:

a. (1963 - 1964) This area was used to calibrate the various neutron sources which included polonium-210/beryllium, plutonium-238/beryllium, and plutonium-239/beryllium. Radioisotopes of concern and their compounds include: [929]

polonium-210 plutonium-238,239

1) Polonium-210 was the major radionuclide of concern with plutonium-238 being second and plutonium-239 third.[930]

b. (1978 - 1988) This room was used for the calibration of monitors used in the uranium mill tailing and site surveillance. Special concern was the radon monitoring. A small amount of radium was used as a source and the radionuclides of concern would be all the daughter products of radium-226. [931]

radon-222 polonium-210,214,218
bismuth-214 lead-210,214
radium-226

1) Radium-226 was the major radionuclide of concern with all others a distant second.[932]

c. (1989) Was D&D'd.[933]

d. (1989 - PRESENT) These rooms are used for calorimetry and use only encapsulated radionuclides. Radioisotopes of concern and their compounds are: [934] [935]

plutonium-238,239 (encapsulated)

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [936]

6.2.36 Room T-234: This room had two functions as discussed below.

a. (1947 - 1972) This was a storage area for reagent chemicals in the polonium-210 process. There were no radionuclides of concern.[937]

b. (1988 - PRESENT) This room is used for a tritium processing operation. Radioisotopes of concern and their compounds are: [938]

tritium

c. See Appendix B for ranking.

6.2.37 Room T-236 (dock)

This dock was used for two programs as discussed below.

a. (1949 - 1973) During the Po-210 operation the irradiated bismuth slugs were unloaded here and then stored in the pool in T-237. Radioisotopes of concern and their compounds are: [939] [940]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[941]

b. (1985 - PRESENT) This is a dock where LSA waste is transferred out of T-Building. It is also where plutonium-238,239 (encapsulated) is received and shipped. Radioisotopes of concern and their compounds are:[942] [943] [944]

tritium	plutonium-238,239

uranium-233,235,238 (encapsulated)

1) Tritium was the major radionuclide of concern with plutonium-238 being a distant second and plutonium-239 third.[945]

6.2.38 Room T-237

This room was used for two major programs as discussed below.

a. (1949 - 1971) Room T-237 was the location of the pool where the irradiated bismuth slugs were deposited when received from Hanford, or other reactor sites. The short half-life radionuclides (impurities in aluminum can and in the bismuth slug) lost some of their activity and more importantly more of the bismuth-210 was transformed into polonium-210, thus enriching the slug. Radioisotopes of concern and their compounds are: [946 947 948 949]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[950]

2) Incident - T-237 (9/28/64, Po-210) [951]

b. (1985 - PRESENT) This room is used for packaging, unpackaging, shipping, and receiving of radioactive materials into T-Building. Common tritium items are commercial tritium sales containers and tritium shipping containers. Common plutonium-238 items include products used in heat sources and calorimetry heat standards for calibration. Radioisotopes of concern and their compounds are: [952 953]

tritium plutonium-238 (encapsulated)

1) Tritium was the major radionuclide of concern with plutonium-238 being a distant second.[954]

2) Incident - (Pu-238, 10/17/86)[955]

6.2.39 Room T-238: This room has the following function:

a. (1985 - PRESENT) This room is used for packaging, unpackaging, shipping, and receiving of radioactive materials into T-Building. Common tritium items are commercial tritium sales containers and tritium shipping containers. Common plutonium-238 items include products used in heat sources and plutonium materials used in processing, calorimetry heat standards for calibration. Radioisotopes of concern and their compounds are: [956] [957]

tritium plutonium-238 (encapsulated)

1) Tritium was the major radionuclide of concern with plutonium-238 being a distant second.[958]

2) Incident - (Pu-238, 10/17/86)[959]

6.2.40 Room T-242

This room had a double function for the polonium neutron source program.

a. (1949 - 1964) This room contained a storage pool for the neutron sources produced in T-277 and T-279. Radioisotopes of concern and their compounds are:

polonium-210

1) Incident - T-242 (10/20/60, Po-210) [960]

b. (1949 - 1960) This area was used to calibrate the polonium-210/beryllium neutron sources produced in T-277 and T-279. This calibration procedure was moved to T-61 and later to T-227. Radioisotopes of concern and their compounds include: [961]

polonium-210

6.2.41 Room T-243

This room was used for two functions as discussed below.

a. (1956 - 1982) This room is the second floor of T-5W. See T-5W for the discussion. Radioisotopes of concern and their compounds include: [962]

tritium tritiated water (HTO)

1) Tritiated water is the major radionuclide of concern with tritium gas being secondary.[963]

b. (1987 - FUTURE) The Tritium Effluent Reduction Facility (TERF) is part of the "Tritium Recycle and Enrichment System." It will replace ERS in SW-8 which will no longer function when TERF is fully on line. However, they will both operate until TERF is fully checked out. To date tritium has never been in the TERF system. [964]

6.2.42 Room T-245: This room had two functions as discussed below.

a. (1949 - 1969) This room was used to store spare parts for polonium process operations. All radionuclides were encapsulated. radioisotopes of concern are:[965]

polonium-210

b. (1968 - 1974) This room was used to store plutonium-238 heat sources. All radionuclides were encapsulated. Radioisotope of concern is:

plutonium-238

6.2.43 Room T-246: This room has two functions as discussed below.

a. (1949 - 1972) This room was a "cold" support lab. There were no radionuclides of concern. [966] [967]

b. (1972 - 1980) This lab used laser photo chemistry in the support of tritium control development. Radionuclides are: [968] [969]

tritium

6.2.44 Room T-247

This room had two important functions as discussed below.

a. (1949 - 1958) This room was a research lab. Radioisotopes of concern and their compounds are:[970 971 972 973]

polonium-210

1) See Appendix B.

b. (1958 - 1966) This room was decontaminated and opened to the cold side of T-Building for a new project.[974]

c. (1966 -1969) This room was a fuel metallurgical compatibility lab for the SNAP-29 program where melting points, encapsulation material compatibility studies and related R&D work were done. Radioisotopes and compounds of concern are: [975 976]

polonium-208,209,210 rare earth polonides

1) See Appendix B for ranking.

6.2.45 Room T-248 --> T-259

These rooms had two functions as discussed below.

a. (1949 - 1965) These rooms were part of the Y-Line work which produced a polonium containing component. Radioisotopes of concern and their compounds are:[977 978 979 980]

polonium-210

1) Rooms T-257 and T-258 had induction heaters used primarily for the recovery of polonium from platinum gauzes. The heaters were also used in filling special orders.[981]

2) See Appendix B.

3) Incident - T-251 (11/17/54, polonium-210) [982]

4) Incident - T-254 (5/26/60, polonium-210) [983]

b. (1966 - 1969) These rooms were renovated to be part of the polonium fuels program (SNAP-29) but never went hot. There are no radionuclides of concern.[984] [985]

c. (1972 - 1992) These rooms were used for support of the heat source program and did not contain radionuclides.

d. Room T-257: (1993 - PRESENT) This room is used to store the "Orphan Sources" before being shipped to PP Building, room PP-113. Gamma ray spectroscopy is used to make some determination as to the contents of the sources before shipping to PP Building. No sources are removed from their containers so possibility of an incident is remote. Radionuclides are in the process of being determined. [986] [987] [988]

6.2.46 Room T-260: This room had the following functions:

a. (1949-1969) Microassay Room - This room was used to prepare samples for microassay from the polonium-210 process lines. The samples were then entered into room T-307 through ports in the walls to measure activity. Radioisotopes of concern and their compounds were:

polonium-210

1) See Appendix B.

b. (1966 - 1969) POLONIUM ISOTOPIC FUELS PROGRAM - A portion of the original T-260 was renovated and became the primary room used for the development of the POODLE and SNAP-29 high specific-power isotopic fuel forms for NASA's space program. Polonium was combined with fine particles of rare earth metals (<44 micron) in a porous refractory metal matrix. In addition, rare earth polonides were prepared for property measurements and characterization studies, material compatibility studies, as well as for fuel encapsulation. These compounds were highly pyrophoric. Radioisotopes of concern and their compounds are: [989] [990]

polonium-208,209,210 rare earth polonides

1) See Appendix B for ranking.

2) Incident - T-260 (8/22/68, polonium-210, Box 10) [991]

6.2.47 Room T-266, 267, 268

These rooms were used for several programs as discussed below.

a. (1949 - 1969) This area was used for the polonium processing steps after the initial dissolution and concentration steps. Radioisotopes of concern and their compounds are: [992 993 994 995]

polonium-210 bismuth-209,210

1) Polonium-210 was the major radionuclide of concern with all others a distant second.[996]

2) Room T-266 had high contamination from the changing of the gloves. There were high urine readings of Po-210 from 9/49 - 2/50.[997] polonium (incident-1966)[998]

3) Incident - T-266 (10/30/64, polonium-210, Glovebox #5) [999]

4) See Appendix B.

b. (1963 - 1966) The south side of this room was used temporarily for polonium fuel development for the Poodle Thruster fuel program until the old Y-Lines were renovated. Upon completing the renovation of the Y-Line area all fuel work was discontinued in this room and moved to the designated new areas (T-260, 247). Radioisotopes of concern and their compounds are: [1000]

polonium-208,209,210 rare earth polonides

1) See Appendix B for ranking.

c. (1966 - 1968) This room was renovated as part of the T-Building Modification Project FY-1966 through FY-1968. [1001 1002]

d. (1970 - 1973) This room was decontaminated.

e. (1988 - PRESENT) Tritium Engineering and Development Lab (TEDL) used this room to conduct experiments with new types of tritium concepts, tritium processing hardware, tritium containment concepts and hardware, and tritium instrumentation, isotopic separation processes, new metal hydride pumping concepts, and microballoons used in the fusion program at other DOE sites. A variety of tritiated compounds could be found there along with the uranium beds which are used for the storage of tritium. Radioisotopes of concern and their compounds are:[1003 1004 1005 1006]

tritium uranium-238 tritide

1) Tritium was the major radionuclide of concern with uranium-238 being a distant second.[1007]

2) See Appendix B.

6.2.48 Room T-270

(1949 - 1963) This area was used for the polonium processing steps after the initial dissolution and concentration steps. Radioisotopes of concern and their compounds are: [1008 1009 1010 1011]

polonium-210 bismuth-209,210

a. Polonium-210 was the major radionuclide of concern with all others being a distant second.[1012]

b. Room T-270 had high contamination from the changing of the gloves. There were high urine readings of Po-210 from 9/49 - 2/50.[1013]

c. Incident - T-270 (10/12/67, polonium-210) [1014]

d. See Appendix B.

6.2.49 Room T-274

This room was used for several projects as discussed below:

a. (1948 -1971) This room was used to load the aluminum can containing the bismuth slug into a slanting tube which extended into rooms T-57

and T-59 where the dissolving occurred. The slugs were brought from the pool (T-237) in a shielded container. There was little chance of an uptake although much beta and gamma radiation was received as an external dose. This room also contained the hydrochloric, nitric, and formic acid used in rooms T-57 and T-59. See rooms T-57 or T-59 for possible radionuclides found in the aluminum can and bismuth slug. [1015] [1016]

b. (1966 - 1969) The NW corner of this room was used for the development of new methods of processing the bismuth slugs. Intentions were to get away from the aqueous methodology and gear up for larger quantities of polonium. Radionuclides of concern are those irradiated impurities in the bismuth slug and the aluminum can:[1017]

iron-55,59	cobalt-60
lead-209	zinc-65
chromium-55	gallium-70,72
cesium-137	selenium-75
bismuth-210	antimony-124
tellurium-121-->134?	mercury-203
polonium-208,209,210	tin-121
silicon-31	vanadium-52
strontium-90	silver-112

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1018]

c. (1986 - PRESENT) Hydrogen Isotope Separation System (HISS) is part of the "Tritium Recycle and Enrichment System." Because of the length of the distillation columns the system extends through the floor down into T-57. It is a tritium enrichment system that employs low-temperature distillation as the separation process. The distillate is returned to the ERS. No waste stream is generated by the HISS. Radioisotopes of concern and their compounds are: [1019] [1020]

tritium	uranium-238 tritide

1) Tritium was the major radionuclide of concern with uranium-238 being a distant second.[1021]

6.2.50 Rooms T-275 and T-276

(1949 - 1969) These were the chemical operations rooms where an elevated operating platform was used to access valves and doors by remote operations. This was used to access the operations in T-57 and T-59 and there were usually no radionuclides except when small spills occurred. These two rooms were above the basement room T-58 but below the second floor room T-274. Radioisotopes of concern and their compounds are:[1022 1023 1024 1025]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1026]

6.2.51 Room T-277 and T-279

These rooms were used for a variety of programs as discussed below.

a. (1949 - 1967) The polonium neutron source program primarily used beryllium, although research was also done with boron, lithium, and other metals. All commercial neutron source work began to be phased out around 1961 although some remained until 1964. Most of the work was moved to the Monsanto, Nicholas Road plant and the Poodle program began to be moved in. Radioisotopes of concern and their compounds are: [1027 1028 1029]

polonium-210	americium-241 [1030]

1) See Appendix B for ranking.

2) Incident - T-277 and 279 (11/27/56, 11/11/60 polonium-210) [1031]

b. (1962 - 1969) This room was also used to pack and ship polonium produced in the P & E lines (T-266 and T-270) to universities and other contractors. Radioisotopes of concern and their compounds are: [1032]

polonium-210

c. (1963 - 1965) The Poodle Heat Source program was located in this room along with work being done in T-260, T-61, and T-61A. Assembly of the Poodle Thruster fuel capsules was accomplished in this area. The polonium-210 heat sources were already encapsulated so that little danger existed from uptakes. The assemblies were then taken to T-61 and T-61A. [1033] [1034]

1) Poodle thruster using polonium-210 was demonstrated in 1965. [1035]

d. (1964 - 1969) A corner of this room was used for the development of new methods of processing the bismuth slugs. Radioisotopes of concern and their compounds include: [1036]

polonium-210 bismuth-209,210

1) Polonium-210 was the major radionuclide of concern with all others being a distant second. [1037]

6.2.52 Room T-300A

This area is used to store the "Orphan Sources" before being shipped to PP Building, room PP-113. Gamma ray spectroscopy is used to make some determination as to the contents of the sources before shipping to PP Building. No source is removed from its container, so possibility of an incident is remote. Radionuclides of concern are uncertain.[1038] [1039] [1040]

6.2.53 Room T-307

This room was used for several functions as discussed below.

a. (1949 - 1964) This room was used for low geometry alpha counters to monitor the purity of the polonium-210 deposition on the platinum

micro-gauzes/foils. All samples entered this room through little ports in the walls. Little opportunity for an incident existed. Radioisotopes of concern and their compounds are: [1041] [1042]

polonium-210

b. (1964 - 1972) This was a bioassay analysis lab where polonium-210 and plutonium-238,239 samples were counted for low level environmental readings.

c. (1972 - 1980) Metals such as tantalum, niobium, and stainless steel were diffused with helium-3 which also may contain trace quantities of tritium. Measurements of the retention of the helium was made in this area. This is considered a cold lab. Radioisotopes of concern and their compounds are: [1043] [1044]

tritium

d. (1980 - PRESENT) This room provides facilities and equipment for the research, development, design, calibration, fabrication, and maintenance of tritium monitors. There was less than 1000 curies in this room at any one time and it was stored in fumehoods. Tritium monitors are tested with all gaseous waste discharged to ERS. Sample preparations of tritium are made in this room. Radioisotopes of concern and their compounds are: [1045]

tritium

6.2.54 Room T-310

This room was used for several functions as discussed below.

a. (1949 - 1969) This room was used as an assay lab for the polonium processing work. Samples were taken from the dissolving chambers (T-57 and T-59) and the P&E Lines (T-266, T-270) and contained radionuclides from the impurities in the aluminum cans and the bismuth as well as polonium. Radioisotopes of concern and their compounds are: [1046] [1047]

iron-55,59	silicon-31
cobalt-60	lead-209

tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1048]

2) This room also contained a storage vault (T-310A) for the processed polonium-210. [1049]

3) Incident - T-310A (12/16/60, polonium-210) [1050]

b. (1969 - 1983) This room is a calorimetric measurement and application facility which contains heat standards and sources. These facilities are used to verify contents for shipping and receiving and to do leak checking. All radionuclides are encapsulated. Radioisotopes of concern and their compounds are: [1051 1052 1053]

plutonium-238,239,240,241	promethium-147
uranium-233,235	americium-241
tritium	

1) Plutonium-238 is the major radionuclide of concern with tritium being second and plutonium-239 being third.[1054]

c. (1986 - PRESENT) This room is used for calorimetry and uses only encapsulated radionuclides. Radioisotopes of concern and their compounds are: [1055 1056]

plutonium-238,239 (encapsulated)

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [1057]

6.2.55 Rooms T-311: This room had several functions as discussed below.

a. (1949 - 1969) This room was used as a lab to prepare (decontaminate) samples from T-310 and make ready for calorimetry which is adjacent to this room. Radioisotopes of concern and their compounds are: [1058] [1059]

polonium-210

1) Incident - T-311 (11/1/67, polonium-210) [1060]

b. (1986 - PRESENT) This room is used for calorimetry and use only encapsulated radionuclides. Radioisotopes of concern and their compounds are: [1061] [1062]

plutonium-238,239 (encapsulated)

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [1063]

6.2.56 Room T-319

(1949 - PRESENT) This room performs calorimetric measurements and contains heat standards and sources. These facilities are used to verify contents for shipping and receiving and to do leak checking. All radionuclides are encapsulated. Radioisotopes of concern and their compounds are:[1064] [1065] [1066]

plutonium-238,239,240,241	promethium-147
uranium-233,235	americium-241
tritium	

a. Plutonium-238 is the major radionuclide of concern with tritium being second and plutonium-239 being third.[1067]

6.2.57 The following room-floors have a high "fixed" radiation potential because of pipes and sumps from the old polonium program. These include T-43, T-44, T-48, T-50, T-57, T-58, T-59, and corridor-51. The radioisotopes of concern in this area are:[1068]

cobalt-60	cesium-137

strontium-90

a. Cobalt-60 is the major radionuclide of concern with cesium-137 being second and strontium-90 third.[1069]

b. Incident - T-Corridor-20 (10/20/61, Po-210) [1070]

6.2.58 See Appendix B for T-Building rooms T-1W, 2W, 4E, 36, 36A, 48, 49, 50, 234, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 266, 267, 268, 269, 270, 271, 277, 279.

7. WD AND WDA BUILDINGS

7.1 WD OVERVIEW

WD Building became operational in February of 1949 and is the central facility for the treatment of liquid radioactive wastes at Mound. A low level alpha waste water system existed from its inception with alpha waste water sources being SW, R, PP, SM, HH, T, B, and H Buildings. The alpha waste water was pre-treated for solid waste/sludge before arriving at WD Building when SM and PP were operational. The pretreatment has been discontinued. Upon arriving at WD Building the waste water is precipitated, coagulated, filtered, and the sludge is solidified so it can be shipped off-site. The supernatant from the clarifloculator is filtered, neutralized to the proper pH, monitored to ensure below standard, and released into the Great Miami River. [1071]

All references to plutonium-238 was of the mixture ratio identified below. This mixture also included trace amounts of americium-241 and neptunium-237, uranium-234.[1072] This information was obtained from MLM-1564 (AEC Research and Development Report), page 31.

1E-4% Pu-236
80.2% Pu-238
15.9% Pu-239
3.0% Pu-240
0.6% Pu-241
0.1% Pu-242

Note: MLM-1564 also makes reference to other mixtures.

Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241. [1073]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

All radionuclides are ranked according to the degree of concern for uptake and amount of activity for internal dosimetry considerations. Rooms which are referenced to Appendix B for additional radionuclides do not have a ranking in this manual since the ranking is done in Appendix B where all radionuclides are listed. This situation is identified as "see Appendix B for ranking." Rooms where additional information on processing or radionuclides in Appendix B does not effect the ranking are identified as "see Appendix B" only.

7.2 WDA OVERVIEW

The WDA alpha waste water treatment facility was constructed in 1966 as an annex onto the WD Building for the treatment of plutonium waste water from the SM and PP Buildings. The facility was designed as both a high-risk drumming station and a low-risk waste water treatment system. The WDA facility replaced the waste treatment facility in SM-1. In August of 1967, the low-risk waste water facility was first used in conjunction with the WTS (Waste Transfer System) pipeline. The high-risk portion of the pipeline was not operational until April 1968. In 1970, the WDA facility was placed in standby status when the polonium operations diminished in activity and the larger WD facility was renovated for the treatment of plutonium waste water.

The Beta Waste water Treatment System began in 1967 with the tritiated waste water sources being SW, R, and HH Buildings. A simple process was used which blended the tritiated water with raw water such that the final concentration was below the acceptable level. This waste water was discharged into disposal pipes where further dilution resulted from other non-tritiated streams uniting in the same disposal pipe as all was transferred to the Great Miami River. This method of disposal terminated in 1971 when a tanker truck loading facility became operational and hauled the tritium waste water to an off-site disposal site. [1074]

In March of 1973 the beta treatment system became operational using ceramic tile pipes. Low-level tritium-contaminated liquid wastes, primarily from shower and decontamination operations in the SW and T-Buildings, are transported to the WDA facility. In about 1977 the pipes were changed to doubly enclosed above ground pipelines. Solidification of all beta waste water in 55-gallon drums is done which is then shipped off-site. [1075]

Table 7 is a summary of rooms, dates, and radioisotopes for WD Building.

Table 7 - WD/WDA BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
WD-1, 8, 101, 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.	1949-1958
	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 radioisotopes, 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-238(D,T), U-235,238,239, Pu-238,239 Am-241, Rn-222, Po-208,209,210,214,218 & Po-210 daughters, Bi-210,214, Pb-210,214, Ra-223,224,226 & Ra daughters, U(D,T), Li(D,T), U/Al(D,T).	1973-PRES
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

Table 7 - WD/WDA BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
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 $Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, PuO_2, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, $Pu(OH)_4$, PuF_4, $PuCl_4$, (also nitrate, sulfate, and fluoride compounds of Am-241, Np-237, and U-234)	1966-1970
	H-3	1967-PRES
WDA-112	Pu-236,238,239,240,241 $Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, PuO_2, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, $Pu(OH)_4$, PuF_4, $PuCl_4$, (also nitrate, sulfate, 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-PRES
WD-PENT-HOUSE	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-PRES

Note: All references to plutonium-238 was of the mixture ratio identified in the introduction to WD Building above. This mixture also included trace amounts of americium-241, neptunium-237, and uranium-234. Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241.[1076]

Note: Polonium was no longer processed after 1973.

7.3 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS

7.3.1 Room WD-1

This room contained the sand filters for water leaving the chlarifloculators in the polonium water treatment process. The treated waste water was then sent to the effluent tanks where, after monitoring for activity, was released to the Great Miami River. 1980 two "bone-char" column filters were installed in this room along with 1-micron high filtering system used to ensure proper effluent waste water. The sludge from the chlarifloculators was also drummed in this room. Because of the drumming operations this room was also highly contaminated. Radioisotopes of concern and their compounds are:

a. (1949-1958) This is the location for the polonium water treatment coming from T-Building. Radioisotopes of concern were/are: [1077] [1078] [1079]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1080]

2) The northern side of WD building was contaminated by an overflow of WD influent tanks containing polonium 210 and cobalt-60. [1081]

b. (1949 - 1990) Aqueous waste from operations in R and SW Buildings also contained a multitude of radionuclides. Decontamination operations of plutonium facilities are also responsible for alpha waste water. Radionuclides from aqueous waste include the following: [1082]

americium-241	protactinium-231
actinium-227	radium-223,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium bromide	actinium fluoride
potassium-40	barium nitrate
uranium-234,235,238	plutonium-238,239 (plus others)
polonium-208,209,210	neptunium-237
tritium	rare earth isotopes
uranium oxide	tellurium-121-->134?
uranium-234,235,238	iron-55,59
tritiated octane	cesium-137
cobalt-60	strontium-90

1) Polonium-210 was the major radionuclide of concern with tritium and plutonium-238 being equally a secondary concern. Actinium-227 and protactinium-231 would be equally a distant third.[1083]

2) Note: Major processing of actinium ceased by 1953 but clean-up continued until 1960.

3) See Appendix B.

c. (1955) A pilot project for the thorium-232 (Monex process) program was initiated in the spring of 1955 but was cancelled in May, 1955. Although some thorium sludge (Brazilian Monazite) was placed in WD Building, no processing was done. Possible radionuclides of concern, if leaking occurred were: [1084] [1085] [1086]

thorium-228,232	radium-224,228
uranium-238	

1) Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. [1087]

2) The thorium sludge was removed in the first quarter of 1956.[1088]

d. (1961 - 1974) Operations in the SM Building resulted in low level aqueous wastes consisting of plutonium-bearing ACIDIC solutions which included nitric and hydrofluoric acids. Other constitutes include hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. BASIC waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Radionuclides contained in the plutonium mixture received from SRP such as Am-241, Np-237, and U-234 were in the form of cations. Anions of nitrate, sulfate, and fluoride were also present which often formed compounds with the radionuclides. [1089]

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary. [1090]

2) See Appendix B.

e. (1974 - 1979) Acid waste from the processing of Cotter Concentrate was sent to WD Building by a waste line and also transported by drum. Radioisotopes of concern and their compounds are: [1091] [1092]

thorium-230,232	uranium-234,235,238
plutonium-238,239	radium-223,224,226
actinium-227	protactinium-231

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity. [1093]

c. (1980 - PRESENT) Two tanks used for bone-char filtration were installed in this room along with another "high filtering system used to ensure proper effluent waste water.

7.3.2 Room WD-8

This room, along with WD-101, was the main facility for waste water treatment. Two 60,000 gallon chlarifloculator tanks used for processing extended through the floor of WD-101 into the basement which is WD-8. This room also contained the pump for putting the chemicals used for treatment into chlarifloculators. Pumps for removing the sludge from the chlarifloculators are also located there. The following major programs were supported by these rooms:

a. (1949-1958) This is the location for the polonium water treatment coming from T-Building. Radioisotopes of concern were/are: [1094] [1095] [1096]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1097]

2) The northern side of WD building was contaminated by an overflow of WD influent tanks containing polonium 210 and cobalt-60. [1098]

b. (1949 - 1990) Aqueous waste from operations in R and SW Buildings also contained a multitude of radionuclides. Decontamination operations of plutonium facilities are also responsible for alpha waste water. Radionuclides from aqueous waste include the following: [1099]

americium-241	protactinium-231
actinium-227	radium-223,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium bromide	actinium fluoride

potassium-40	barium nitrate
uranium-234,235,238	plutonium-238,239 (plus others)
polonium-208,209,210	neptunium-237
tritium	rare earth isotopes
uranium oxide	tellurium-121-->134?
uranium-234,235,238	iron-55,59
tritiated octane	cesium-137
cobalt-60	strontium-90

1) Polonium-210 was the major radionuclide of concern with tritium and plutonium-238 being equally a secondary concern. Actinium-227 and protactinium-231 would be equally a distant third.[1100]

Note: Major processing of actinium ceased by 1953 but clean-up continued until 1960.

2) See Appendix B.

c. (1955) A pilot project for the thorium-232 (Monex process) program was initiated in the spring of 1955 but was cancelled in May, 1955. Although some thorium sludge (Brazilian Monazite) was placed in WD Building, no processing was done. Possible radionuclides of concern, if leaking occurred were: [1101] [1102] [1103]

thorium-228,232	radium-224,228
uranium-238	

1) Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. [1104]

2) The thorium sludge was removed in the first quarter of 1956.[1105]

d. (1961 - 1974) Operations in the SM Building resulted in low level aqueous wastes consisting of plutonium-bearing ACIDIC solutions which included nitric and hydrofluoric acids. Other constitutes include hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. BASIC waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Radionuclides contained in the plutonium mixture received from SRP such as Am-241, Np-237, and U-234 were in the form

of cations. Anions of nitrate, sulfate, and fluoride were also present which often formed compounds with the radionuclides. [1106]

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary. [1107]

2) See Appendix B.

e. (1974 - 1979) Acid waste from the processing of Cotter Concentrate was sent to WD Building by a waste line and also transported by drum. Radioisotopes of concern and their compounds are: [1108] [1109]

thorium-230,232	uranium-234,235,238
plutonium-238,239	radium-223,224,226
actinium-227	protactinium-231

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity. [1110]

7.3.3 Room WDA-9

(1973 - PRESENT) This room had the pumps for the two influent holding tanks for tritium waste water. This tritium waste water was sent to WDA-110 for solidified and drumming for off-site deposition. Radionuclides of concern are: [1111]

radon-222	polonium-208,209,210,214,218
bismuth-210,214	lead-210,214
radium-223,224,226	uranium tritide
tritium	uranium-235,238,239

plutonium-238,239	lithium tritide
americium-241	aluminum/uranium tritide
polonium-210 daughters	radium daughters

any radionuclide used in T and SW Bldg.

a. Tritium is the major radionuclide of concern with any others be a distant second. Residuals are possible as evidenced by the plutonium incident. [1112]

7.3.4 Room WDA-10

(1961 - 1974) This room had two 400 gallon holding tanks for high level influent coming from SM and PP Buildings by way of the pumping station in Building 42. Operations in the SM Building resulted in aqueous wastes consisting of high activity, plutonium-bearing ACIDIC solutions which included nitric and hydrofluoric acids. Other constitutes include hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. BASIC waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Radionuclides contained in the plutonium mixture received from SRP such as Am-241, Np-237, and U-234 were in the form of cations. Anions of nitrate, sulfate, and fluoride were also present which often formed compounds with the radionuclides. This room was used to solidify and drum the waste. Radionuclides of concern are: [1113]

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

a. Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary. [1114]

b. This room was highly contaminated and often necessitated bubble suit use because of leaking drums and splattering of waste. Vapors carried

radionuclides all over the room. A corncobb absorbant was used for most of this period of time and the waste would settle out in the bottom of the drums. A plastic liner was used in the metal drums but would often tear. The acidic waste would quickly corrode the drum and leaking was common. Polyethylene drums were later used. This room was a mess![1115]

c. A high risk filter bank was also located in this room. It is still needed because this room is so hot.

7.3.5 Room WD-101

This room along with WD-8 was the main facility for waste water treatment. Two 60,000 gallon chlarifloculator tanks used for processing extended through the floor of WD-101 into the basement which is WD-8. This room also contained the inffluent tanks used for receiving the waste water, and then through chemicals pumped in from WD-8 and aggitation, the water was treated before being sent to the chlarifloculators for precipitation. The following major programs were supported by these rooms:

a. (1949-1958) This is the location for the polonium water treatment coming from T-Building. Radioisotopes of concern were/are: [1116] [1117] [1118]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1119]

2) The northern side of WD building was contaminated by an overflow of WD influent tanks containing polonium 210 and cobalt-60. [1120]

b. (1949 - 1990) Aqueous waste from operations in R and SW Buildings also contained a multitude of radionuclides. Decontamination operations of plutonium facilities are also responsible for alpha waste water. Radionuclides from aqueous waste include the following: [1121]

americium-241	protactinium-231
actinium-227	radium-223,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium bromide	actinium fluoride
potassium-40	barium nitrate
uranium-234,235,238	plutonium-238,239 (plus others)
polonium-208,209,210	neptunium-237
tritium	rare earth isotopes
uranium oxide	tellurium-121-->134?
uranium-234,235,238	iron-55,59
tritiated octane	cesium-137
cobalt-60	strontium-90

1) Polonium-210 was the major radionuclide of concern with tritium and plutonium-238 being equally a secondary concern. Actinium-227 and protactinium-231 would be equally a distant third.[1122]

Note: Major processing of actinium ceased by 1953 but clean-up continued until 1960.

2) See Appendix B.

c. (1955) A pilot project for the thorium-232 (Monex process) program was initiated in the spring of 1955 but was cancelled in May, 1955. Although some thorium sludge (Brazilian Monazite) was placed in WD Building, no processing was done. Possible radionuclides of concern, if leaking occurred were: [1123] [1124] [1125]

thorium-228,232	radium-224,228
uranium-238	

1) Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. [1126]

2) The thorium sludge was removed in the first quarter of 1956.[1127]

d. (1961 - 1974) Operations in the SM Building resulted in low level aqueous wastes consisting of plutonium-bearing ACIDIC solutions which included nitric and hydrofluoric acids. Other constitutes include hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. BASIC waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Radionuclides contained in the plutonium mixture received from SRP such as Am-241, Np-237, and U-234 were in the form of cations. Anions of nitrate, sulfate, and fluoride were also present which often formed compounds with the radionuclides. [1128]

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary. [1129]

2) See Appendix B.

e. (1974 - 1979) Acid waste from the processing of Cotter Concentrate was sent to WD Building by a waste line and also transported by drum. Radioisotopes of concern and their compounds are: [1130] [1131]

thorium-230,232	uranium-234,235,238
plutonium-238,239	radium-223,224,226
actinium-227	protactinium-231

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity. [1132]

7.3.6 Room WD-104

(1949 - PRESENT) This is the lab for monitoring of waste water effluents and treatment processes. Radionuclides of concern are:

a. (1949-1958) This is the location for the polonium water treatment coming from T-Building. Radioisotopes of concern were/are: [1133 1134 1135]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1136]

2) The northern side of WD building was contaminated by an overflow of WD influent tanks containing polonium 210 and cobalt-60. [1137]

b. (1949 - 1990) Aqueous waste from operations in R and SW Buildings also contained a multitude of radionuclides. Decontamination operations of plutonium facilities are also responsible for alpha waste water. Radionuclides from aqueous waste include the following: [1138]

americium-241	protactinium-231
actinium-227	radium-223,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium bromide	actinium fluoride
potassium-40	barium nitrate
uranium-234,235,238	plutonium-238,239 (plus others)
polonium-208,209,210	neptunium-237
tritium	rare earth isotopes
uranium oxide	tellurium-121-->134?

uranium-234,235,238	iron-55,59
tritiated octane	cesium-137
cobalt-60	strontium-90

1) Polonium-210 was the major radionuclide of concern with tritium and plutonium-238 being equally a secondary concern. Actinium-227 and protactinium-231 would be equally a distant third.[1139]

2) Note: Major processing of actinium ceased by 1953 but clean-up continued until 1960.

3) See Appendix B.

c. (1955) A pilot project for the thorium-232 (Monex process) program was initiated in the spring of 1955 but was cancelled in May, 1955. Although some thorium sludge (Brazilian Monazite) was placed in WD Building, no processing was done. Possible radionuclides of concern, if leaking occurred were: [1140] [1141] [1142]

thorium-228,232	radium-224,228
uranium-238	

1) Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. [1143]

2) The thorium sludge was removed in the first quarter of 1956.[1144]

d. (1961 - 1974) Operations in the SM Building resulted in low level aqueous wastes consisting of plutonium-bearing ACIDIC solutions which included nitric and hydrofluoric acids. Other constitutes include hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. BASIC waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Radionuclides contained in the plutonium mixture received from SRP such as Am-241, Np-237, and U-234 were in the form of cations. Anions of nitrate, sulfate, and fluoride were also present which often formed compounds with the radionuclides. [1145]

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate

plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary. [1146]

2) See Appendix B.

e. (1974 - 1979) Acid waste from the processing of Cotter Concentrate was sent to WD Building by a waste line and also transported by drum. Radioisotopes of concern and their compounds are: [1147] [1148]

thorium-230,232	uranium-234,235,238
plutonium-238,239	radium-223,224,226
actinium-227	protactinium-231

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity. [1149]

7.3.7 Room 107 and basement

(1976 - 1981) This area used an ultra filtration concept and sometimes reverse osmosis to remove the following radioisotopes from waste water. This was a historical operation which has been discontinued. The equipment has been dismantled and removed. [1150] [1151]

cesium-137	americium-241
uranium-235,238	neptunium-237

a. These were all in trace amounts and are of equally little concern.[1152]

7.3.8 Room WD-108

(1949 - 1981) This room had a stack with filter which was highly contaminated. It was removed in 1981. Radionuclides of concern are:

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

7.3.9 Room WD-110

This room had the following functions:

a. Room WDA-110 (1966 - 1970) The WDA alpha waste water treatment facility replaced the low-risk waste treatment facility in SM-1 in August of 1967. The facility was designed as both a high-risk drumming station and a low-risk waste water treatment system for PP Building. The high-risk waste water treatment became operational in April 1968. In 1970 the WDA facility ceased its alpha waste water operations with the larger WD facility having been renovated for the treatment of plutonium waste water. Radioisotopes and compounds of concern are: [1153] [1154]

plutonium nitrate pentahydrate	plutonium-hydroxide
plutonium-hexanitrate	plutonium-nitrate
plutonium-dioxide	plutonium-oxide hydrate
(high-fired and non-high-fired)	
plutonium-tetrachloride	
plutonium-tetrafluoride	

(also nitrate, sulfate, and fluoride compounds of Am-241, Np-237, and U isotopes)

b. Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [1155]

7.3.10 Room WDA-110

(1967 - PRESENT) The Beta Waste water Treatment System began in 1967 with the low-level tritium contaminated liquid wastes from shower and decontamination operations in the SW Building being transported to the WDA facility in doubly enclosed above ground pipelines. Drums of liquid waste water from T-Building comes to WDA. The tritiated water was diluted with raw water such that the final concentration was below the acceptable level. This beta waste water was discharged into disposal pipes to the Great Miami River. This method of disposal terminated in 1971 when a tanker truck loading facility became operational and hauled the tritium waste water to an off-site disposal site. In March of 1973 all beta waste water was solidified in 55-gallon drums and then was shipped off-site. Radioisotopes of concern and their compounds are: [1156]

tritium

a. See Appendix B for ranking.

7.3.11 Room WDA-112

Two major phases of analytical work were done for the separation of radioisotopes from the waste water.

a. (1966 - 1979) Much work was done with Pu-238 and Pu-239 in development of techniques for separation of these radioisotopes from waste water. Additional radioisotopes were also encountered. Radioisotopes of concern were: [1157]

plutonium-236,238,239,240,241,242	polonium-210
plutonium nitrate pentahydrate	iodine-131
plutonium-hexanitrate	plutonium-nitrate
plutonium-dioxide	plutonium-oxide hydrate
(high-fired and non-high-fired)	plutonium-hydroxide
plutonium-tetrachloride	uranium-232,234,238
plutonium-tetrafluoride	cobalt-60

(also nitrate, sulfate, and fluoride compounds of Am-241, Np-237, and U-234)

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [1158]

2) Incident - (Pu-238, 8/1/77)[1159]

b. (1980 - 1984) (perhaps some time before 1980) much work was done with cesium-137 in separation techniques from waste water. A major spill occurred during this time with this radioisotope. Radioisotope of concern is: [1160]

cesium-137

7.3.12 Room WDA-113

(1979 - 1994) This room was used for the storage of radionuclides used in analytical work. These radionuclides were part of the Orphan Source program which were removed in 1994. Radioisotopes of concern were: [1161 1162 1163]

cesium-137	cobalt-60
iodine-131	plutonium-238,239

a. Plutonium-238 was the major radionuclide of concern with cesium-137 being second. [1164]

7.3.13 Room WDA 118 A&B

This room is used for incineration of waste. Two programs were initiated as discussed below. Two Cyclone incinerators were used to burn waste.

a. (1977 - 1981) WDA-118A: A laboratory scale Cyclone incinerator was used to perform tests by spiking the waste before burning. Less than 10 mCi of radioactive material was purchased to be used in the testing. The incinerator was removed in 1981. Radioisotopes of concern and their compounds are: [1165]

cobalt-60	cesium-137
iodine-131	strontium-90

1) All are equally of little concern. [11661167]

b. (1975 - 1985) WDA-118B: A large Cyclone incinerator was actually used to burn wastes for two years in addition to testing. Most work was done

with plutonium although one set of experiments were conducted using tritium. The incinerator was removed in 1990. Radioisotopes of concern and their compounds are: [1168]

plutonium-238,239	tritium

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [1169]

c. (1981 - PRESENT) Room 111B contains a "glass-melter furnace" which consumes ion-exchange resins and scintillation fluid. This system is in place but is not currently in operation. Some of the radionuclides of concern would be: [1170] [1171] [1172]

cobalt-60	cesium-137
manganese-54	strontium-90

1) All were of equal importance. [1173]

7.3.14 Room WD-Penthouse

(1949 - PRESENT) This area houses the filterbank for WD and WDA Buildings. Any radionuclide in the building is likely to have found its way up to the penthouse. Radionuclides of concern are:[1174]

thorium-230,232	uranium-234,235,238
plutonium-238,239	radium-223,224,226,228
actinium-227	protactinium-231
cesium-137	americium-241
neptunium-237	tritium
polonium-208,209,210	tellurium-121-->134?
cobalt-60	iron-55,59
strontium-90	

a. Incident - (Pu-238, 11/12/75)[1175]

7.3.15 Tanks/WDA

Incident - (Pu-238, 5/26/72)[1176]

7.3.16 Cleaning of tanks and equipment in WD Building occurred several times as discussed below which would give opportunity for incidents and uptakes. Radionuclides of concern could have been any of the above, especially those mentioned with WD-1 and WD-101.[1177] [1178]

a. (1953) WD Influent Tanks / Tank "A": Decontamination of actinium in this tank was started in March, 1953. [1179]The Tank A was completed in May, 1953 and the decontamination work on tank B was started in May, 1953. [1180]Tank B was completed in July, 1953 and Tank C was started in July, 1953.[1181]

b. (1954) The overflow tanks on the sand filters were cleaned in 1954.

c. (1956) The clariflocculator tanks were emptied, cleaned, and painted.

d. (1958) The influent tanks were again cleaned and repaired.

e. (1964) The large influent tanks were sandblasted and painted along with the clariflocculators.

8. ENDNOTES AND REFERENCES

Note: The dates given here represent the date the person was contacted, and not when he was employed.

1. Paul Lamberger, 10/93, Specialist, Senior-1

2. William Eckenrode, 8/93, Master Engineering Technician for HH Building

3. Paul Lamberger, 10/93, Specialist, Senior-1

4. Reed Watkins, 2/94, Retired, HH Building Employee

5. Dick Vallee, 3/94, Vice President EG&G Mound

6. William Eckenrode, 8/93, Master Engineering Technician for HH Building

7. Dave Jones, 2/94, Research Technician in HH Building

8. Reed Watkins, 2/94, Retired, HH Building Employee

9. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

10. William Eckenrode, 8/93, Master Engineering Technician for HH Building

11. Charles Eck, 2/94, Retired 1975

12. Dave Jones, 2/94, Research Technician

13. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;75

14. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 8.

15. Memo on 1/1/56 discussing Pa-231 separation being set up in HH Building.

16. Quarterly Health Physics Report, October through December 1956, 1/15/57, page 10.

17. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

18. Joe Garner, 1/94, Supervisor Health Physics

19. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;58-60

20. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 7.

21. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 4, 7.

22. Separation of Protactinium from Uranium Residues, Murrell Salutsky, Kenneth Shaver, Andrew Elmlinger, Mary Lou Curtis, Journal of Inorganic Nuclear Chemistry, Pergamon Press Ltd., London, 1956, Vol. 3, page 289-295.

23. Paul Figgins, 11/93, Senior Research Specialist

24. Ranking was by Paul Figgins, 1/95

25. William Eckenrode, 8/93, Master Engineering Technician for HH Building

26. Paul Lamberger, 10/93, Specialist, Senior-1

27. Reed Watkins, 2/94, Retired, HH Building Employee

28. Dick Vallee, 3/94, Vice President EG&G Mound

29. William Eckenrode, 8/93, Master Engineering Technician for HH Building

30. Dave Jones, 2/94, Research Technician in HH Building

31. Reed Watkins, 2/94, Retired, HH Building Employee

32. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

33. William Eckenrode, 8/93, Master Engineering Technician for HH Building

34. Charles Eck, 2/94, Retired 1975

35. Dave Jones, 2/94, Research Technician

36. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;75

37. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 8.

38. Memo on 1/1/56 discussing Pa-231 separation being set up in HH Building.

39. Quarterly Health Physics Report, October through December 1956, 1/15/57, page 10.

40. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

41. Joe Garner, 1/94, Supervisor Health Physics

42. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;58-60

43. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 7.

44. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 4, 7.

45. Separation of Protactinium from Uranium Residues, Murrell Salutsky, Kenneth Shaver, Andrew Elmlinger, Mary Lou Curtis, Journal of Inorganic Nuclear Chemistry, Pergamon Press Ltd., London, 1956, Vol. 3, page 289-295.

46. Paul Figgins, 11/93, Senior Research Specialist

47. Ranking was by Paul Figgins, 1/95

48. Paul Lamberger, 10/93, Specialist, Senior-1

49. CERCLA, Vol. 7, Waste Management, Weston Inc., 7/92, page 2;6-9

50. Paul Lamberger, 11/93, Specialist, Senior-1

51. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

52. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/63, page 8

53. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

54. CERCLA, Vol. 7, Waste Management, Weston Inc., 7/92, page 2;6-8

55. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

56. Dick Vallee, 3/94, Vice President EG&G Mound

57. Reed Watkins, 2/94, Retired, HH Building Employee

58. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

59. Reed Watkins, 2/94, Retired, HH Building Employee

60. Paul Lamberger, 10/93, Specialist, Senior-1

61. CERCLA, Vol. 7, Waste Management, Weston Inc., 7/92, page 2;6-9

62. Paul Lamberger, 11/93, Specialist, Senior-1

63. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

64. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/63, page 8

65. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

66. CERCLA, Vol. 7, Waste Management, Weston Inc., 7/92, page 2;6-8

67. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

68. Dick Vallee, 3/94, Vice President EG&G Mound

69. Reed Watkins, 2/94, Retired, HH Building Employee

70. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

71. Paul Figgins, 11/93, Senior Research Specialist

72. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

73. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

74. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

75. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

76. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

77. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

78. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

79. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

80. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

81. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

82. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

83. Dick Colvin, 1/94, Analytical Technician

84. Ronald Sohn, 1/94, Previous PP Building Manager

85. Ronald Sohn, 1/94, Previous PP Building Manager

86. Incident #462 - Colvin, Dick., 4/6/87, Pu-239, 240, PP-113

87. Ronald Sohn, 1/94, Previous PP Building Manager

88. Toby Elswick, 6/95, Manager Plutonium Operations / Tritium Production

89. Toby Elswick, 6/95, Manager Plutonium Operations / Tritium Production

90. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

91. Ron Daily, 6/95, Manager of Radiological Instrumentation

92. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

93. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

94. Ernest Johnson, 10/93, Specialist, Heat Source Production

95. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

96. Ernest Johnson, 10/93, Specialist, Heat Source Production

97. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Operations

98. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Operations

99. Ernest Johnson, 10/93, Specialist, Heat Source Production

100. Ernest Johnson, 10/93, Specialist, Heat Source Production

101. Don Rogers, 9/93, Senior Fellow

102. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

103. Ernest Johnson, 10/93, Specialist, Heat Source Production

104. Toby Elswick, 11/93, Manager Plutonium Operations / Tritium Production

105. Don Rogers, 9/93, Senior Fellow

106. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

107. Toby Elswick, 6/95, Manager Plutonium Operations / Tritium Production

108. Toby Elswick, 6/95, Manager Plutonium Operations / Tritium Production

109. Don Rogers, 9/93, Senior Fellow

110. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Operations

111. Ernest Johnson, 10/93, Specialist, Heat Source Production

112. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Operations

113. Toby Elswick, 10/93, Manager Plutonium Operation / Tritium Production.

114. Paul Figgins, 11/93, Senior Research Specialist

115. Toby Elswick, 10/93, Manager Plutonium Operation / Tritium Production.

116. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

117. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

118. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

119. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

120. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

121. Ernest Johnson, 10/93, Specialist, Heat Source Production

122. Paul Figgins, 11/93, Senior Research Specialist

123. MLM-1564, AEC Research and Development Report, page 31

124. Tom Flanagan, 9/93, Specialist ES&H

125. Don Hobrock, 10/93, Senior Fellow

126. Doug Draper, 10/93, Manager RAM

127. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

128. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

129. MLM-MU-59-62-0001, Quarterly Health Physics Report, October through December 1958, 2/2/59, page 8.

130. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 9.

131. Tom Flanagan, 1/94, Specialist ES&H

132. Earl Johns, 2/94, Supervisor of Tritium System Operations

133. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

134. Incident #584 - Murphy, E., 4/10/58, tritium, R-105
No incident # - Phillips, Robert, 8/8/60, tritium, R-105
" - Barnett, D., 6/11/62, " "

135. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 221-222

136. Tom Flanagan, 1/94, Specialist ES&H

137. Jack Melke, 2/94, Senior Development Engineer

138. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

139. Joe Garner, 1/94, Supervisor Health Physics

140. Earl Johns, 2/94, Supervisor of Tritium System Operations

141. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 203-208

142. Tom Flanagan, 1/94, Specialist ES&H

143. Earl Johns, 2/94, Supervisor of Tritium System Operations

144. MLM-MU-59-64-0001, Quarterly Health Physics Report, January through March 1959, 4/29/59, page 4.

145. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

146. Earl Johns, 2/94, Supervisor of Tritium System Operations

147. Tom Flanagan, 1/94, Specialist ES&H

148. Paul Figgins, 2/94, Senior Research Specialist

149. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

150. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 208-214

151. Dave Billing, 2/94, Manager of SW Building

152. Earl Johns, 2/94, Supervisor of Tritium System Operations

153. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

154. Joe Garner, 1/94, Supervisor Health Physics

155. Paul Figgins, 2/94, Senior Research Specialist

156. Ralph Watrous, 4/94, Chemist

157. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

158. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

159. MLM-821, Health Physics Monthly Information Report, 2/28/53, page 4.

160. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

161. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

162. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

163. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

164. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

165. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 222-224

166. Tom Flanagan, 1/94, Specialist ES&H

167. Albert Attalla, 2/94, Analytical Specialist

168. Albert Attalla, 2/94, Analytical Specialist

169. Joe Garner, 1/94, Supervisor Health Physics

170. Paul Figgins, 2/94, Senior Research Specialist

171. MLM-736, Health Physics Information Report, 7/31/52, page 5.

172. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

173. Ralph Watrous, 4/94, Chemist

174. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

175. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

176. Incident, 7/22/52, Watrin, Joe Garner, T. Eyles, Actinium-227, R-114

177. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

178. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

179. Tom Flanagan, 9/93, Specialist ES&H

180. Paul Figgins, 9/93, Senior Research Specialist

181. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

182. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 220-221

183. Tom Flanagan, 1/94, Specialist ES&H

184. Mike Deaton, 1/94, Function Testing Supervisor

185. Jack Melke, 2/94, Senior Development Engineer

186. Joe Garner, 1/94, Supervisor Health Physics

187. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 8.

188. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

189. Incident #519, 8/19/60, Charles Wells, Pu&Be-13, R-116A
Incident #336, 7/19/61, Charles Wells, Pu&Be-13, R-116B

190. Memo on 3/22/56 discusses the use of Pu-238 in room R-116

191. Martin Hertz, 4/94, Senior Research Chemist

192. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

193. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 220-221

194. Don Rogers, 2/94, Senior Fellow

195. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

196. Calvin Love, 2/94, Senior Research Specialist

197. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 222-224

198. Albert Attalla, 2/94, Analytical Specialist

199. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

200. Don Rogers, 2/94, Senior Fellow

201. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

202. MLM-1044, Quarterly Health Physics Report, January through March 1955, 4/12/55, page 6.

203. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

204. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 7.

205. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 4, 7.

206. Paul Figgins, 11/93, Senior Research Specialist

207. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

208. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

209. Joe Garner, 4/94, Supervisor Health Physics

210. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

211. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

212. MLM-736, Health Physics Information Report, 7/31/52, page 5

213. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

214. Joe Garner, 4/94, Supervisor Health Physics

215. Paul Figgins, 2/94, Senior Research Specialist

216. Ralph Watrous, 4/94, Chemist

217. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

218. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

219. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

220. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

221. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 7.

222. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 4, 7.

223. Paul Figgins, 11/93, Senior Research Specialist

224. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

225. Memo on 3/22/56 discusses the use of Th-230 in room R-120

226. MLM-MU-58-68-0001, Quarterly Health Physics Report, April through June 1958, 8/11/58, page 8.

227. Martin Hertz, 4/94, Senior Research Chemist

228. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

229. Don Rogers, 9/93, Senior Fellow

230. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

231. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

232. Incident #518, 7/6/60, Miller, R., Pu-238, R-120
#240, 7/3/63, Boggs, R., " "
#078, 1/28/71, Breakall, K., " "
#311, 8/3/73, Chadwell, C., " "

233. Incident #264 - Apple, H., 1/9/63, Tritium, R-123

234. John Gill, 2/94, Science Fellow

235. Tom Flanagan, 2/94, Specialist ES&H

236. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 14, 52

237. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

238. Doug Draper, 10/93, Manager RAM

239. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 6-8

240. MLM-1028, Quarterly Health Physics Report - October through December 1954, 1/5/55, page 7.

241. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

242. Joe Garner, 4/94, Supervisor Health Physics

243. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

244. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

245. MLM-809, Health Physics Monthly Information Report, 1/31/53, page 5.

246. Dick Vallee, 3/94, Vice President EG&G Mound

247. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 9.

248. Parameters of Thermal Diffusion Columns, Proceedings of the Symposium on Isotope Separation, Amsterdam, 1957, G.R. Grove, K.W. Foster, and R.E. Vallee, page 462-470.

249. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

250. Don Rogers, 9/93, Senior Fellow

251. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

252. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

253. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 52

254. Tom Flanagan, 1/94, Specialist ES&H

255. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

256. Joe Garner, 4/94, Supervisor Health Physics

257. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

258. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

259. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

260. Don Rogers, 2/94, Senior Fellow

261. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

262. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 14, 52

263. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 224-229

264. Tom Flanagan, 1/94, Specialist ES&H

265. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

266. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

267. Joe Garner, 4/94, Supervisor Health Physics

268. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

269. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

270. MLM-736, Health Physics Information Report, 7/31/52, page 5.

271. Joe Garner, 1/94, Supervisor Health Physics

272. Paul Figgins, 2/94, Senior Research Specialist

273. Ralph Watrous, 4/94, Chemist

274. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

275. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

276. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

277. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

278. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

279. Don Rogers, 2/94, Senior Fellow

280. Joe Garner, 1/94, Supervisor Health Physics

281. Tom Flanagan, 1/94, Specialist ES&H

282. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

283. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 52

284. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

285. Joe Garner, 4/94, Supervisor Health Physics

286. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

287. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

288. Don Rogers, 9/93 & 2/94, Senior Fellow

289. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

290. Paul Figgins, 2/94, Senior Research Specialist

291. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

292. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 52

293. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

294. Joe Garner, 4/94, Supervisor Health Physics

295. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

296. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

297. MLM-736, Health Physics Information Report, 7/31/52, page 5

298. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

299. Joe Garner, 4/94, Supervisor Health Physics

300. Paul Figgins, 2/94, Senior Research Specialist

301. Ralph Watrous, 4/94, Chemist

302. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

303. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

304. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

305. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

306. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 7.

307. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 4, 7.

308. Paul Figgins, 11/93, Senior Research Specialist

309. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

310. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

311. Don Rogers, 2/94, Senior Fellow

312. Memo of 3/22/56 discusses the use of Th-230 in room R-133

313. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

314. Richard Carlson, 1/94, Senior Research Chemist

315. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 237-238

316. Steve Tentman, 1/94, Senior Development Engineer

317. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

318. MLM-736, Health Physics Information Report, 7/31/52, page 5

319. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

320. Joe Garner, 4/94, Supervisor Health Physics

321. Paul Figgins, 2/94, Senior Research Specialist

322. Ralph Watrous, 4/94, Chemist

323. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

324. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

325. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

326. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

327. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, Tom Flanagan, and Bob Myers.

328. Paul Figgins, 11/93, Senior Research Specialist

329. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

330. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

331. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

332. Doug Draper, 10/93, Manager RAM

333. Paul Figgins, 11/93, Senior Research Specialist

334. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

335. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

336. Incident #086 - Barnhart, B., 9/27/74, Pu-238, R-140

337. Joe Garner, 1/94, Supervisor Health Physics

338. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

339. Incident #428 - Goode, J., 5/4/50, Radium, R-142

340. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

341. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

342. Joe Garner, 1/94, Supervisor Health Physics

343. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

344. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

345. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

346. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

347. Laurie Brehm, 2/94, Lab Technician

348. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

349. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

350. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

351. Quarterly Health Physics Report, July through September 1955, 10/25/55, page 7.

352. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

353. Don Rogers, 2/94, Senior Fellow

354. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 52

355. Joe Garner, 4/94, Supervisor Health Physics

356. Paul Figgins, 2/94, Senior Research Specialist

357. MLM-736, Health Physics Information Report, 7/31/52, page 4,5.

358. Ralph Watrous, 4/94, Chemist

359. Fractionation of Barium-Radium Mixtures as Chromates, Murrell Salutsky, Joseph Stites, A.W. Martin, November, 1953

360. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

361. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

362. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

363. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

364. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;61

365. Joe Garner, 4/94, Supervisor Health Physics

366. Lerroy Jones, 4/94, Director of Research and Development

367. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

368. Memo on 3/22/56, talks about microcurie quantities of Pa-231 being handled.

369. Paul Figgins, 1/94, Senior Research Specialist

370. MLM-MU-58-68-0001, Quarterly Health Physics Report, April through June 1958, 8/11/58, page 7.

371. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

372. Don Kelly, 10/93, Heat Source Program Manager

373. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

374. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

375. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

376. Incident #019, 5/11/61, E. Bousquet, Pu-238 Oxide, R-145/147
#023, 6/5/62, Ray Steinmeyer, plutonium, R-145

377. No incident # - Redding, Phil, 8/26/65, Pu-238, 239, U-234, R-145

378. Doug Draper, 10/93, Manager RAM

379. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 52

380. Charles Brown, 2/94, Chemist

381. Joe Garner, 4/94, Supervisor Health Physics

382.382. Paul Figgins, 2/94, Senior Research Specialist

383. MLM-736, Health Physics Information Report, 8/31/52, page 4,5.

384. Preparation of Actinium Metal, Joseph Stites, Murrell Salutsky, Bob Stone, Journal of the American Chemical Society, 77, 1955, page 237-240.

385. MLM-821, Health Physics Monthly Information Report, 2/28/53, page 5.

386. Fractionation of Barium-Radium Mixtures as Chromates, Murrell Salutsky, Joseph Stites, A.W. Martin, November, 1953

387. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

388. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

389. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

390. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;60-64

391. Quarterly Health Physics Report, October through December 1956, 1/15/57, page 10.

392. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

393. Memo on 3/22/56, talks about microcurie quantities of Pa-231 being handled.

394. Doug Drapper, 10/93, Manager Radiological Assessment and Measurement

395. Paul Figgins, 11/93 & 2/94, Senior Research Specialist

396. Don Kelly, 3/94, Heat Source Project Manager, Production Support

397. No incident # - 5/19/60, Lucius Jones, Pu-238, R-149
Incident #372 - 6/2/60, Lucius Jones, Pu-238, R-148/149
No incident # - 1/16/63, Redding, Phillip, " R-149
Incident #044 - 4/19/65, Hendrickson, E.; " R-149

NOTE: Paul Figgins believes the Phillip Redding incident occurred in R-151.

398. Joe Garner, 1/94, Supervisor Health Physics

399. Don Kelly, 3/94, Heat Source Project Manager, Production Support

400. Don Rogers, 9/93, Senior Fellow

401. Dick Eppley, 10/93, Manager Isotopic Separation

402. Paul Figgins, 11/93, Senior Research Specialist

403. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

404. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

405. Doug Draper, 10/93, Manager RAM

406. MLM-ML-88-48-0003, Final Report: R-149 Laboratory Decommissioning Project, J.R. Geichman, R.R. Jaeger, V.E. Castleberry, 9/30/88, page 3

407. Paul Figgins, 11/93, Senior Research Specialist

408. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

409. Joe Garner, 4/94, Supervisor Health Physics

410. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

411. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

412. Calvin Love, 10/93, Senior Research Specialist

413. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

414. Paul Figgins, 2/94, Senior Research Specialist

415. MLM-MU-58-68-0001, Quarterly Health Physics Report, April through June 1958, 8/11/58, page 7.

416. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

417. Don Rogers, 9/93, Senior Fellow

418. Incident #083 - Hapner, G., 2/11/74, Pu-238, R-151

419. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

420. Joe Garner, 4/94, Supervisor Health Physics

421. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

422. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

423. MLM-736, Health Physics Information Report, 7/31/52, page 5

424. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

425. Joe Garner, 4/94, Supervisor Health Physics

426. Paul Figgins, 2/94, Senior Research Specialist

427. Ralph Watrous, 4/94, Chemist

428. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

429. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

430. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

431. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

432. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

433. Joe Garner, 4/94, Supervisor Health Physics

434. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

435. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

436. Reactor Fuels and materials Development - Plutonium Research, MLM-1156, 1162, 1171, 1199, 1244, 1262; L.J. Wittenberg and G.R. Grove, 1963 - 1965

437. Paul Figgins, 11/93 & 2/94, Senior Research Specialist

438. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

439. Don Rogers, 9/93, Senior Fellow

440. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

441. Paul Figgins, 11/93, Senior Research Specialist

442. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

443. Joe Garner, 4/94, Supervisor Health Physics

444. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

445. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

446. Reactor Fuels and materials Development - Plutonium Research, MLM-1156, 1162, 1171, 1199, 1244, 1262; L.J. Wittenberg and G.R. Grove, 1963 - 1965

447. Paul Figgins, 11/93 & 2/94, Senior Research Specialist

448. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

449. Don Rogers, 9/93, Senior Fellow

450. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

451. Don Kelly, 3/94, Project Manager, Production Support

452. Paul Figgins, 11/93, Senior Research Specialist

453. Dick Eppley, 10/93, Manager Isotopic Separation

454. MLM-ML-88-48-0003, Final Report: R-149 Laboratory Decommissioning Project, J.R. Geichman, R.R. Jaeger, V.E. Castleberry, 9/30/88, page 3

455. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 14, 52

456. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

457. Joe Garner, 4/94, Supervisor Health Physics

458. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

459. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

460. MLM-821, Health Physics Monthly Information Report, 2/28/53, page 4.

461. Joe Garner, 1/94, Supervisor Health Physics

462.462. Paul Figgins, 2/94, Senior Research Specialist

463. MLM-736, Health Physics Information Report, 8/31/52, page 4,5.

464. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

465. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

466. MLM-809, Health Physics Monthly Information Report, 1/31/53, page 5.

467. MLM-1028, Quarterly Health Physics Report - October through December 1954, 1/5/55, page 7.

468. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

469. Joe Garner, 4/94, Supervisor Health Physics

470. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

471. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

472. MLM-727, Health Physics Monthly Information Report, 6/1/52, page 4.

473. MLM-821, Health Physics Monthly Information Report, 2/28/53, page 4.

474. Joe Garner, 1/94, Supervisor Health Physics

475. Paul Figgins, 2/94, Senior Research Specialist

476. MLM-736, Health Physics Information Report, 8/31/52, page 4,5.

477. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

478. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

479. MLM-798, Health Physics Monthly Report, 12/31/52, page 4

480. MLM-821, Health Physics Monthly Information Report, 2/28/53, page 4,5

481. MLM-621, MLM-MU-51-71-0037, Decontamination Of Process Waste Solutions Containing Fission Products By Adsorption And Coprecipitation Methods, C.S. Lowe, 11/13/51, page 9

482. Larry Bentz, 2/94, Analytical Chemist (Retired - 1974)

483. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;76-83

484. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

485. Larry Bentz, 2/94, Analytical Chemist (Retired - 1974)

486. Larry Bentz, 2/94, Analytical Chemist (Retired - 1974)

487. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

488. Wayne Amos, 2/94, Program Manager Heat Source RTG Programs

489. MLM-MU-58-70-0001, Quarterly Health Physics Report, July through September 1958, 10/23/58, page 9.

490. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

491. Paul Lamberger, 11/94, Specialist, Senior-1

492. MLM-621, MLM-MU-51-71-0037, Decontamination Of Process Waste Solutions Containing Fission Products By Adsorption And Coprecipitation Methods, C.S. Lowe, 11/13/51, page 9

493. Larry Bentz, 2/94, Analytical Chemist (Retired)

494. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;76-83

495. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

496. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;61

497. Lerroy Jones, 4/94, Director of Research and Development

498. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

499. Paul Figgins, 11/93, Senior Research Specialist

500. MLM-MU-58-70-0001, Quarterly Health Physics Report, July through September 1958, 10/23/58, page 9.

501. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

502. Joe Garner, 4/94, Supervisor Health Physics

503. Residue Adsorption-I, Separation of Strontium-90 and Yttrium-90, H.W. Kirby, August 1962, Journal of Inorganic Chemistry, 1963, Vol.25, page 483-499.

504. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

505. Don Rogers, 9/93, Senior Fellow

506. Paul Figgins, 11/93, Senior Research Specialist

507. Letters between Harold Kirby and R.P. Schuman of the Phillips Petroleum Company, Idaho Falls, Idaho, 1960-1965, Ionium Capsules Bur-49-65A.

508. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

509. Memo on 3/22/56 discusses the use of Pa-231 in R-167

510. Incident #105 - Henderson, J., 7/8/83, Cm-244, R-167

511. Lerroy Jones, 4/94, Director of Research and Development

512. Paul Figgins, 11/93, Senior Research Specialist

513. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

514. Richard Carlson, 10/93, Senior Research Chemist

515. Richard Eppley, 10/93, Manager Isotopic Separation

516. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

517. Don Rogers, 2/94, Senior Fellow

518. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

519. Joe Garner, 4/94, Supervisor Health Physics

520. Paul Figgins, 2/94, Senior Research Specialist

521. MLM-736, Health Physics Information Report, 7/31/52, page 4,5.

522. Ralph Watrous, 4/94, Chemist

523. Don Rogers, 2/94, Senior Fellow

524. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

525. Incident #177 - 6/27/51, Economides, M., Radium, R-171, 172

526. Don Rogers, 2/94, Senior Fellow

527. T.B. Rhinehammer, 4/94, Research Chemist

528. T.B. Rhinehammer, 4/94, Research Chemist

529. Richard Eppley, 10/93, Manager Isotopic Separation

530. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

531. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

532. Don Rogers, 2/94, Senior Fellow

533. Incident #095 - Pitre, E., 9/8/78, tritium, R-176

534. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

535. Paul Figgins, 2/94, Senior Research Specialist

536. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

537. Phillip Rhude, 4/94, Supervisor Health Physics

538. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

539. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 14, 52

540. Don Hobrock, 10/93, Senior Fellow

541. Paul Figgins, 1/94, Senior Research Specialist

542. Joe Garner, 1/94, Supervisor Health Physics

543. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

544. MLM-ML-88-48-0003, Final Report: R-149 Laboratory Decommissioning Project, J.R. Geichman, R.R. Jaeger, V.E. Castleberry, 9/30/88, page 3

545. Incident #184 - Jordan, C., 1/31/89, Ac-227, R-Corr 5

546. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, Tom Flanagan, and Bob Myers.

547. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

548. Don Rogers, 9/93, Senior Fellow

549. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

550. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

551. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

552. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

553. Ernest Johnson, 10/93, Specialist, Heat Source Production

554. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

555. Ernest Johnson, 10/93, Specialist, Heat Source Production

556. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

557. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

558. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

559. Calvin Love, 10/93, Senior Research Specialist

560. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

561. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

562. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

563. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

564. Ernest Johnson, 10/93, Specialist, Heat Source Production

565. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

566. Ernest Johnson, 10/93, Specialist, Heat Source Production

567. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

568. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

569. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

570. Calvin Love, 10/93, Senior Research Specialist

571. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

572. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

573. Paul Figgins, 11/93, Senior Research Specialist

574. Ernest Johnson, 10/93, Specialist, Heat Source Production

575. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

576. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

577. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

578. Ernest Johnson, 10/93, Specialist, Heat Source Production

579. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

580. Ernest Johnson, 10/93, Specialist, Heat Source Production

581. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

582. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

583. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

584. Calvin Love, 10/93, Senior Research Specialist

585. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

586. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

587. Don Rogers, 9/93, Senior Fellow

588. Paul Lamberger, 10/93, Specialist, Senior-1

589. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

590. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

591. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 6-8

592. Paul Lamberger, 10/93, Specialist, Senior-1

593. Tom Flanagan, 9/93, Specialist ES&H

594. Don Hobrock, 10/93, Senior Fellow

595. Doug Draper, 10/93, Manager RAM

596. Consulting committee for this appendix consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Harold (Andy) Anderson, and Chuck Woods, 12/94.

597. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 69

598. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 69, 79

599. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 69, 80

600. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 72, 81

601. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 72, 82-83

602. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 72, 84-85

603. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 73, 86

604. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 73, 87-88

605. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 73, 89-90

606. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 74, 91

607. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 74, 92-93

608. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 75, 94

609. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 75, 95-96

610. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 76, 97

611. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

612. Pat Adams, 1/94, Manager Health Physics

613. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 229-235

614. Earl Johns, 2/94, Manager Tritium Recovery Operations

615. Dick Vallee, 3/94, Vice President EG&G Mound

616. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

617. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 187-200

618. Paul Lamberger, 10/93, Specialist, Senior-1

619. Pat Adams, 1/94, Manager Health Physics

620. Earl Johns, 2/94, Manager Tritium Isotopic Separation

621. Tom Flanagan, 1/94, Specialist ES&H

622. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

623. Harold Anderson, 12/93, Manager Stockpile Evaluation

624. Joe Garner, 1/94, Supervisor Health Physics

625. No incident # - memo, 6/7/61, Tritium, SW-8
No incident # - Ratleff, A., 5/26/72, " "
Incident #076 - Conover, J., 3/13/73, " "
#310 - Gibbs, G., 7/18/73, " "

626. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

627. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 138

628. Paul Lamberger, 10/93, Specialist, Senior-1

629. Terry Buxton, 12/93, Manager Nuclear Technology

630. Don Hobrock, 7/93, Senior Fellow

631. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

632. Dick Carlson, 1/94, Senior Research Specialist

633. MLM-621, MLM-MU-51-71-0037, Decontamination Of Process Waste Solutions Containing Fission Products By Adsorption And Coprecipitation Methods, C.S. Lowe, 11/13/51, page 9

634. Larry Bentz, 2/94, Analytical Chemist (Retired)

635. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;76-83

636. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

637. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

638. MLM-809, Health Physics Monthly Information Report, 1/31/53, page 5.

639. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2; 50-54

640. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

641. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;50-58

642. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

643. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

644. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 8.

645. Memo on 1/1/56 discussing Pa-231 separation being set up in HH Building.

646. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

647. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 138

648. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

649. No incident # - Zink, John, 8/27/64, tritium, SW-13/1B

650. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 214-220

651. Calvin Love, 10/93, Senior Research Specialist

652. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

653. Incident #370, 8/28/85, Ray Steinmeyer, Tritium, SW-12, 13,

654. Paul Figgins, 8/93, Senior Research Specialist

655. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2; 48-50

656. MLM-700, Health Physics Monthly Information Report, 4/30/52, page 4.

657. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

658. Paul Figgins, 8/93, Senior Research Specialist

659. MLM-736, Health Physics Information Report, 7/31/52, page 6.

660. MLM-832, Health Physics Monthly Information Report, 3/31/53, page 5

661. MLM-870, Health Physics Monthly Information Report, 6/30/53, page 5.

662. MLM-Mu-59-62-0001, Quarterly Health Physics Report, October through December 1958, 2/2/59, page 4.

663. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 183

664. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 152, 153

665. Incident #617 - Blevins, B., 9/24/86, Tritium, SW-20

666. Paul Figgins, 8/93, Senior Research Specialist

667. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;68,69

668. Paul Figgins, 8/93, Senior Research Specialist

669. MLM-2151, "A Solvent Extraction Method For Recovery Of Thorium-229 From Aged Uranium-233, M.R. Hertz, W.S. Stringham, R.M. Watrous, 1/31/75.

670. M. Ray Hertz, 4/94, Senior Research Chemist

671. Richard Eppley, 10/93, Manager Isotopic Separation

672. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

673. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

674. Richard Eppley, 10/93, Manager Isotopic Separation

675. Paul Figgins, 11/93, Senior Research Specialist

676. MLM-2985, The Recovery Of Protactinium-231 and Thorium-230 From Cotter Concentrate: Pilot Plant Operation and Process Development, M.R. Hertz, P.E. Figgins, W.R. Deal, 2/10/83.

677. M. Ray Hertz, 4/94, Senior Research Chemist

678. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

679. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

680. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

681. Richard Eppley, 10/93, Manager Isotopic Separation

682. Paul Figgins, 11/93, Senior Research Specialist

683. M. Ray Hertz, 4/94, Senior Research Chemist

684. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

685. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

686. Richard Eppley, 10/93, Manager Isotopic Separation

687. Paul Figgins, 11/93, Senior Research Specialist

688. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

689. Incident #096 - 10/31/78, Deal, W., Ac-227, SW-132

690. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

691. Paul Figgins, 8/93, Senior Research Specialist

692. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

693. Richard Eppley, 10/93, Manager Isotopic Separation

694. Paul Figgins, 11/93, Senior Research Specialist

695. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

696. Paul Figgins, 8/93, Senior Research Specialist

697. M. Ray Hertz, 4/94, Senior Research Chemist

698. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

699. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

700. Richard Eppley, 10/93, Manager Isotopic Separation

701. Paul Figgins, 11/93, Senior Research Specialist

702. M. Ray Hertz, 4/94, Senior Research Chemist

703. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

704. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

705. Joe Garner, 1/94, Supervisor Health Physics

706. Tom Flanagan, 1/94, Specialist ES&H

707. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 214-220

708. Calvin Love, 10/93, Senior Research Specialist

709. Tom Flanagan, 1/94, Specialist ES&H

710. Richard Carlson, 10/93, Senior Research Specialist

711. Incident #196, 11/20/64, R. Goss, Tritium, SW-142
#370, 8/28/85, Ray Seeinmeyer, Tritium, SW-142

712. Incident #630 - Brown, J., 1/25/65, Mercury, SW-142

713. Dave Billing, 1/94, Manager SW Building

714. Earl Johns, 1/95, Supervisor of Tritium Systems Operations

715. Earl Johns, 1/95, Supervisor of Tritium Systems Operations

716. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 171-180

717. Tom Flanagan, 1/94, Specialist ES&H

718. Paul Lamberger, 1/95, Specialist, Senior-1

719. Tom Flanagan, 1/94, Specialist ES&H

720. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

721. Paul Lamberger, 10/93, Specialist, Senior-1

722. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

723. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 187-200

724. Paul Lamberger, 10/93, Specialist, Senior-1

725. Harold (Andy) Anderson, 12/93, Manager Materials Stockpile

726. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

727. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 138

728. Tom Flanagan, 1/94, Specialist ES&H

729. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

730. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 154, 181

731. Tom Flanagan, 1/94, Specialist ES&H

732. Pat Adams, 1/94, Manager Health Physics

733. Tom Flanagan, 1/94, Specialist ES&H

734. Incident #573 - Bolton, M., 8/11/61, Po-210, SW-202

735. Pat Adams, 1/94, Manager Health Physics

736. Tom Flanagan, 1/94, Specialist ES&H

737. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 229-235

738. Tom Flanagan, 1/94, Specialist ES&H

739. Pat Adams, 1/94, Manager Health Physics

740. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 154-164, 171

741. Tom Flanagan, 1/94, Specialist ES&H

742. Mike Deaton, 1/94, Function Testing Supervisor

743. Harold (Andy) Anderson, 12/93, Manager of Stockpile Evaluation

744. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

745. Tom Flanagan, 1/94, Specialist ES&H

746. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 154-164, 171

747. Tom Flanagan, 1/94, Specialist ES&H

748. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

749. Mike Deaton, 1/94, Function Testing Supervisor

750. Tom Flanagan, 1/94, Specialist ES&H

751. Joe Garner, 1/94, Supervisor Health Physics

752. M. Ray Hertz, 4/94, Senior Research Chemist

753. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

754. Harold (Andy) Anderson, 12/93, Manager Stockpile Evaluation

755. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

756. Terry Buxton, 12/93, Manager Nuclear Technology

757. Mike Deaton, 1/94, Function Testing Supervisor

758. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

759. Tom Flanagan, 1/94, Specialist ES&H

760. Joe Garner, 1/94, Supervisor Health Physics

761. Incident #075, 7/28/72, Stevenson, R., Tritium, SW-231

762. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 123-138

763. Tom Flanagan, 1/94, Specialist ES&H

764. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

765. Joe Garner, 1/94, Supervisor Health Physics

766. Terry McConville, 6/95, Science Fellow

767. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 9

768. A Summary Review of Mound Laboratory's experience in D&D of Radioactive Facilities, 1949 - 1973, J.M. Garner & W.P. Davis, Mound Laboratory, page 6.

769. Carl Kershner, 3/94, Senior Fellow

770. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

771. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

772. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

773. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

774. Paul Lamberger, 10/93, Specialist, Senior-1

775. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

776. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

777. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

778. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

779. SAR, T Building, 12/93, page 102, 138-150

780. SAR, T Building, 12/93, page 140

781. Jack Melke, 2/94, Senior Development Engineer

782. SAR, T Building, 12/93, page 68, 73

783. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

784. Paul Lamberger, 4/94, Senior Research Specialist

785. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

786. Jack Melke, 2/94, Senior Development Engineer

787. FSAR, T Building, 12/93, page 218-220

788. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

789. MLM-940, Health Physics Monthly Information Report, 1/31/54, page 4.

790. MLM-933, Health Physics Monthly Information Report, 12/31/53, page 4.

791. Jack Melke, 2/94, Senior Development Engineer

792. SAR, T Building, 12/93, page 60, 61, 73

793. Al Nunn, 4/94, Chemist

794. SAR, T Building, 12/93, page 135, 228

795. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

796. Jack Melke, 2/94, Senior Development Engineer

797. SAR, T Building, 12/93, page 60, 61, 73

798. Al Nunn, 4/94, ...

799. SAR, T Building, 12/93, page 67, 73

800. Jack Melke, 2/94, Senior Development Engineer

801. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

802. Clyde Gallaher, 8/93, T Building Manager

803. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

804. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

805. SAR, T Building, 12/93, page 102, 103, 232-240

806. Paul Lamberger, 4/94, Senior Research Specialist

807. Clyde Gallaher, 3/94, Manager of T Building

808. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

809. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

810. Drawing, T Building Service Floor, 2/68

811. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

812. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

813. SAR, T Building, 12/93, page 47-49, 73

814. Terry Buxton, 12/93, Manager Nuclear Technology

815. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

816. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

817. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

818. Drawing, T Building Service Floor, 2/68

819. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

820. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

821. SAR, T Building, 12/93, page 47-49, 73

822. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

823. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

824. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

825. Drawing, T Building Service Floor, 2/68

826. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

827. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

828. SAR, T Building, 12/93, page 47-49, 73

829. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

830. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

831. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

832. Drawing, T Building Service Floor, 2/68

833. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

834. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

835. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

836. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

837. Drawing, T Building Service Floor, 2/68

838. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

839. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

840. FSAR, T Building, 12/93, page 36, 45, 181, 220-222

841. Jack Melke, 2/94, Senior Development Engineer

842. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

843. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

844. Jack Melke, 2/94, Senior Development Engineer

845. FSAR, T Building, 12/93, page 218-220

846. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

847. Jack Melke, 2/94, Senior Development Engineer

848. Clyde Gallaher, 3/94, Manager T Building

849. SAR, T Building, 12/93, page 139, 170-171, 223-227

850. Quarterly Health Physics Report - April through June 1955, page 4.

851. Jack Melke, 2/94, Senior Development Engineer

852. Clyde Gallaher, 3/94, Manager T Building

853. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

854. SAR, T Building, 12/93, page 201-217

855. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

856. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

857. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

858. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 6

859. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

860. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

861. CERCLA, Vol 7, Waste Management, Weston Inc., page 2;7-9

862. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

863. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C: Lange, 7/12/93, page 8

864. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

865. CERCLA, Vol 7, Waste Management, Weston Inc., page 2;7-9

866. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

867. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

868. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

869. Ken Foster, 3/94, Senior Research Specialist

870. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 11

871. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

872. Carl Kershner, 3/94, Senior Fellow

873. Earl Johns, 2/95, Supervisor Tritium Recovery Operations

874. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

875. Incident #061 - 8/28/68, Delong, J., Po-210, T-57

876. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;37

877. Jack Melke, 2/94, Senior Development Engineer

878. SAR, T Building, 12/93, page 139, 171-178

879. Paul Lamberger, 4/94, Senior Research Specialist

880. Jack Melke, 2/94, Senior Development Engineer

881. Charles Wiedenheft, 3/94, Supervisor Mass Spec/Thermal Analysis

882. SAR, T Building, 12/93, page 139, 170-171, 223-227

883. Ken Foster, 3/94, Senior Research Specialist

884. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

885. Carl Kershner, 3/94, Senior Fellow

886. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 11

887. Earl Johns, 2/95, Supervisor Tritium Recovery Operations

888. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

889. Don Hobrock, 10/93, Senior Fellow

890. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

891. Jack Melke, 2/94, Senior Development Engineer

892. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

893. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

894. SAR, T Building, 12/93, page 183-186

895. M. Ray Hertz, 4/94, Senior Research Chemist

896. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

897. Ernest Johnson, 10/93, Specialist, Heat Source Production

898. Don Kelly, 10/93, Heat Source Program Manager

899. Carl Kershner, 3/94, Senior Fellow

900. Don Hobrock, 10/93, Senior Fellow

901. Jack Melke, 2/94, Senior Development Engineer

902. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;37

903. SAR, T Building, 12/93, page 139, 165-170

904. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

905. Charlie Lindsey, 10/93, Supervisor Mechanical Testing

906. Charlie Sienkiewicz, 10/93, Engineering Specialist

907. Paul Lamberger, 10/93, Specialist, Senior-1

908. SAR, T Building, 12/93, page 139, 154-165

909. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

910. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

911. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

912. Drawing, T Building Service Floor, 2/68

913. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

914. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

915. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

916. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

917. Paul Lamberger, 11/93, Specialist, Senior-1

918. Charlie Lindsey, 10/93, Supervisor Mechanical Testing

919. Charlie Sienkiewicz, 10/93, Engineering Specialist

920. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

921. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

922. Drawing, T Building Service Floor, 2/68

923. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

924. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

925. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

926. SAR, T Building, 12/93, page 64,76

927. Jack Melke, 2/94, Senior Development Engineer

928. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

929. M. Ray Hertz, 4/94, Senior Research Chemist

930. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

931. Carl Kershner, 3/94, Senior Fellow

932. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

933. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

934. SAR, T Building, 12/93, page 77,79

935. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

936. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

937. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

938. SAR, T Building, 12/93, page 137, 230-232

939. Paul Lamberger, 11/93, Specialist, Senior-1

940. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

941. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

942. Clyde Gallaher, 8/93, T Building Manager

943. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

944. SAR, T Building, 12/93, page 77

945. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

946. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

947. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 11

948. Paul Lamberger, 11/93, Specialist, Senior-1

949. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

950. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

951. Incident #126, Coleman, H., 9/28/64, Po-210, T-237

952. SAR, T Building, 12/93, page 36, 45, 181

953. Clyde Gallaher, 3/94, Manager of T Building

954. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

955. Incident #522 - Carmack, J., 10/17/86, Pu-238, T-238

956. SAR, T Building, 12/93, page 36, 45, 181

957. Clyde Gallaher, 3/94, Manager of T Building

958. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

959. Incident #522 - Carmack, J., 10/17/86, Pu-238, T-238

960. Incident #562 - Bond, B., 10/20/60, Po-210, T-242

961. M. Ray Hertz, 4/94, Senior Research Chemist

962. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

963. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

964. SAR, T Building, 12/93, page 102

965. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

966. Carl Kershner, 3/94, Senior Fellow

967. Joseph Grasso, 3/94, Project Manager SNAP-29 Program

968. SAR, T Building, 12/93, page 77

969. Clyde Gallaher, 3/94, Manager T Building

970. Carl Kershner, 3/94, Senior Fellow

971. Joseph Grasso, 3/94, Project Manager SNAP-29 Program

972. Earl Johns, 7/93, Supervisor Tritium Recovery Operations

973. Paul Lamberger, 10,93, Senior Research Specialist

974. MLM-MU-58-68-0001, Quarterly Health Physics Report, April through June 1958, 8/11/58, page 5.

975. Carl Kershner, 3/94, Senior Fellow

976. Joseph Grasso, 3/94, Project Manager SNAP-29 Program

977. Carl Kershner, 3/94, Senior Fellow

978. Joseph Grasso, 3/94, Project Manager SNAP-29 Program

979. Earl Johns, 7/93, Supervisor Tritium Recovery Operations

980. Paul Lamberger, 10,93, Senior Research Specialist

981. Bob Phillips, 5/94, Research Chemist

982. Incident #002, 11/17/54, W. Craft, Polonium, T-251

983. Incident on 5/26/60, E. Stoeckel, F. Neff, Po-210, T-254

984. Carl Kershner, 3/94, Senior Fellow

985. Joseph Grasso, 3/94, Project Manager SNAP-29 Program

986. Jack Melke, 2/94, Senior Development Engineer

987. Harold (Andy) Anderson, 12/93, Manager Stockpile Evaluation

988. SAR, T Building, 12/93, page 58, 59

989. Carl Kershner, 7/93, Senior Fellow

990. Donald Kelly, 10/93, Heat Source Program Manager

991. Incident #060, Brown, D., 8/22/68, Alpha (Po-210), T-260 Box 10

992. Carl Kershner, 3/94, Senior Fellow

993. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 12, 13

994. Polonium-210 Production, presentation at the SYMPOSIUM ON ISOTOPIC POWER FUELS at Oak Ridge National Laboratory on June 26, 1963, report by F.M. Huddleson, R.K.Harris, and M.R. Hertz, July 9, 1963

995. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

996. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

997. Incident Memo Reports, 2/28/50 & 9/19/50.

998. Incident #512, Leslie, R; 8/9/66, polonium, T-266

999. Incident #124, 10/30/64, Carl Kershner, polonium, T-267, GB #5

1000. Carl Kershner, 3/94, Senior Fellow

1001. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 9

1002. Carl Kershner, 7/93, Senior Fellow

1003. Don Hobrock, 10/93, Senior Fellow

1004. Jack Melke, 2/94, Senior Development Engineer

1005. SAR, T Building, 12/93, page 187, 194-200

1006. Paul Lamberger, 11/94, Senior Research Specialist

1007. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1008. Carl Kershner, 3/94, Senior Fellow

1009. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 12, 13

1010. Polonium-210 Production, presentation at the SYMPOSIUM ON ISOTOPIC POWER FUELS at Oak Ridge National Laboratory on June 26, 1963, report by F.M. Huddleson, R.K.Harris, and M.R. Hertz, July 9, 1963

1011. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

1012. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1013. Incident Memo Reports, 2/28/50 & 9/19/50.

1014. Incident #612 - Love, C., 10/12/67, Po-210, T-270

1015. Carl Kershner, 3/94, Senior Fellow

1016. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 11

1017. Carl Kershner, 3/94, Senior Fellow

1018. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1019. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;37

1020. Jack Melke, 2/94, Senior Development Engineer

1021. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1022. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 6

1023. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

1024. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

1025. Paul Lamberger, 4/94, Senior Research Specialist

1026. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1027. Carl Kershner, 3/94, Senior Fellow

1028. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 18

1029. William Bond, 3/94, Supervisor Neutron Source Program

1030. MLM-???, Quarterly Health Physics Report - April through June 1955, page 4.

1031. Incident #003, 11/27/56, Birden, J., polonium, T-277,279
Incident #003, 11/27/56, E. Winterland, polonium, T-277, 279
Incident #017, 11/11/60, Bullen, C., Po-210, T-279

1032. M. Ray Hertz, 4/94, Senior Research Chemist

1033. Carl Kershner, 3/94, Senior Fellow

1034. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 19, 21

1035. Don Kelly, 3/94, Heat Source Project Manager, Production Support

1036. Carl Kershner, 3/94, Senior Fellow

1037. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1038. Jack Melke, 2/94, Senior Development Engineer

1039. Harold (Andy) Anderson, 12/93, Manager Stockpile Evaluation

1040. SAR, T Building, 12/93, page 58, 59

1041. Carl Kershner, 3/94, Senior Fellow

1042. Paul Lamberger, 4/94, Senior Research Specialist

1043. Carl Kershner, 3/94, Senior Fellow

1044. Paul Lamberger, 4/94, Senior Research Specialist

1045. SAR, T Building, 12/93, page 102, 103, 137, 228-230

1046. Carl Kershner, 3/94, Senior Fellow

1047. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

1048. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1049. Joseph Grasso, 3/94, Project Manager for SNAP-29

1050. Incident #018 - Copsey, B., 12/16/60, Po-210, T-310A

1051. SAR, T Building, 12/93, page 51, 79

1052. Charles Wiedenheft, 3/94, Supervisor Mass Spec/Thermal Analysis

1053. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

1054. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1055. SAR, T Building, 12/93, page 77,79

1056. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

1057. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1058. Carl Kershner, 3/94, Senior Fellow

1059. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

1060. Incident #111, 11/1/67, Lucius Jones, Po-210, T-311

1061. SAR, T Building, 12/93, page 77,79

1062. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

1063. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1064. SAR, T Building, 12/93, page 51, 79

1065. Charles Wiedenheft, 3/94, Supervisor Mass Spec/Thermal Analysis

1066. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

1067. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1068. Mark McClelland, 7/93, Radiation Technician

1069. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1070. Incident #022, Bullen, C., 10/20/61, Po-210, T-Corr. 20

1071. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;3-8

1072. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

1073. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

1074. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;15, 16

1075. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;15, 16

1076. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

1077. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;8,9

1078. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

1079. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

1080. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1081. CERCLA, Vol 3, Site Scoping Report, Radiological Site Survey, 3/93, page 3;6

1082. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;3-9, 15

1083. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1084. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

1085. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;51

1086. Larry Klinger, 2/95, Specialist, Industrial Waste

1087. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1088. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 5.

1089. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;26-30, 4;9-15

1090. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1091. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;73

1092. Larry Klinger, 2/95, Specialist, Industrial Waste

1093. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1094. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;8,9

1095. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

1096. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

1097. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1098. CERCLA, Vol 3, Site Scoping Report, Radiological Site Survey, 3/93, page 3;6

1099. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;3-9, 15

1100. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1101. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

1102. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;51

1103. Larry Klinger, 2/95, Specialist, Industrial Waste

1104. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1105. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 5.

1106. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;26-30, 4;9-15

1107. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1108. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;73

1109. Larry Klinger, 2/95, Specialist, Industrial Waste

1110. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1111. Pat Adams, 2/95, Manager Health Physics

1112. Pat Adams, 2/95, Manager Health Physics

1113. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;26-30, 4;9-15

1114. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1115. Fred Traino, 2/95, Manager of WD Building

1116. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;8,9

1117. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

1118. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

1119. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1120. CERCLA, Vol 3, Site Scoping Report, Radiological Site Survey, 3/93, page 3;6

1121. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;3-9, 15

1122. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1123. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

1124. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;51

1125. Larry Klinger, 2/95, Specialist, Industrial Waste

1126. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1127. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 5.

1128. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;26-30, 4;9-15

1129. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1130. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;73

1131. Larry Klinger, 2/95, Specialist, Industrial Waste

1132. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1133. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;8,9

1134. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

1135. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

1136. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1137. CERCLA, Vol 3, Site Scoping Report, Radiological Site Survey, 3/93, page 3;6

1138. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;3-9, 15

1139. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1140. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

1141. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;51

1142. Larry Klinger, 2/95, Specialist, Industrial Waste

1143. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1144. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 5.

1145. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;26-30, 4;9-15

1146. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1147. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;73

1148. Larry Klinger, 2/95, Specialist, Industrial Waste

1149. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1150. Larry Klinger, 10/93, Chemist in WD / Specialist in waste management

1151. Larry Klinger, 2/95, Specialist, Industrial Waste

1152. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1153. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;9

1154. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

1155. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1156. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;15, 16

1157. Gary Silver, 10/93, Fellow

1158. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1159. Incident #325 - Roberts, R., 8/1/77, Pu-238, WDA-112

1160. Gary Silver, 10/93, Fellow

1161. Barbara Alexander, 10/93, Chemist WD / WDA

1162. Gary Silver, 10/93, Fellow

1163. Pat Adams, 2/95, Manager of Health Physics

1164. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1165. Barbara Alexander, 2/95, Engineering Specialist

1166. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1167. Barbara Alexander, 2/95, Engineering Specialist

1168. Larry Klinger, 2/95, Specialist, Industrial Waste

1169. Larry Klinger, 2/95, Specialist, Industrial Waste

1170. Barbara Alexander, 2/95, Engineering Specialist

1171. Gary Silver, 10/93, Fellow

1172. Larry Klinger, 2/95, Specialist, Industrial Waste

1173. Larry Klinger, 2/95, Specialist, Industrial Waste

1174. Barbra Alexander, 2/95, Engineering Specialist

1175. Incident #090 - Lawhun, P., 11/12/75, Pu-238, WDA-Penthouse

1176. No incident # - Report, 5/26/72, Pu-238, Tanks

1177. CERCLA, Vol. 7, Waste Management, Weston Inc., 7/92, 4;8

1178. MLM-883, Health Physics Monthly Information Report, 7/31/53, page 4.

1179. MLM-832, Health Physics Monthly Information Report, 3/31/53, page 4.

1180. MLM-854, Health Physics Monthly Information Report, 5/31/53, page 4.

1181. MLM-883, Health Physics Monthly Information Report, 7/31/53, page 4.

TABLE OF CONTENTS FOR SECTION 2
SUPPORTING BUILDINGS

1. BACKGROUND INFORMATION 1

2. WAREHOUSE #9 1

3. WAREHOUSE #13 2

4. WAREHOUSE #15 3

5. BUILDING #21 3

6. BUILDING #34 4

7. BUILDING #50 5

8. BUILDING #59 (CFX) 5

9. BUILDING #68 6

10. B-BUILDING 6
    - 10.1 Room B-146 7

11. E-BUILDING 7
    - 11.1 Room E-105 7
    - 11.2 Room E-107 7
    - 11.3 Room E-113 8
    - 11.4 Room E-141, 142, 144, 155 8
    - 11.5 Rooms E-174, 175, 177, 185, 194 8

12. H-BUILDING 9

13. I BUILDING 10

14. M BUILDING 10

15. P BUILDING 10

16. R&R BUILDING 11

17. SD BUILDING 12

18. BUILDINGS WHERE RADIONUCLIDE UPTAKE IS UNLIKELY 13

19. ENDNOTES AND REFERENCES 14

SUPPORTING BUILDINGS

1. BACKGROUND INFORMATION

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation. Any buried waste lines would also be contaminated.

All radionuclides are ranked according to the degree of concern for uptake and internal dosimetry considerations for each room. Rooms referenced to Appendix B for additional information usually will not have a ranking in this manual since the ranking is done in that appendix, where all radionuclides are listed.

2. 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 off-site shipment. Radioisotopes of concern and their compounds are:[1]

ruthenium-106	cesium-137	antimony-125
tellurium-121,127	zirconium-93,95	niobium-94
strontium-90	rare earths (especially cerium)	
yttrium-88,90,91	plutonium-238,239	

Note: All radionuclides were of equal concern.[2]

3. WAREHOUSE #13

(1953) This warehouse was used for the storage and then shipping of several drums of sludge from the Purex/Bismuth Phosphate decontamination program. The settling and mixing tanks were also taken there. Radioisotopes of concern and their compounds are: [3]

ruthenium-106	cesium-137	antimony-125
tellurium-121,127	zirconium-93,95	niobium-94
strontium-90	plutonium-238,239	
yttrium-88,90,91	rare earths (especially cerium)	

Note: All radionuclides were of equal concern.[4]

This warehouse was also used for temporary storage for drums of low level contamination from the radium-226/actinium-227 decontamination operations. Radioisotopes of concern and their compounds are: [5 6]

radium-226	radium carbonate
actinium-227	radium nitrate
radium bromide	actinium oxalate
actinium fluoride	potassium-40
barium nitrate	radon and daughters
thorium-228	thorium-229
thorium-230	

Note: Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a close second. The polonium-208, 209, 210 are all a distant third.[7]

4. WAREHOUSE #15

(1955 - 1961) This warehouse stored 1,650 tons of the thorium-232 refinery program (Monex) sludge. It was highly corrosive and continually leaked through the barrels causing much contamination. Over 34 isotopes were identified from the feedstock of this program with most being nonradioactive. Radioisotopes of concern and their compounds are: [8]

thorium-232,228	radium-228,224
uranium-238	thorium-232 daughters (especially thallium-208)

Note: Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. However, when considering the quantity of radionuclides, and not activity, 99% of the mass of radionuclides are thorium-232.[9]

5. BUILDING #21

This building was constructed in 1964 for bulk storage of the thorium ores and sludge from the old Monex project, a thorium-232 refinery program. Originally designed like a silo with no doors or windows, the oxalate sludge was stored in one side and hydroxide sludge in the other. Up to 1973 at least 117 55-gallon leaky drums still remained outside of the building. Contamination of the surrounding grounds occurred from the fugitive dust resulting from the dumping of this sludge into this "silo." From October of 1974 to July of 1975 this sludge was repackaged in 55-gallon drums and shipped off site. Radionuclide contents of the sludge were primarily thorium isotopes, rare earth isotopes, uranium, and others. [10]

In 1975 1,251 55-gallon drums of Cotter Concentrate was stored in Building 21 until 1987 when they were shipped off site. This concentrate contained significant quantities of the following which are radionuclides of concern:[11]

thorium-230,232	uranium-234,235,238
actinium-227	protactinium-231
radium-223,224,226	actinium nitrate
actinium oxide	

5.1 Thorium-230 was the major radionuclide of concern with over 95% of the activity. [12]

5.2 Fourteen elements besides those isotopes listed above are also contained in the Cotter Concentrate as listed on page 2-71 of CERCLA, VOL. 7, July 1992. There is no indication that these fourteen additional elements are radioactive.

5.3 **The surrounding grounds** also served as storage for Pu-238 waste packages in 1967. There was a 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 of sludge through the roof, and the repackaging into drums. [13,14]

5.3.1 A surface sample of 34,000 Pci/g was taken at about 80 feet from Building #21.

5.3.2 A surface sample of 54.3 Pci/g of thorium was taken 150 ft from Building #21.

5.3.3 In general it was found that all surface samples were much higher around Building #21 than further down the hill.

6. BUILDING #34

This building has a dual purpose: Serving as a drop test area for waste packages and simulation of pyrophoric metal training for the fire fighters.[15]

The empty 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 fire fighting practice to simulate pyrophoric situations. Radioisotopes of concern include:

uranium-238 oxide

7. BUILDING #50

Building 50 is designated as the assembly and testing building for the RTG (Radioisotopic Thermoelectric Generators).

In Building 50, the RTG is 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 with high 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.[16] [17]

8. BUILDING #59 (CFX)

This building contains a sub-critical assembly which has the capability to produce some fission products. However, all fission products were sealed inside aluminum containers so the probability of contamination is remote. The water surrounding the containers inside the assembly is constantly monitored and no contamination has been observed.[18] [19]

Californium-252 and enriched uranium were used for irradiation. These radioisotopes were encapsulated in metal cladding so no concern for internal dosimetry.[20] Some intentional irradiation is done with the major contamination being Fe-55,59 and Co-60.[21] [22] Radionuclides or concern are:

californium-252	uranium-234,235,238
iron-55,59	cobalt-60

Note: Historically the major radionuclides of concern were californium-252 and uranium-235 equally. In the future when tearing down the facility radionuclides of concern will be uranium-235 and iron-59 in the form of rust.[23]

This building has not been operational since 1990 and is not expected to ever operate again. [24]

9. BUILDING #68

This building functions as a decontamination and decommissioning staging area and handles the radionuclide waste from R Building.[25 26 27]

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:

plutonium-238 oxide plutonium-239 oxide

10. B-BUILDING

From ~1950 to ~1955 this building was used for biological research of the effects of polonium-210, actinium-227, and other alpha emitters on animals. These results were used to estimate the effects of radionuclides used at Mound on humans. All biological testing was discontinued in about 1955 when detonator manufacturing began. Biological research was discontinued by 1955. [28 29 30]

A Biological Research Quarterly from June of 1954 discusses some mice and rat experiments which were conducted over a two year period with polonium-210. In another experiment rats were given an actinium-227 solution which also contained thorium-227, radium-223, radon-219, polonium-215, and bismuth-211. [31]

Another report by D.S. Anthony and K.A. Bush discusses experimental results of single acute and multiple exposures of polonium-210 to rats with higher dosages of polonium than in the previous report. [32]

Studies with plutonium was also done with a special emphasis on Pu-238.

Other reports discuss experimental work using radium-226 and actinium-227.[33 34]

10.1 Room B-146

One of the lab rooms where early research was done.

Radioisotopes of concern and their compounds are:

polonium-210	actinium-227
plutonium-238	thorium-227
radium-223,226	radon-219
polonium-215	bismuth-211

10.1.1 Polonium-210 was the major radionuclide of concern with actinium-227 being secondary.[35]

10.1.2 Incident - (Pu-238, 7/5/78)[36]

10.1.3 B-Building was decontaminated by July of 1955. [37]

11. E-BUILDING

This building provides analytical services such as environmental labs. Functions include low level counting of soil and water samples, including fish and vegetation. [38]

11.1 Room E-105

(1949 - PRESENT) This room provides analytical services such as low level environmental counting.

11.2 Room E-107

(1949 - PRESENT) This room provides analytical services such as low level environmental counting. Low level plutonium-238 standards were produced in this room. They also leak checked welded containers containing tritium.[39] [40]

11.2.1 Operations have been drastically curtailed since 1990.

11.2.2 The fumehoods are contaminated.[41]

11.2.3 Incident - (plutonium, 9/30/88)[42]

11.3 Room E-113

(1952) This is a room where chemistry test tubes, pipettes, etc. were stored.

11.3.1 **Health Physics Monthly Information Report** reported alpha contamination from preparing slide mounts in R-Building and then placing the pipettes in clean test tubes and storing them in E-113. Somehow the rack holding the test tubes was contaminated which led to alpha contamination of E-113.[43]

11.4 Room E-141, 142, 144, 155

(1981 - 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 the lead-210 being encapsulated. These are all stored in E-141 but are also used in rooms E-142, 144, 155 which are also environmental labs. Radionuclides of concern are:[44]

plutonium-238,239	thorium-229,230
tritium	uranium-232,234,236,238
lead-210	

11.5 Rooms E-174, 175, 177, 185, 194

These rooms have been used for cold storage and were therefore not thought to contain any radionuclides. However, recent surveying has turned up items in these rooms which were contaminated with alpha, beta, and gamma radiation. The following specific results were found.[45]

11.5.1 Room 174 - alpha from an unknown source

11.5.2 Room 175 - beta and gamma from an unknown source

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

11.5.4 Room 185 - (~1985 - PRESENT) alpha and beta on metallurgical sample contaminated with U-235, a second sample with suspected contamination from Th-232.

11.5.5 Room 194 - alpha from possible plutonium, beta and gamma from possible U-235 and or U-238

An overview of operations in E Building include the following radionuclides of concern: [46] [47]

nitrate and chloride solutions of:

plutonium-238,239,242	uranium-232,234,235,236,238
thorium-229,230	polonium-210
tritium	lead-210

Note: Plutonium-238 was the major radionuclide of concern with polonium-210 being second and tritium third.[48]

12. H-BUILDING

Although this building performs many innocuous tasks such as credit union and change rooms, there are some activities which have the potential of radionuclide uptakes. [49]

The laundry had a "hot laundry" capability where clothes exposed to radionuclides were dealt with, which is the primary reason the building was built.

Bioassay labs and other environmental labs are housed in H Building and have the potential for low levels of exposure.

Most radionuclides are tracer nitrate and chloride solutions of Pu-238, Pu-239, Pu-242, U-232, U-236, and Th-229. Tritium and Po-210 may also be included. [50]

It has also been suggested that radium-226, thorium-228, and actinium-227 also be included in the list. [51]

Radionuclides and related compounds of concern are:

plutonium-238,239,242
thorium-228,229
radium-226
tritium
uranium-232,236
actinium-227
polonium-210

Note: Plutonium-238 was the major radionuclide of concern with polonium-210 being second and actinium-227 third.[52]

13. I BUILDING

I Building refers to "Isolation Building."

13.1 Low level counting of bioassay (urine and fecal) samples, and environmental counting such as soil, vegetation, etc., were done. There is little possibility of uptakes to be concerned with. [53]

13.2 (~1955 - PRESENT) This area is used for Non-Destructive Testing (NDT) and the assembly of explosive devices. No radionuclides are used. [54]

14. M BUILDING

Room M-20 had a Livermore drybox.[55]

Machining of uranium-238 was also done in this building.

15. P BUILDING

"P" for Powerhouse Building - In 12/12/50 there was an incident where a pipe broke spraying the body with 213°F steam. There was soft beta associated with this incident.[56]

Note: Very dilute tritium was the only radionuclide of concern.[57]

16. R & R BUILDING

This was a small building located between the SM and the PP Buildings. It was used for the sorting of plutonium solid waste, some of which could be reprocessed.[58] [59]

Special concern was given to the old drums which had begun to leak. The material in these drums was sorted and repacked to alleviate any leaking problems.

The compound forms of this plutonium and lung solubility classes are as follows.

16.1 Plutonium oxide - PuO_2 - Class Y This could also take the form of a plutonium oxide hydrate - $PuO_2.XH_2O$

16.2 Plutonium hydroxide - $Pu(OH)_4$ - Class Y

16.3 Plutonium nitrate - $Pu(NO_3)_4$ - Class W This could also take the form of plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$

16.4 Incident - (Pu-238, 2/27/74, several others)[60]

16.5 Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary.[61]

R & R Building no longer exists. It has been D&D'd.

17. SD BUILDING

(1947 - 1970) This was an old sanitation building which could have had some contaminated sludge from broken lines/pipes. Contamination would have been minor in concentration but radionuclides from the polonium processing could have been found there. Radionuclides of concern and related compounds are:[62]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate
plutonium-238,239	

Note: Polonium-210 was the major radionuclide of concern with plutonium-238 second and zinc-65 being third.[63]

18. BUILDINGS WHERE RADIONUCLIDE UPTAKE IS UNLIKELY

No Radionuclide uptake for the following buildings is likely. Radionuclides may have been present in the past or may even be present now but are sealed in such a way that an uptake would be unlikely.

1. Building 19
2. Building 23
3. Building 30
4. Building 31
5. Building 41
6. Building 45
7. Building 51
8. Building 57

19. ENDNOTES AND REFERENCES

Note: The dates given here represent the date the person was contacted, and not when he was employed.

1. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;85

2. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

3. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;85

4. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

5. MLM-752, Health Physics Information Report, 8/31/52, page 4.

6. MLM-883, Health Physics Monthly Information Report, 7/31/53, page 5.

7. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

8. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;50-58

9. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

10. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;50-58

11. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

12. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

13. CERCLA, Vol 3, Site Scoping Report, 12/92, page 5;1-6

14. Paul Figgins, 11/93, Senior Research Specialist

15. Walter Wallace, 7/93, Senior Health Physicist

16. Walter Wallace, 7/93, Senior Health Physicist

17. Ernest Johnson, 10/93, Specialist, Heat Source Production

18. IRT-0033-001, Neutron Radiography Facility Safety Analysis Report, Kay Crosbie and Jack Young, 4/29/76

19. Analysis of Residual Radioactivity in CFX Core, A. Shapiro and J. Bartels, 5/92

20. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

21. Paul Figgins, 11/93, Senior Research Specialist

22. Paul Lamberger, 11/93, Specialist, Senior-1

23. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

24. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

25. Walter Wallace, 7/93, Senior Health Physicist

26. MLM-ML-88-48-0003, Final Report: R-149 Laboratory Decommissioning Project, J.R. Geichman, R.R. Jaeger, V.E. Castleberry, 9/30/88, page 3

27. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 22

28. Paul Lamberger, 11/93, Specialist, Senior-1

29. Paul Lamberger, 10/93, Specialist, Senior-1

30. Doug Draper, 11/93, Manager of RAM

31. MLM-989, Biological Research Quarterly Progress Report through June 17, 1954, D.S. Anthony

32. J-77, "Experimental Data Useful in Establishing Maximum Permissible Single and Multiple Exposures to Polonium", D.S. Anthony, K.A. Bush, and entire staff of biological division, Mound, Miamisburg, Ohio, no date given.

33. Reports written by Stringam and Murphy in possession of Joe Garner, 1/94, Supervisor Health Physics

34. MLM-736, Health Physics Information Report, 7/31/52, page 6.

35. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

36. Incident #525 - Jarvis, J., 7/5/78, Pu-238, B-146

37. Quarterly Health Physics Report - April through June 1955, page 4.

38. Walter Wallace, 7/93, Senior Health Physicist

39. Paul Lamberger, 10/93, Specialist, Senior-1

40. Walter Wallace, 1/94, Specialist Health Physics

41. Phil Ryan, 7/95, Helth Physics Supervisor

42. Incident #492 - Mcatee, V., 9/30/88, plutonium, E-107

43. MLM-764, Health Physics Monthly Information Report, 9/30/52, page 5

44. Lowell (Hoppy) Hopkins, 7/95, Senior Chemist

45. Occurrence report: OH-MB-EGGM-EGGMAT04-1995-0004, 4/27/95, also latest 10 day Update 5/20/95

46. Paul Figgins, 11/93, Senior Research Specialist

47. Paul Lamberger, 11/93, Specialist, Senior-1

48. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

49. Walter Wallace, 7/93, Senior Health Physicist

50. Paul Figgins, 11/93, Senior Research Specialist

51. Joe Garner, 1/94, Supervisor Health Physics

52. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

53. Joe Garner, 1/94, Supervisor Health Physics

54. Jeff Mathews, 2/94, Manager of I Building

55. Incident, 5/24/55, Charles Wells, LiOH, M-20

56. Incident, Heinlein, Herman, 12/12/50, soft beta, P Building

57. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

58. Walter Wallace, 7/93, Senior Health Physicist

59. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;12

60. Incident #084 - 2/27/74, Gephart, P., Pu, R&R

61. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

62. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

63. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

INFORMATION ON APPENDIX B

Appendix B is classified and is located in Document Control. It is a supplement to Section 1 and presents additional classified information for the buildings discussed above in Section 1. Information on the following rooms can be found in Appendix B:

R Building:	108	111	112	120
	127	129	130	133
	137	145	149	152
	160	161	167	171
	172			
SM Building:	3	10		
SW Building:	8	9	13	19
	22	142	150	152
	208	210	219	238
	240			
T-Building:	1W	2W	4E	36
	36A	48	49	50
	234	247	248	249
	250	251	252	253
	254	255	256	257
	258	259	260	266
	267	268	269	270
	271	277	279	
WD Building:	1	101		
WDA Building:	110			

APPENDIX A

This appendix will list most of the major daughter nuclides of the radionuclides listed in the main document. Only where branching occurs, and a very small fraction of the parent radionuclides is involved, will the daughters NOT be listed. Associated with the daughter radionuclides will be their nuclear half-life (not biological), and the result of decaying 1.0 curie of the parent radionuclide over a 50-year period. If the daughters are included in more than one branching scenario, then the activity of all occurrences will be summed together.

The parents are listed alphabetically with the daughters listed somewhat in the order they occur in the decay chain. The only exception to the ordered listing is where summing occurs with more than one appearance of a daughter radionuclide.

NUCLIDE	HALF-LIFE	CURIES
Actinium-225	1.00e+1 da	0.0
Fr-221	4.80e-0 min	0.0
At-217	3.23e-2 sec	0.0
Bi-213	4.57e+1 min	0.0
Pb-209	3.25e-0 hr	0.0
Po-213	4.20e-6 sec	0.0
Actinium-227	2.18e+1 yr	2.036e-1
Ra-223	1.14e+1 da	2.043e-1
Rn-219	3.96e-0 sec	2.043e-1
Po-215	7.78e-4 sec	2.043e-1
Pb-211	3.61e+1 min	2.043e-1
Bi-211	2.13e-0 min	2.043e-1
Tl-207	4.77e-0 min	2.038e-1
Th-227	1.87e+1 da	2.012e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Aluminum-26	7.20e+5 yr	9.999e-1
Antimony-124	6.02e+1 da	4.769e-92
Astatine-217	3.23e-2 sec	0.0
Bi-213	4.57e+1 min	0.0
Pb-209	3.25e-0 hr	0.0
Po-213	4.20e-6 sec	0.0
Calcium-45	1.63e+2 da	1.624e-34
Cesium-137	3.02e+1 yr	3.170e-1
Ba-137m	2.55e-0 min	2.999e-1
Cobalt-60	5.27e-0 yr	1.395e-3
Curium-244	1.81e+1 yr	1.475e-1
Pu-240	6.54e+3 yr	2.354e-3
U-236	3.42e+6 yr	1.556e-8
Th-232	1.41e+10 yr	1.456e-17
Ra-228	5.75e-0 yr	9.685e-18
Ac-228	6.13e-0 hr	9.684e-18
Th-228	1.91e-0 yr	8.223e-18
Ra-224	3.62e-0 da	8.215e-18
Rn-220	5.56e+1 sec	8.215e-18
Po-216	1.46e-1 sec	8.215e-18
Pb-212	1.06e+1 hr	8.215e-18

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Bi-212	6.06e+1 min	8.215e-18
Tl-208	3.05e-0 min	2.951e-18
Po-212	2.98e-7 sec	5.263e-18
Gallium-72	1.41e+1 hr	0.0
Hydrogen-3	1.23e+1 yr	5.947e-2
Iron-55	2.70e-0 yr	2.663e-6
Iron-59	4.46e+1 da	6.594e-124
Krypton-85	1.07e+1 yr	3.944e-2
Lead-209	3.25e-0 hr	0.0
Mercury-203	4.66e+1 da	1.063e-118
Neptunium-237	2.14e+6 yr	9.999e-1
Pa-233	2.70e+1 da	9.999e-1
U-233	1.59e+5 yr	2.172e-4
Th-229	7.34e+3 yr	5.109e-7
Ra-225	1.48e+1 da	5.097e-7
Ac-225	1.00e+1 da	5.089e-7

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Fr-221	4.80e-0 min	5.089e-7
At-217	3.23e-2 sec	5.089e-7
Bi-213	4.57e+1 min	5.089e-7
Pb-209	3.25e-0 hr	5.088e-7
Po-213	4.20e-6 sec	4.979e-7
Niobium-94	2.03e+4 yr	9.983e-1
Plutonium-236	2.85e-0 yr	5.256e-6
U-232	7.20e+1 yr	2.548e-2
Th-228	1.91e-0 yr	2.617e-2
Ra-224	3.62e-0 da	2.618e-2
Rn-220	5.56e+1 sec	2.618e-2
Po-216	1.46e-1 sec	2.618e-2
Pb-212	1.06e+1 hr	2.618e-2
Bi-212	6.06e+1 min	2.618e-2
Tl-208	3.05e-0 min	9.405e-3
Po-212	2.98e-7 sec	1.677e-2
Plutonium-238	8.78e+1 yr	6.737e-1
U-234	2.44e+5 yr	1.171e-4
Th-230	7.70e+4 yr	2.808e-8
Ra-226	1.60e+3 yr	2.081e-10
Rn-222	3.82e-0 da	2.079e-10
Po-218	3.05e-0 min	2.079e-10
Pb-214	2.68e+1 min	2.079e-10
Bi-214	1.99e+1 min	2.079e-10
Po-214	6.37e-5 sec	2.078e-10
Pb-210	2.23e+1 yr	6.202e-11

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Bi-210	5.01e-0 da	6.193e-11
Po-210	1.38e+2 da	5.952e-11
Plutonium-239	2.41e+4 yr	9.986e-1
U-235	7.04e+4 yr	4.921e-8
Th-231	2.55e+1 hr	4.920e-8
Pa-231	3.28e+4 yr	2.602e-11
Ac-227	2.18e+1 yr	9.686e-12
Ra-223	1.14e+1 da	9.625e-12
Rn-219	3.96e-0 sec	9.625e-12
Po-215	7.78e-4 sec	9.625e-12
Pb-211	3.61e+1 min	9.625e-12
Bi-211	2.13e-0 min	9.625e-12
Tl-207	4.77e-0 min	9.599e-12
Th-227	1.87e+1 da	9.515e-12
Plutonium-240	6.54e+3 yr	9.947e-1
U-236	3.42e+6 yr	1.101e-5
Th-232	1.41e+10 yr	1.250e-14
Ra-228	5.75e-0 yr	9.037e-15
Ac-228	6.13e-0 hr	9.037e-15
Th-228	1.91e-0 yr	7.962e-15
Ra-224	3.62e-0 da	7.956e-15
Rn-220	5.56e+1 sec	7.956e-15
Po-216	1.46e-1 sec	7.956e-15
Pb-212	1.06e+1 hr	7.955e-15
Bi-212	6.06e+1 min	7.955e-15
Tl-208	3.05e-0 min	2.858e-15
Po-212	2.98e-7 sec	5.097e-15

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Plutonium-241	1.44e+1 yr	9.011e-2
Am-241	4.32e+2 yr	2.870e-2
Np-237	2.14e+6 yr	3.254e-7
Pa-233	2.70e+1 da	3.244e-7
U-233	1.59e+5 yr	2.761e-11
Th-229	7.34e+3 yr	3.583e-14
Ra-225	1.48e+1 da	3.568e-14
Ac-225	1.00e+1 da	3.558e-14
Fr-221	4.80e-0 min	3.558e-14
At-217	3.23e-2 sec	3.558e-14
Bi-213	4.57e+1 min	3.558e-14
Pb-209	3.25e-0 hr	3.557e-14
Po-213	4.20e-6 sec	3.481e-14
Plutonium-242	3.76e+5 yr	9.999e-1
U-238	4.47e+9 yr	7.756e-9
Th-234	2.41e+1 da	7.742e-9
Pa-234m	1.17e-0 min	7.742e-9
Pa-234	6.70e-0 hr	1.239e-11
U-234	2.44e+5 yr	5.476e-13
Th-230	7.70e+4 yr	8.415e-17
Ra-226	1.60e+3 yr	3.538e-10
Rn-222	3.82e-0 da	5.466e-18
Po-218	3.05e-0 min	6.469e-18
Pb-214	2.68e+1 min	9.404e-18
Bi-214	1.99e+1 min	9.857e-18
Po-214	6.37e-5 sec	7.859e-18
Pb-210	2.23e+1 yr	1.009e-17
Bi-210	5.01e-0 da	1.122e-17
Po-210	1.38e+2 da	1.170e-17

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Polonium-209	1.02e+2 yr	7.119e-1
Pb-205	1.51e+7 yr	1.941e-6
Polonium-210	1.38e+2 da	1.868e-4
Potassium-40	1.28e+9 yr	1.000e+0
Promethium-146	2.02e+3 da	1.899e-3
Promethium-147	2.62e+0 yr	1.831e-6
Sm-147	6.90e+9 yr	3.802e-10

Promethium-148, 148m, 149 all have such short half-lives that essentially no measurable activity remains after 50 years. This is also true for the daughters.

Protactinium-231	3.28e+4 yr	9.989e-1
Ac-227	2.18e+1 yr	7.959e-1
Ra-223	1.14e+1 da	7.951e-1
Rn-219	3.96e-0 sec	7.951e-1
Po-215	7.78e-4 sec	7.951e-1
Pb-211	3.61e+1 min	7.951e-1
Bi-211	2.13e-0 min	7.951e-1
Tl-207	4.77e-0 min	7.930e-1
Th-227	1.87e+1 da	7.844e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Radium-223	1.14e+1 da	0.0
Rn-219	3.96e-0 sec	0.0
Po-215	7.78e-4 sec	0.0
Pb-211	3.61e+1 min	0.0
Bi-211	2.13e-0 min	0.0
Tl-207	4.77e-0 min	0.0
Radium-224	3.62e-0 da	0.0
Rn-220	5.56e+1 sec	0.0
Po-216	1.46e-1 sec	0.0
Pb-212	1.06e+1 hr	0.0
Bi-212	6.06e+1 min	0.0
Tl-208	3.05e-0 min	0.0
Po-212	2.98e-7 sec	0.0
Radium-225	1.48e+1 da	0.0
Ac-225	1.00e+1 da	0.0
Fr-221	4.80e-0 min	0.0
At-217	3.23e-2 sec	0.0
Bi-213	4.57e+1 min	0.0
Pb-209	3.25e-0 hr	0.0
Po-213	4.20e-6 sec	0.0
Radium-226	1.60e+3 yr	9.786e-1
Rn-222	3.82e-0 da	9.786e-1
Po-218	3.05e-0 min	9.786e-1
Pb-214	2.68e+1 min	9.783e-1
Bi-214	1.99e+1 min	9.783e-1
Po-214	6.37e-5 sec	9.781e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Pb-210	2.23e+1 yr	7.782e-1
Bi-210	5.01e-0 da	7.781e-1
Po-210	1.38e+2 da	7.746e-1
Radium-228	5.75e-0 yr	2.412e-3
Ac-228	6.13e-0 hr	2.412e-3
Th-228	1.91e-0 yr	3.615e-3
Ra-224	3.62e-0 da	3.621e-3
Rn-220	5.56e+1 sec	3.621e-3
Po-216	1.46e-1 sec	3.621e-3
Pb-212	1.06e+1 hr	3.621e-3
Bi-212	6.06e+1 min	3.621e-3
Tl-208	3.05e-0 min	1.301e-3
Po-212	2.98e-7 sec	2.321e-3
Rhodium-106	2.99e+1 sec	0.0
Selenium-75	1.20e+2 da	1.267e-46
Silicon-31	1.57e+2 min	0.0
Strontium-90	2.86e+1 yr	2.977e-1
Y-90	6.41e+1 hr	2.977e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES

Tellurium-121, 125, 127, 131, 132, 133, 134 all have such short half-lives that essentially no measurable activity remains after 50 years. This is also true for the daughters.

Tellurium-123	1.00e+13 yr	1.000e-0
Tellurium-129	6.96e+1 min	0.000e-0
I-129	1.57e+7 yr	8.429e-12
Thorium-228	1.91e-0 yr	1.358e-8
Ra-224	3.62e-0 da	1.365e-8
Rn-220	5.56e+1 sec	1.365e-8
Po-216	1.46e-1 sec	1.365e-8
Pb-212	1.06e+1 hr	1.365e-8
Bi-212	6.06e+1 min	1.365e-8
Tl-208	3.05e-0 min	4.907e-9
Po-212	2.98e-7 sec	8.750e-9
Thorium-229	7.34e+3 yr	9.953e-1
Ra-225	1.48e+1 da	9.953e-1
Ac-225	1.00e+1 da	9.953e-1
Fr-221	4.80e-0 min	9.953e-1
At-217	3.23e-2 sec	9.953e-1
Bi-213	4.57e+1 min	9.953e-1
Pb-209	3.25e-0 hr	2.150e-2
Po-213	4.20e-6 sec	9.738e-1
Pb-209	3.25e-0 hr	9.738e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Thorium-230	7.70e+4 yr	9.996e-1
Ra-226	1.60e+3 yr	2.142e-2
Rn-222	3.82e-0 da	2.142e-2
Po-218	3.05e-0 min	2.142e-2
Pb-214	2.68e+1 min	2.141e-2
Bi-214	1.99e+1 min	2.141e-2
Po-214	6.37e-5 sec	2.141e-2
Pb-210	2.23e+1 yr	1.058e-2
Bi-210	5.01e-0 da	1.058e-2
Po-210	1.38e+2 da	1.039e-2
Thorium-232	1.41e+10 yr	1.000e-0
Ra-228	5.75e-0 yr	9.976e-1
Ac-228	6.13e-0 hr	9.976e-1
Th-228	1.91e-0 yr	9.964e-1
Ra-224	3.62e-0 da	9.964e-1
Rn-220	5.56e+1 sec	9.964e-1
Po-216	1.46e-1 sec	9.964e-1
Pb-212	1.06e+1 hr	9.964e-1
Bi-212	6.06e+1 min	9.964e-1
Tl-208	3.05e-0 min	3.580e-1
Po-212	2.98e-7 sec	6.383e-1
Uranium-232	7.20e+1 yr	6.180e-1
Th-228	1.91e-0 yr	6.348e-1
Ra-224	3.62e-0 da	6.349e-1
Rn-220	5.56e+1 sec	6.349e-1
Po-216	1.46e-1 sec	6.349e-1
Pb-212	1.06e+1 hr	6.349e-1
Bi-212	6.06e+1 min	6.349e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Tl-208	3.05e-0 min	2.281e-1
Po-212	2.98e-7 sec	4.068e-1
Uranium-233	1.59e+5 yr	9.998e-1
Th-229	7.34e+3 yr	4.710e-3
Ra-225	1.48e+1 da	4.705e-3
Ac-225	1.00e+1 da	4.701e-3
Fr-221	4.80e-0 min	4.701e-3
At-217	3.23e-2 sec	4.701e-3
Bi-213	4.57e+1 min	4.701e-3
Pb-209	3.25e-0 hr	4.701e-3
Po-213	4.20e-6 sec	4.599e-3
Uranium-234	2.44e+5 yr	9.999e-1
Th-230	7.70e+4 yr	4.500e-4
Ra-226	1.60e+3 yr	4.839e-6
Rn-222	3.82e-0 da	4.836e-6
Po-218	3.05e-0 min	4.836e-6
Pb-214	2.68e+1 min	4.835e-6
Bi-214	1.99e+1 min	4.835e-6
Po-214	6.37e-5 sec	4.834e-6
Pb-210	2.23e+1 yr	1.774e-6
Bi-210	5.01e-0 da	1.772e-6
Po-210	1.38e+2 da	1.721e-6
Uranium-235	7.04e+8 yr	1.000e-0
Th-231	2.55e+1 hr	1.000e-0
Pa-231	3.28e+4 yr	1.057e-3
Ac-227	2.18e+1 yr	5.283e-4

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Ra-223	1.14e+1 da	5.263e-4
Rn-219	3.96e-0 sec	5.193e-4
Po-215	7.78e-4 sec	5.263e-4
Pb-211	3.61e+1 min	5.263e-4
Bi-211	2.13e-0 min	5.263e-4
Tl-207	4.77e-0 min	5.249e-4
Th-227	1.87e+1 da	5.198e-4
Uranium-238	4.47e+9 yr	1.000e-0
Th-234	2.41e+1 da	1.000e-0
Pa-234m	1.17e-0 min	1.000e-0
Pa-234	6.70e-0 hr	1.600e-3
U-234	2.44e+5 yr	1.415e-4
Th-230	7.70e+4 yr	3.177e-8
Ra-226	1.60e+3 yr	2.277e-10
Rn-222	3.82e-0 da	2.275e-10
Po-218	3.05e-0 min	2.275e-10
Pb-214	2.68e+1 min	2.275e-10
Bi-214	1.99e+1 min	2.275e-10
Po-214	6.37e-5 sec	2.274e-10
Pb-210	2.23e+1 yr	6.671e-11
Bi-210	5.01e-0 da	6.660e-11
Po-210	1.38e+2 da	6.395e-11
Vanadium-52	3.75e-0 min	0.0

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES

Xenon-122, 125, 127, 129, 131, 133, 135, 137, 138 all have such short half-lives that no essentially no measurable activity remains after 50 years. This is also true for the daughters.

Xenon-123	2.14e-0 hr	0.0
I-123	1.31e+1 hr	0.0
Te-123	1.00e+13 yr	2.441e-17

Yttrium-88, 90, 90m, 91, 91m all have such short half-lives that no essentially no measurable activity remains after 50 years. This is also true for the daughters.

Zinc-65	2.44e+2 da	3.206e-23
Zirconium-93	1.53e+6 yr	9.999e-1
Nb-93m	1.46e+1 yr	9.069e-1
Zirconium-95	6.40e+1 da	1.341e-86
Nb-95	3.51e+1 da	2.965e-86

Mound ER Library
DUPLICATE
Classification Code: 04-01
Accession No: 9604150056

MOUND

TECHNICAL MANUAL

MD–22153, ISSUE 1
MOUND SITE RADIONUCLIDES BY LOCATION

Section	Issue
Intro	1
1	1
2	1
3	1
Appen A	1
Appen B	1

Page	Issue
1	1
2	1
3	1

D.V. Eckman, DOE/MB

Ken Armstrong, BD–48
Dave Billing, SW–202
Clyde Gallaher, T–320
George Gartrell, OSW–213
TR– Wayne King, BD–91
Paul Lamberger, T–245
Al Ogurek, BD–91
E– M. J. Pacinda
Rob Robinson, A–22
Terry L. Vaughn. BD–91
Ray Weaver, BD–91
Drawing Control, OSW–3
Technical Manuals

CHANGES INCORPORATED

- ☐ Replace
- ☐ Insert (New Pages)
- ☐ Remove
- ☐ Complete Reprint

All appropriate reviews by senior safety committees were conducted. This issue is authorized for use by Advanced Change Order on file in Technical Manuals.

Terry L. Vaughn, 6–22–95
Radiological Control Manager

IMPORTANT

VERIFY that the procedure you are using is the latest issue.

- **Check the Manuals Tracking System on PVC.**
- **Non-PVC users, call x3804 for issue information.**

PUBLICATION RECORD

ISSUE	DATE	APPLICATION	CHANGE DATE	CHANGE ACO
1	7-26-95	Radiological Control	6–22–95	950249MD–C

TABLE OF CONTENTS

Introduction

Section 1: Primary Research and Production Buildings

Section 2: Supporting Buildings

Section 3: Information on Appendix B

Section 4: Information from GIS Report--To Be Published Later

Appendix A: Major Daughter Nuclides

Appendix B: Suppliment to Section 1; located in Document Control

MOUND SITE RADIONUCLIDES BY LOCATION

INTRODUCTION

1. Purpose

There are three major objectives of this document. The first is to identify the radionuclides used in each of the rooms for each of the buildings at Mound. This will include a listing of all compound forms of each radionuclide for specific time frames because of specific programs, which are also identified.

The second objective is to determine information about a given radionuclide which would facilitate internal dose assessment. This includes the compound forms with which the radionuclides are associated, information to indicate the probable lung solubility class, the relative abundance of radioisotopes in each room for a given time frame, and the particle size.

The third objective is to compile all information about ground surveys and core sample results to indicate possible intakes at specific locations as a result of D&D and other work performed.

When doing either a historic or current internal dose assessment for an individual, the records do not always indicate the details of an incident or a chronic condition. By knowing the approximate date and location of an exposure, this document can be used to determine which radioisotopes existed in that area. Since chemical compound, temperature in processing, and particle size all can affect the lung solubility class, this information is of great help in determining the parameters used in the biokinetic model which predicts the internal dose from lung deposition. This information is also valuable for uptakes resulting from ingestion or wounds.

2. Scope

This document is a historic and current compilation, listing radionuclides at Mound by buildings, rooms, and dates. It also includes ground survey and core sample results of site.

Notes:

- Ground surveys and core sample results will not be available until the Geographical Information System (GIS) report is available October 1. The GIS report will compile that information from several sources and will have accompanying site drawings showing the site location for the data. The relevant information will be included in this document.

- A critique of this document is welcomed. Please consider the technical accuracy, format, and any other information which should be included. Address all comments to Wayne King, Building 91, X-3207.

3. Organization of Material

The information in this document is organized into four sections:

Section 1 identifies the primary buildings where research, development, and production, involving radioisotopes, were performed. Appendix A lists the daughter products of their radionuclides. The buildings include HH Building, PP Building (also called Building 38), R Building, SM Building, SW Building, T Building, and WD/WDA Buildings.

Section 2 represents supporting buildings which were, or are not directly involved in research or production. Although these buildings were, or are occupied by radionuclides in one form or another, they do NOT represent a significant location for uptakes nor incidents. These support buildings include: Warehouse #9, #13, #15, and Buildings 15, 21, 34, 50, 59, 68, B, E, H, I, M, P, RR, and SD. All information in this category is unclassified.

Section 3 is a supplement to Section 1 which presents additional information for the same rooms and buildings in a Secret Restricted Appendix (SRD), Appendix B. Appendix B gives additional information about processes and additional radionuclides which could not be presented in the unclassified Section 1. A "See Appendix B" statement is given in the unclassified document for each place this "SECRET" information is available.

Please Note: Much important information is contained in this secret appendix. It is strongly recommended that a reading of the material in Appendix B be made when looking at a section of this document where the statement "see Appendix B" is made. The material given for many rooms in R, SW, and T Buildings is vague and cannot be fully understood without using this appendix.

Section 4 gives a compilation of ground survey and core sample results taken from the GIS report. This information includes maps of where survey and survey core sample results were taken and tables of those results. This information came from four data bases which, when integrated, give a comprehensive listing. The four data bases are: The "Site Survey Data Base," "Decontamination and Decommissioning Data Base," "Environmental Monitoring Data Base," and "Construction Engineering Data Base."

4. Limitations of Biokinetic Models

The parameters for the biokinetic models are not straightforward and are subject to much experimentation for the following reasons:

- Traditionally ICRP #30 teaches that plutonium compounds should be lung solubility class W except for the oxides (dioxide, oxide hydrate, hydroxide) which should be lung solubility class Y.

- In processes where plutonium oxides (traditionally class Y) have not been subjected to any heat it may be possible to classify them as lung solubility class W, or some intermittent value such as 200 days for class Y, since they appear to be more soluble.

- In processes where plutonium nitrates and oxalate are involved in an aqueous form, the plutonium could possess a lung solubility class of a W or even D.

- After the precipitation of plutonium, the self-generating heat produced oxide solids (dioxide, oxide hydrate, hydroxide). These should be classified as a class Y, but since no process sintering was done it is more likely to possess some lesser solubility factor such as 200 days as mentioned above.

- The particle diameters of the plutonium compounds varied greatly from submicron (< 1.0 μm) conditions, which were abundant, to particulate exceeding 20 μm. Some processes involved vaporization of plutonium-containing materials or other radioisotopes which created extremely fine particulate. As a result of the abundance of fine particulate, the biological half-life time may be greatly reduced from what is recommended by the ICRP manuals.

- Some processes used complexing agents such as EDTA and citrates which cause rapid depletion of plutonium and the other radionuclides from the body if an uptake occurred. These complexes act like chelating agents which cause the excretion of abnormally large amounts of radionuclides into the urine in a relatively short time.[1]

- Polonium-210 dosimetric analysis will vary somewhat from the ICRP #30 and #54 model. A model was developed in 1989 by Dr. Ken Scrable of the University of Lowell and Dr. Cohen of New York University through the direction of Gene Runkle of DOE Albuquerque Health Protection Division. The polonium section of this Technical Basis Manual presents the details of the dosimetry model parameter recommendations.

- Other radioisotopes from the polonium work, as identified under the polonium section in T Building, will be analyzed in accordance with ICRP #30 and #54 recommendations. These analyses will include dose from internal beta and gamma photon energies.

---

[1] Don Rogers, 9/93, Senior Fellow

- Tritium gas, HTO, and metal tritides will be analyzed according to parameters and models established in the Technical Basis Manual.

5. Other Considerations

5.1 Incidents

"Incidents," with the dates and radionuclides, have been listed for the various rooms of all buildings to support claims of their presence. All incidents were listed where room number and radioisotope was given. In cases where more than one person was involved only one of the persons was identified. (The incident number and all significant data are given in the "endnote" such that further inquiries would be possible.)

Listings were not given for incidents involving Pu-238 in SM and PP Buildings since it is well documented that most all work involved Pu-238. Only incidents involving other radionuclides will be listed for those two buildings.

5.2 Rooms

The rooms are listed in numerical order for each building where radionuclides exist (or have existed). Much duplicate information exists so that each room "stands alone" in a user-friendly format. Only the "OVERVIEW" to the building being referenced should be considered along with the room number since some guidance is presented there. Other rooms associated with that room need not be considered for this reason.

5.3 Dates

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for decontamination work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides, and daughters, which MAY BE present as fixed radiation.

5.4 Radionuclide Ranking

All radionuclides are ranked according to the degree of concern for uptake and amount of activity for internal dosimetry considerations. Rooms which are referenced to Appendix B for additional radionuclides do not have a ranking in this manual since the ranking is performed in Appendix B, where all radionuclides are listed. This situation is identified as "see Appendix B for ranking." Rooms where additional information on processing or radionuclides in Appendix B does not effect the ranking are identified as "see appendix" only.

CAUTION

The room numbers listed in this document do not always agree with current building drawings. The numbers listed within this document sometimes refer to older floor plans.

TABLE OF CONTENTS FOR SECTION 1
PRIMARY RESEARCH AND PRODUCTION BUILDINGS

1. HH BUILDING 1
   1.1 OVERVIEW 1
   1.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS 3
      1.2.1. Room HH-3, 4 3
      1.2.2 Room HH-5 3
      1.2.3 Room HH-6 5
      1.2.4 Room HH-8 6
      1.2.5 Room HH-9 7
      1.2.6 Rooms HH-10, 11, and 12 7
      1.2.7 Room HH-119, 120, 121, 122 8

2. PP BUILDING 9
   2.1 OVERVIEW 9
   2.2 RADIONUCLIDES, ROOM, AND DATES ASSOCIATED WITH SPECIFIC HEAT SOURCE PROGRAMS 13
      2.2.1 PP-Corr-5A 13
      2.2.2 Room PP-6 13
      2.2.3 Room PP-6W 13
      2.2.4 PP-CORR-10 13
      2.2.5 Room PP-13 14
      2.2.6 Room PP-14 14
      2.2.7 PP-CORR-15, CORR-16, CORR-17 14
      2.2.8 Room PP-18 14
      2.2.9 Room PP-24 15
      2.2.10 Room PP-100 15
      2.2.11 Room PP-113 15
      2.2.12 PP-CORR-115 16
      2.2.13 Room PP-127 16
      2.2.14 PP-CORR-134, CORR-135, CORR-136 16
      2.2.15 PP-CORR-140, CORR-141, CORR-142 17
      2.2.16 Room PP-143 (A1) 17
      2.2.17 Rooms PP-144 (A2), 147 (B2), & 148 (B3) 17
      2.2.18 Room PP-145 (A3) 20
      2.2.19 Room PP-149 (B4) 20
      2.2.20 Rooms PP-146 (B1), 150 (C1), 151 (C2), 152 (C3), 153 (C4), 154 (D1), 156 (D3) 20
      2.2.21 Room PP-157 22
      2.2.22 Room PP-158 22
      2.2.23 Room PP-159 22
      2.2.24 Room PP-161 (Same as F-1) 22
      2.2.25 Rooms PP-162 and 163 (Same as F-2 & F-3) 23

3. R BUILDING 24
   3.1 OVERVIEW 24
   3.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS 33
      3.2.1 Room R-105, 106 33

TABLE OF CONTENTS FOR SECTION 1
PRIMARY RESEARCH AND PRODUCTION BUILDINGS

3.2.2 Room R-108 33
3.2.3 Room R-110 34
3.2.4 Room R-111 35
3.2.5 Room R-112 36
3.2.6 Rooms R-113, 114, and 115 36
3.2.7 Room R-116 (A&B) 37
3.2.8 Room R-117 38
3.2.9 Room R-118 39
3.2.10 Rooms R-120 and support rooms R-118, 119, 121, 123 40
3.2.11 Room R-127 43
3.2.12 Room R-128 45
3.2.13 Room R-129 and R-130 46
3.2.14 Room R-131 47
3.2.15 Room R-133 48
3.2.16 Room R-134 50
3.2.17 Room R-137 50
3.2.18 Room R-140 51
3.2.19 Room R-142 52
3.2.20 Rooms R-143 and 144 53
3.2.21 Rooms R-145 and 147 54
3.2.22 Room R-149 also support room R-148 56
3.2.23 Room R-151 58
3.2.24 Room R-152 59
3.2.25 Room R-155 60
3.2.26 Room R-159 62
3.2.27 Room R-160 63
3.2.28 Room R-161 64
3.2.29 Room R-162 65
3.2.30 Room R-166 66
3.2.31 Room R-167 67
3.2.32 Room R-168 69
3.2.33 Room R-169 (A,B,C) 69
3.2.34 Room R-170 70
3.2.35 Rooms R-171, 172 70
3.2.36 Room R-174, 176 71
3.2.37 Room R-197A 72
3.2.38 Room R-198 72
3.2.39 The crawl space above R Building 72
3.2.40 R-Corr 5 73

4. SM BUILDING 74
4.1 OVERVIEW 74
4.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS 78
4.2.1 Room SM-1 78
4.2.2 Room SM-2 79
4.2.3 Room SM-3, 10 79
4.2.4 Room 20 79

TABLE OF CONTENTS FOR SECTION 1
PRIMARY RESEARCH AND PRODUCTION BUILDINGS

4.2.5 Room SM-21 79
4.2.6 Room SM-26 80
4.2.7 Room SM-27,28 80
4.2.8 Room SM-34 82
4.2.9 Rooms SM-35, 35A 83
4.2.10 Room SM-38 84
4.2.11 Room SM-39 86
4.2.12 Rooms SM-58, 59A, and 59B 87
4.2.13 Room SM-60 88
4.2.14 Rooms SM-61, 62 88
4.2.15 Environmental concerns 89
4.2.16 See Appendix B for SM Building Room SM-10 89

5. SW BUILDING 90
5.1 OVERVIEW 90
5.1.1 Original SW Complex (1950) 91
5.1.2 Hot Gas Facility (1957) 92
5.1.3 Ceramics Facility (1958) 92
5.1.4 Disassembly and Surveillance (1960) 92
5.1.5 SW-1C: Second Floor Addition and Mechanical Room on first floor (1960) 92
5.1.6 Change House (1961) 92
5.1.7 North Alterations / Second Floor Addition and a Two Story Support Building (1961) 92
5.1.8 Nuclear Component Development and Pre-Production Facility (NCDPF) (1965) 93
5.1.9 Addition To Existing SW-9 (1967) 93
5.1.10 Surveillance and Environmental Test Facility (1969) 93
5.1.11 Cooling Tower and Chiller (1972) 93
5.1.12 Impact Test Facility (1975) 93
5.1.13 Thorium Facility (1976) 93
5.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC PROGRAMS IN SW BUILDING 97
5.2.1 Room SW-2 97
5.2.2 Room SW-8 97
5.2.3 Room SW-9 99
5.2.4 Room SW-10 99
5.2.5 Room SW-13 and supporting rooms SW-11, 12, 14, 15, 16 (Area SW-1B) . 99
5.2.6 Room SW-19 (Old Cave) 102
5.2.7 Room SW-20, 21 103
5.2.8 Room SW-22: "New Cave" and Laboratory Area 103
5.2.9 Room SW-128, 129, 130, 134 105
5.2.10 Room SW-132 105
5.2.11 Rooms SW-136 and SW-137 106
5.2.12 Room SW-140 107
5.2.13 Room SW-142 108
5.2.14 Rooms SW-146, 147 109
5.2.15 Room SW-149 and 149A 110

TABLE OF CONTENTS FOR SECTION 1
PRIMARY RESEARCH AND PRODUCTION BUILDINGS

5.2.16 Rooms SW-150 and 152 111
5.2.17 Room SW-200 111
5.2.18 Room SW-202 111
5.2.19 Room SW-205 112
5.2.20 Room SW-208 112
5.2.21 Room SW-210 113
5.2.22 Room SW-219 113
5.2.23 Room SW-231 114
5.2.24 Rooms SW-238, 240 115

6. T-BUILDING 116
6.1 OVERVIEW 116
6.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS 125
6.2.1 Room T-1W 125
6.2.2 Room T-2W 125
6.2.3 Room T-4E 125
6.2.4 Room T-5W 125
6.2.5 Room T-5E 125
6.2.6 Room T-8 126
6.2.7 Room T-9 or 9A 126
6.2.8 Room T-13 126
6.2.9 Room T-15B 126
6.2.10 Room T-16A 127
6.2.11 Room T-18 127
6.2.12 Room T-19, T-19A 127
6.2.13 Room T-20 128
6.2.14 Room T-22 128
6.2.15 Rooms T-25 and T-26 129
6.2.16 Room T-27 129
6.2.17 Rooms T-28, 29, 30, 31, 32, 33, 34, 35 130
6.2.18 Room T-36, T-36A 131
6.2.19 Room T-37 131
6.2.20 Room T-40 132
6.2.21 Room T-41 132
6.2.22 Room T-46 132
6.2.23 Room T-48, T-49, T-50 132
6.2.24 Room T-53 133
6.2.25 Room T-54A, 55A, 55 133
6.2.26 Room T-57 135
6.2.27 Room T-58 136
6.2.28 Room T-59 136
6.2.29 Room T-61, T-61A 137
6.2.30 Room T-63 138
6.2.31 Rooms T-72, 73, 74, 75 and T-92, 93, 96, 97, 98 138
6.2.32 Room T-99 139
6.2.33 Rooms T-100, 102, 103, 104 139
6.2.34 Room T-208A 140

TABLE OF CONTENTS FOR SECTION 1
PRIMARY RESEARCH AND PRODUCTION BUILDINGS

6.2.35 Room T-229 141
6.2.36 Room T-234 142
6.2.37 Room T-236 (dock) 142
6.2.38 Room T-237 143
6.2.39 Room T-238 144
6.2.40 Room T-242 144
6.2.41 Room T-243 145
6.2.42 Room T-245 145
6.2.43 Room T-246 145
6.2.44 Room T-247 146
6.2.45 Room T-248 --> T-259 146
6.2.46 Room T-260 147
6.2.47 Room T-266, 267, 268 148
6.2.48 Room T-270 149
6.2.49 Room T-274 149
6.2.50 Rooms T-275 and T-276 151
6.2.51 Room T-277 and T-279 151
6.2.52 Room T-300A 152
6.2.53 Room T-307 152
6.2.54 Room T-310 153
6.2.55 Rooms T-311 155
6.2.56 Room T-319 155

7. WD AND WDA BUILDINGS 157
7.1 WD OVERVIEW 157
7.2 WDA OVERVIEW 158
7.3 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS 161
7.3.1 Room WD-1 161
7.3.2 Room WD-8 164
7.3.3 Room WDA-9 166
7.3.4 Room WDA-10 167
7.3.5 Room WD-101 168
7.3.6 Room WD-104 171
7.3.7 Room 107 and basement 173
7.3.8 Room WD-108 173
7.3.9 Room WD-110 174
7.3.10 Room WDA-110 175
7.3.11 Room WDA-112 175
7.3.12 Room WDA-113 176
7.3.13 Room WDA 118 A&B 176
7.3.14 Room WD-Penthouse 177
7.3.15 Tanks/WDA 177
7.3.16 Cleaning of tanks and equipment in WD 178

8. ENDNOTES AND REFERENCES 179

MOUND SITE RADIONUCLIDES BY LOCATION

PRIMARY RESEARCH AND PRODUCTION BUILDINGS

1. HH BUILDING

1.1 OVERVIEW

HH means "Hydrolysis House," which is a name derived from its first primary function, the hydrolysis of highly radioactive bismuth chloride and aluminum chloride solutions. In 1963 HH Building was converted to stable gaseous isotope separation using thermal diffusion, liquid diffusion, and cryogenic processes. [1]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for decontamination work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

All radionuclides are ranked according to the degree of concern for uptake and internal dosimetry considerations for each room. Rooms that reference Appendix B for additional information usually will not have a ranking in this manual, since the ranking is done in Appendix B, where all radionuclides are listed.

Table 1 is a summary of the rooms, dates, and radionuclides for H-H Building.

Table 1 - HH BUILDING SUMMARY

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
HH-3, 4	H-3	1960-1990
	Xe (all isotopes), Kr-85	1964-1983
	Stable isotopes, Kr-85	1964-PRES
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), Kr-85	1964-1983
	Stable isotopes, Kr-85	1964-PRES
HH-6	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
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, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, 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, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-->134?, Hg-203	1949-1958
HH-119, 120, 121, 122	H-3	1964-1980

1.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS

1.2.1. Room HH-3, 4 These rooms had several functions:

a. (1960 - 1990) The helium-3 separation program was a gaseous thermal diffusion method initiated in SW-8 (1957-1960). In this process helium-3 was separated from aged tritium and helium-3 was used for commercial sales. A pipeline was installed which transported the tritium-containing waste gas to R-108 where it was oxidized and released to the ERS in SW Building. Radionuclides of concern and their compounds are: [2 3 4 5]

tritium

b. (1964 - 1983) Xenon gas, resulting from fission within a reactor, had its isotopes separated from each other using gaseous thermal diffusion. This was one of two methods used for isotope separation. Radioisotopes of concern and their compounds are: [6 7 8]

all xenon isotopes krypton-85

1) Krypton-85 is the major radiological concern and that is minimal.[9]

c. (1964 - PRESENT) Stable Isotope Separation - Initially carbon-12,13 and helium-3 and later neon-20,21,22, argon-36,38,40, xenon-124,126,...,131,134,136, nitrogen-14,15, oxygen-16,17,18, chlorine-35,37, bromine-79,81, and krypton-78,80,82,83,84,86, gases were separated isotopically by a thermal diffusion process. All of the isotopes are nonradioactive and are of no interest to this study. Sulfur-34,36 isotopes were later separated using a unique liquid thermal diffusion process.[10 11 12 13]

1) Krypton-85, a radionuclide, is an impurity found in some of the feed gases received for enrichment.

1.2.2 Room HH-5 This room had several functions:

a. (1955 - 1956) Initially this room was set up as a pilot plant for the separation of protactinium-231 from residues (raffinates) of a previously processed uranium substance called "Sperry Cake." Research work for processing had previously been done in R-145 & 147. This room became the actual processing room for the protactinium separation work from

the Sperry Cake substance. Radioisotopes of concern and their compounds are: [14 15 16]

iron-59	aluminum-26	calcium-45
cobalt-60	protactinium-231	copper-65

1) Protactinium-231 is the major radiological concern and all others are a distant second.[17]

2) By 1958 this area was completely decontaminated and all equipment removed. [18]

b. (1956) The Ionium (Th-230) program, developed in R-133, was a process closely related to the protactinium-231 program discussed above and also similar to the Cotter Concentrate program of the 1970's. The separation of Th-230 from "airport cake," a raffinate produced by an extraction process of uranium, required large columns for the actual separation production. The process was moved to HH Building since the large columns could be used there. Radioisotopes of concern and their compounds are: [19 20 21 22 23]

uranium-233,234,235,238	thorium-230,232
protactinium-231	thorium-230,232 daughters

1) Thorium-230 was the major radionuclide with all others being as distant second. [24]

c. (1960 - 1990) The helium-3 separation program consisted of three programs of which the gaseous thermal diffusion method initiated in SW-8 (1957-1960) is one. In this process helium-3 was separated from aged tritium and helium-3 was used for commercial sales. A pipeline was installed which transported the tritium-containing waste gas to R-108 where it was oxidized and released to the ERS in SW Building. Radionuclides of concern are: [25 26 27 28]

tritium

d. (1964 - 1983) Xenon gas, resulting from fission within a reactor, had its isotopes separated from each other using gaseous thermal diffusion. This

was one of two methods used for isotope separation. Radioisotopes of concern and their compounds are: [29 30 31]

all xenon isotopes krypton-85

1) The radioactive Xenon isotopes are the major radiological concern.[32]

e. (1964 - PRESENT) Stable Isotope Separation -Initially carbon-12,13 and helium-3 and later neon-20,21,22, argon-36,38,40, xenon-127,129,131,133, nitrogen-14,15, oxygen-16,17,18, chlorine-35,37, bromine-79,81, and krypton-78,80,82,83,84,86, gases were separated isotopically by a thermal diffusion process. All of the isotopes are nonradioactive and are of no interest to this study. Sulfur-34,36 isotopes were later separated using a unique liquid thermal diffusion process. [3334 35 36]

1) Krypton-85, a radionuclide, is an impurity found in some of the feed gases received for enrichment.

1.2.3 Room HH-6 This room had two functions:

a. (1955 - 1956) Initially this room was set up as a pilot plant for the separation of protactinium-231 from residues (raffinates) of a previously processed uranium substance called "Sperry Cake." Research work for processing had previously been done in R-145 & 147. This room became the actual processing room for the protactinium separation work from the Sperry Cake substance. Radioisotopes of concern and their compounds are: [37 38 39]

iron-59	aluminum-26	calcium-45
cobalt-60	protactinium-231	copper-65

1) Protactinium-231 is the major radiological concern and all others are a distant second.[40]

2) By 1958 this area was completely decontaminated and all equipment removed. [41]

b. (1956) The Ionium (Th-230) program, developed in R-133, was a process closely related to the protactinium-231 program discussed above and also similar to the Cotter Concentrate program of the 1970's. The separation of Th-230 from "airport cake," a raffinate produced by an extraction

process of uranium, required large columns for the actual separation production. The process was moved to HH Building since the large columns could be used there. Radionuclides of concern and their compounds are: [42 43 44 45 46]

uranium-233,234,235,238	thorium-230,232
protactinium-231	thorium-230,232 daughters

1) Thorium-230 was the major radionuclide with all others being as distant second. [47]

1.2.4 Room HH-8 This room had two functions:

a. (1949 - 1958) Hydrolysis for Po-210 Program - Radioactive aluminum chloride and bismuth chloride waste were received from the processing of the aluminum cans and bismuth in T-Building. Hydrolysis of these compounds produced a gelatinous bismuth oxychloride sludge which was stored in a quonset hut for possible recovery of the bismuth and re-irradiation at Hanford. The bismuth sludge was shipped off site in April of 1954. The aluminum sludge was solidified and shipped off site as it was produced. [48 49]

1) The sludge possessed high levels of radioactivity at 0.02 Ci/L of alpha, 0.002 Ci/L of beta, and 100 mrem of gamma at a distance of 1.0 foot. Radioisotopes of concern and their compounds are: [50 51 52]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a) Polonium-210 is the major radionuclide of concern with zinc-65 being the second. All others are a distant third.[53]

2) The bismuth chloride aqueous wastes and aluminum chloride aqueous wastes were transferred from T Building to HH Building via two separate 4 inch diameter Pyrex lines. These two waste streams were received and processed in the HH building until 1959 when all polonium operations ceased in the HH building. The hydrolysis of these wastes was done in T-54 after 1958. [54 55 56]

b. (1961 - 1963) Xenon, resulting from fission within a reactor, had its isotopes separated from each other using a "still" to separate the isotopes of xenon and the krypton-85. This was done on an experimental basis. Radioisotopes of concern and their compounds are: [57]

all xenon isotopes krypton-85

1) The radioactive xenon isotopes are the major radiological concern.[58]

1.2.5 Room HH-9

(1964 - 1985) In this room one of three methods was used to obtain helium-3 from a tritium/helium mixture. A charcoal process was used in combination with cryogenics in separating the tritium from helium-3. The tritium was the waste and the helium-3 was the desired product. Radioisotope of concern is: [59]

tritium

1.2.6 Rooms HH-10, 11, and 12

(1949 - 1958) Hydrolysis for Po-210 Program - Radioactive aluminum chloride and bismuth chloride waste were received from the processing of the aluminum cans and bismuth in T-Building. Hydrolysis of these compounds produced a gelatinous bismuth oxychloride sludge which was stored in a quonset hut for possible recovery of the bismuth and re-irradiation at Hanford. It was shipped off site in April 1954. The aluminum sludge was solidified and shipped off site as it was produced. [60 61]

a. The sludge possessed high levels of radiation at 0.02 Ci/L of alpha, 0.002 Ci/L of beta, and 100 mrem of gamma at a distance of 1.0 foot. Radioisotopes of concern and their compounds are: [62 63 64]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being the second. All others are a distant third.[65]

b. The bismuth chloride aqueous wastes and aluminum chloride aqueous wastes were transferred from T Building to HH Building via two separate 4-inch diameter Pyrex lines. These two waste streams were received and processed in the HH building until 1959, when all polonium operations ceased in the HH building. The hydrolysis of these wastes were done in T-54 after 1958. [66 67 68]

1.2.7 Room HH-119, 120, 121, 122

(1964 - 1980) The cryogenic process for the separation of helium-3 from tritium was used in this area. Radioisotope of concern is: [69]

tritium

2. PP BUILDING

2.1 OVERVIEW

Plutonium Processing (PP) Building (Building 38) was completed in December of 1967. The Special Metallurgical (SM) Building processes, fabrication operations, and recovery processes were transferred to PP Building along with waste treatment facilities, research and development, which included material research, and analytical laboratory support activities. This building was used primarily for processing plutonium-238 dioxide, received from 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 MLM-1564 (AEC Research and Development Report), page 31.

(1 ppm)-->1E-4% Pu-236
80.2% Pu-238
15.9% Pu-239
3.0% Pu-240
0.6% Pu-241
0.1% Pu-242

Note: MLM-1564 also makes reference to other mixtures.

All reference to plutonium-238 in PP Building was a composite of the mixture identified above. This mixture also included trace amounts of americium-241, neptunium-237, and uranium-234. [70]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

Thorium-232 was often substituted for Pu-238 compounds for modeling purposes in research and development, since this isotope was less expensive, less hazardous, and had physical characteristics similar to Pu-

238. It is therefore possible to find Th-232 compounds identical to the Pu-238 compounds. [71] [72]

The term "high-fired" is sometimes used, which implies that the plutonium compound has been heated in a plasma torch process such that the lung solubility class is definitely a "Y" or perhaps even a "YY." The term "non-high-fired" implies an absence of such heating and in extreme cases, where indicated, a lung solubility class of "W" or even a "D" may exist where there is high solubility.

Although a multitude of incidents occurred in the PP Building, only a few were listed because they were all from plutonium-238. It was already mentioned in the introduction to the document that only radioisotopes other than plutonium-238 would be listed for incidents in PP and SM Buildings.

A ranking of radionuclides according to the degree of concern for uptake and internal dosimetry consideration, as was done in HH and R Building, was NOT done in PP Building since all radionuclides were plutonium. The mixture of plutonium isotopes as shown above will dictate the ranking of radionuclides to be concerned with in all incidents and internal dosimetry dose calculations.

Table 2 is a summary of rooms, dates, and radioisotopes for PP Building.

Table 2 - BUILDING 38 AND PP BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	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	PuO2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967-PRES
PP-CORR-10	PuO_2	1967-PRES
PP-13	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967-1980
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	PuO2, $Pu(NO_3)_4$	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 orphan sources	1975-1989 1988-PRES
PP-CORR-115	Pu(238,239)O2	1967-PRES
PP-127	PuO_2, $Pu(NO_3)_4$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1967-PRES
PP-CORR-134, CORR-135, CORR-136	PuO_2	1967-PRES
PP-CORR-140, CORR-141, CORR-142	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, Th-232, $Th(NO_3)_4$, ThO_2, $Th(C_2O_4)_4$, $Th(OH)_4$	1967-PRES
PP-143 (A1)	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, Th-232, $Th(NO_3)_4$, ThO_2, $Th(C_2O_4)_4$, $Th(OH)_4$	1967-1980

Table 2 - BUILDING 38 AND PP BUILDING

PP-144 (A2),	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC, Th-232, $Th(NO_3)_4$, ThO_2, $Th(C_2O_4)_4$, $Th(OH)_4$, ThF_4	1967-1980
PP-145 (A3)	PuO_2	1967-1982
PP-146 (B1)	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC	1967-1980
147 (B2), 148 (B3)	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC, Th-232, $Th(NO_3)_4$, ThO_2, $Th(C_2O_4)_4$, $Th(OH)_4$, ThF_4	1967-1980
PP-149 (B4)	PuO_2	1967-1982
PP-150-->156 (C1->C4, D1->D3)	$Pu(NO_3)_4$, PuO_2, $Pu(C_2O_4)_4$, $Pu(OH)_4$, PuF_4, PuC	1967-1980
PP-157 (E1)	PuO_2	1967-1980
PP-158 (E2)	PuO_2	1967-1980
PP-159 (E3)	PuO_2, $Pu(NO_3)_4$, $Pu(OH)_4$, PuF_4	1967-1980
PP-162, 163	PuO_2	1967-1980

Note: Pu-238 was the designated radioisotope in every room unless otherwise specified. Other isotopes of plutonium were also present in the mixture identified in the introduction along with small amounts of americium-241, neptunium-237, and uranium-234. Th-232 was sometimes used as a "stand-in" for the plutonium.

2.2 RADIONUCLIDES, ROOM, AND DATES ASSOCIATED WITH SPECIFIC HEAT SOURCE PROGRAMS

2.2.1 PP-Corr-5A

(1967 - 1974) Function and location is uncertain. Radionuclides of concern are probably the plutonium dioxides. [73] .

2.2.2 Room PP-6

(1967 - 1980) This room contains the PP Building filter bank and controls the negative air pressure with respect to the outside. Radioisotopes of concern and their compounds are: [74]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.3 Room PP-6W

(1967 - PRESENT) This room contains the corrosive vaporization filtering system to support the north analytical lab (room PP-113). Radioisotopes of concern and their compounds are: [75]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

a. Incident - (Pu-238 and Pu-239, 1/10/89)

2.2.4 PP-CORR-10

(1967 - PRESENT) This is a corridor/aisle on the first floor of PP Building. Radioisotope of concern and the compound is: [76]

plutonium oxide

2.2.5 Room PP-13

(1967 - 1980) The corrosive vaporization filtering system is located in this area which is used to support the analytical labs. A caustic scrubber system is used to remove caustic vapors from the air and transport to the liquid waste system. Radioisotopes of concern and their compounds are: [77]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.6 Room PP-14

(1967 - 1980) The PP Building vacuum system is contained in this room. This system enabled specific process systems, housed in gloveboxes, to operate under vacuum conditions when procedures dictated that environment. Radioisotopes of concern and their compounds are: [78]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.7 PP-CORR-15, CORR-16, CORR-17

(1967 - 1974) These corridors supported the glovebox lines located on the floor above. Radioisotopes of concern and their compounds are: [79]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.8 Room PP-18

(1967 - PRESENT) This room is the "cold" side of the basement where reagents are made for scrubbing. It is believed that room PP-154 had a spill which leaked down into this room. Radioisotopes of concern and their compounds are: [80]

plutonium oxide plutonium nitrate

2.2.9 Room PP-24

(1967 - PRESENT) This room is an air-lock between PP-13 and PP-14. Radioisotopes of concern and their compounds are: [81]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.10 Room PP-100

(1967 - PRESENT) Function of this room is uncertain. Radionuclides of concern are probably the plutonium dioxides. [82]

plutonium oxide

2.2.11 Room PP-113

(1975 - PRESENT) Often called North Line, this room has been used for a variety of programs as discussed below.[83] [84]

a. (1975 - 1989) This room was an analytical lab used in the "Sample Exchange" program. Samples containing Pu-239 were monitored for total percent plutonium along with other measurements. Radionuclides of concern are:

plutonium-238,239

1) Plutonium-239 was the major radionuclide of concern with plutonium-238 being second. [85]

b. (1988 - PRESENT) The "orphan source" program is used to determine which radioisotopes are contained in unknown sources. Some characterization studies are also being done on these unknown sources. Support for the decontamination work is also conducted in this lab. Radioisotopes of concern are varied.

c. (1995 - FUTURE) This lab may be used for the repackaging of Pu-239 contained in vaults in T Building but this is uncertain at this time. Radioisotopes of concern will be Pu-239.

d. Incident - (Pu-239, 240, 4/6/87)[86]

2.2.12 PP-CORR-115

(1967 - PRESENT) This is an access corridor for the north line gloveboxes used for a variety of purposes as discussed under PP-113. Radionuclides of concern are:

plutonium-238,239 orphan sources

a. Plutonium-239 was the major radionuclide of concern with plutonium-238 being second until 1988. Since that time orphan sources may be found here. [87]

2.2.13 Room PP-127

(1967 - PRESENT) This is an airlock supporting corridor 141. Radioisotopes of concern and their compounds are: [88]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide

2.2.14 PP-CORR-134, CORR-135, CORR-136

(1967 - PRESENT) These are access corridors to the various rooms for rooms containing glovebox lines A-->E. [89]

a. (1967 - 1974) These corridors possessed minimal contamination, usually in the form of plutonium dioxide. Radionuclides of concern are:

plutonium dioxide

b. (1975 - PRESENT) Only CORR-136 was used for support to PP-113. Radionuclides of concern are:

plutonium-238,239 orphan sources

2.2.15 PP-CORR-140, CORR-141, CORR-142

(1967 - 1985) This corridor supports the glovebox lines, A-->F. Radioisotopes of concern and their compounds are: [90]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate

plutonium nitrate	plutonium hydroxide
thorium nitrate	thorium hydroxide
thorium dioxide	thorium oxide hydrate

a. Actual processing work ceased in 1974. These corridors and rooms associated with them were essentially idle until D&D work in 1985. Some use was made for packaging during this time. [91]

2.2.16 Room PP-143 (A1)

(1967 - 1980) Analytical lab for determining plutonium concentrations and acidity of solutions. Also prepared samples for impurity determination. [92]

a. Radioisotopes of concern and their compounds are:

plutonium nitrate pentahydrate $Pu(NO_3)_4.5H_2O$

plutonium hexanitrate	plutonium nitrate
plutonium dioxide	plutonium oxide hydrate
(high fired and non)	plutonium hydroxide
thorium nitrate	thorium hydroxide
thorium dioxide	thorium oxide hydrate

2.2.17 Rooms PP-144 (A2), 147 (B2), & 148 (B3)

(1967 - 1980) These rooms were the primary ones used for all major operations in PP Building as discussed below.

a. Plutonium-Molybdenum Cermet (PMC) Process - From 1969 - 1973 the (PMC) program took precipitated, dried plutonium dioxide, crushed and sized, sintered in pure oxygen, sieved and sized again to 43 - 250 micron, coated the particles with molybdenum, and vacuum HOT PRESSED into right circular cylinders. The molybdenum coating produces pathways for even heat transfer. The plutonium disks were machined to a required

dimension and assembled into heat source capsules. Radioisotopes of concern and their compounds are: [93] [94]

plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$
plutonium hexanitrate
plutonium dioxide
(high fired and non)
plutonium nitrate
plutonium oxide hydrate
plutonium-hydroxide

b. Pressed Plutonium Oxide (PPO) - This method was the longest lived of the plutonium programs extending from 1970 to the late 1970's when encapsulated heat sources were then received from SRP. The process was similar to the PMC process except that there was no particulate molybdenum coating. The material was transferred to a hot press facility where a sphere was fabricated in a die body. The spheres were then sent to PP-161 for encapsulation. Compounds and mixtures which may be encountered in PP-144, 147, 148 from the PPO process: [95] [96]

plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$
plutonium hexanitrate
plutonium carbide
plutonium dioxide
(high-fired and non-high-fired)
plutonium nitrate
plutonium oxide hydrate
plutonium hydroxide

c. Milliwatt Generator Program - This program existed from 1974 - 1979 and followed the same initial steps up to the sizing as was done in the PMC and the PPO process. The 105 - 500 micron shards were poured loosely into a heat source capsule with yttrium chips and sealed. [97]

Note: The compounds and mixtures were the same as for PPO program discussed above.

d. Solid Solution Process - Sporadically from 1970 - 1974 (probably only one year total) a process was developed which kept the plutonium-238 in solution for most of the process. Thorium nitrate was added to the solution in a 9 part plutonium to 1 part thorium nitrate, with the goal to raise the melting point. Precipitation, crushing, sieving, hot pressing were then performed. Radioisotopes of concern and their compounds are: [98] [99]

plutonium-238
thorium-232
plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$

plutonium hexanitrate
plutonium dioxide
(high fired and non)
plutonium thorium nitrate
plutonium nitrate
plutonium oxide hydrate
plutonium hydroxide
thorium homolog (to each of the above plutonium counterpart)

e. Sol-Gel Process - Sporadically from 1969 - 1971 plutonium-238 nitrate, with the same isotopic mixture as was discussed in the overview, was suspended in a gelatinous organic solvent solution (EDTA complexes) to form a plutonium polymer 10 - 20 angstroms in diameter. No heat, vaporization, crushing, or grinding existed which made it a much safer operation in regards to inhalation. [100]

1) If an uptake occurred with the polymerized Pu-238 nitrate in organic solvent solution it reacted quite different from typical plutonium solutions. 100% would go to the liver and be hydrolyzed. It would act as a class W solubility class. [101]

2) The EDTA complexes made the Pu-238 very soluble in the lung and gut.

f. Microsphere Process - (1967 - 1970) There was a continuation of the microsphere process developed in the SM Building where plutonium dioxide spheres with a diameter of 50 to 250 μm were produced. There are two phases to this process where were carried out in two different areas.

1) Rooms PP-144, 147, and 148: The precursor material was chemically processed through several steps and then was crushed, sieved, and sintered. There is a large quantity of very fine particulate material produced from the crushing and sifting process with much airborne material submicron in size. Compounds and mixtures which may have been encountered are: [102] [103]

plutonium dioxide
plutonium hydroxide
plutonium oxide hydrate
plutonium nitrate
plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$
plutonium oxalate--------{ $Pu(C_2O_4)_4$ }
plutonium peroxide
plutonium fluoride

2) The second phase of the process was done in rooms PP-162 and 163. These rooms are discussed in their proper numerical order.

3) The lung solubility class varied greatly during the procedure. In PP-144, 147, 148 there was a class D or W for the first few steps where nitrates and oxalate are involved with little heating. A weak class Y developed where oxides were formed but prior to the plasma processing. In PP-162 and 163 a definite class Y emerged after the plasma process since the heated plutonium dioxide was much less soluble in tissue fluids after this high-temperature sintering step.[104] [105]

2.2.18 Room PP-145 (A3)

(1967 - 1980) Lab for plutonium support work. Also an access to elevator for the building conveyor system. Radionuclides of concern are: [106]

plutonium dioxides

2.2.19 Room PP-149 (B4)

This room contained a gamma scanning assay well under the floor. Radionuclides of concern are: [107]

plutonium dioxides

2.2.20 Rooms PP-146 (B1), 150 (C1), 151 (C2), 152 (C3), 153 (C4), 154 (D1), 156 (D3)

(1967 - 1980) These rooms were designated for recovery operations using ultrasonic cleaners and other recovery techniques from both solid and liquid waste: [108]

a. Aqueous wastes consisted of plutonium-bearing acidic solutions which included nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. Caustic waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Recoverable aqueous waste was sent back to the processing lines.

1) In the recovery process an organic resin, DOWEX-1, was used as an anion-exchange column to recover the plutonium. The plutonium was dissolved in various solutions such as nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, sodium hydroxide, or complexing agents such as EDTA and citrates which made the plutonium extremely soluble. This accentuates the statement made about being a class W or even class D at certain times. The solutions contained nitrate, sulfate, and fluoride ions, and as such formed various compounds with the available plutonium, americium-241, neptunium-237 and uranium isotopes. These other elements were minuscule in quantity, as compared to the plutonium dioxide. Radionuclide of concern and its compounds are: [109 110 111]

plutonium	plutonium oxide
americium-241	neptunium-237
uranium-238	uranium-238 nitrate
plutonium nitrate	uranium-238 fluoride
americium-241 nitrate	neptunium-237 nitrate
plutonium fluoride	plutonium fluoride
americium-241 fluoride	neptunium-237 fluoride
uranium-238 sulfate	neptunium-237 sulfate
plutonium sulfate	plutonium oxide sulfate
americium-241 sulfate	neptunium-237 hydroxide
plutonium hydroxide	uranium-238 hydroxide
americium-241 hydroxide	

2) Plutonium radionuclides were the major radionuclides of concern. [112]

b. Solid waste processing consisted of washing and leaching of the glove box residue material with the aid of ultrasonic cleaning equipment. Combustible wastes generated in glove boxes were put into an incinerator located in one of the glove boxes.

1) Materials containing recoverable plutonium were dissolved in a mixture of nitric and hydrofluoric acid or underwent fusion with pyrosulfate. Glass fiber filters were dissolved in a hydrofluorinator and the acidic solutions containing plutonium were sent to the plutonium recovery process. Recovery precipitation procedures used oxalic acid. Compounds from recovery procedures include the following: [113]

plutonium nitrate pentahydrate $Pu(NO_3)_4.5H_2O$
plutonium hexanitrate plutonium nitrate
plutonium dioxide plutonium oxide hydrate
plutonium fluoride plutonium hydroxide

Note: Th-232 which was often substituted for Pu-238 for modeling purposes but was NEVER put into recovery operations since it was not desirable to mix the Pu-238 and the Th-232. [114] [115]

2.2.21 Room PP-157

(Same as PP-E1), (1967 - 1980) Analytical lab. Probable radioisotope of concern is: [116]

plutonium dioxide

2.2.22 Room PP-158

(Same as PP-E2), (1967 - 1980) - Analytical lab used for determining density and gas rack analysis. Radionuclides of concern is: [117]

plutonium dioxide

2.2.23 Room PP-159

(Same as PP-E3), (1967 - 1980) - Received PuO_2 shipments and transferred to production area. Dissolving of plutonium in nitric acid was also done in this area. Radioisotopes of concern and their compounds are: [118]

plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$
plutonium hexanitrate plutonium nitrate
plutonium dioxide plutonium oxide hydrate
plutonium hydroxide plutonium fluoride

2.2.24 Room PP-161 (Same as F-1)

(1970 - 1978) The plutonium-238 PPOs were received from PP-144, 147, 148. In PP-161 they were encapsulated into iridium hemispheres and welded. Radioisotopes of concern and their compounds are: [119]

plutonium-238 dioxide

2.2.25 Rooms PP-162 and 163 (Same as F-2 & F-3)

Microsphere Process - (1967 - 1970) Plutonium dioxide spheres with a diameter of 50 to 250 μm were produced in a previous operation. The second phase of this process took the sintered plutonium oxide compound from the above process and performed a plasma torch process which formed "microspheres." The ceramic spheres were chemically stable and essentially free from loose contamination. Significant quantities of plutonium dioxide were vaporized during the plasma process which resulted in extremely fine particulates, most of it submicron in diameter. The only radionuclide compound of concern is: [120 121]

plutonium-238 dioxide

3. R BUILDING

3.1 OVERVIEW

"R" (for RESEARCH) Building was built in 1948 and has had a multitude of programs involving radionuclides over the years. A brief description of some of the major programs are listed below. Also included are the elemental radionuclides and radioisotopic compounds resulting from those processes.

Beginning in the fall of 1948 research and development for the polonium-210 program began. This was all pilot scale work for the actual production processing done in T Building. Later R&D work with polonium extended into the early 1970's.

Plutonium-238 research began in R Building in about 1959 and continued through the 1960's. The following plutonium isotope concentration was typical for the material received at Mound from the Savannah River Plant.[122]

1E-4% Pu-236	3.0% Pu-240
80.2% Pu-238	0.6% Pu-241
15.9% Pu-239	0.1% Pu-242[123]

Starting in the early 1980's, tritium research and development was conducted in the following rooms: Rooms R-105, 106, 108, 110, 113, 114, 120, 127, 128, 130, 134. Experimentation with metal tritides and deuterides such as uranium tritide and lithium tritide was done. Developmental studies with tritiated water and its handling were also done.

Some tritides and tritiated solvents were so poorly metabolized that the biological half-times were in the order of hours. This was not true for uranium tritides. [124] [125] [126]

Nickel Carbonyl has been identified in several incident reports. This gas mixture is NOT radioactive but it is highly toxic. It should be disregarded in internal dosimetry analysis.

In regards to the particle sizes of the radionuclides the following general rules can be applied.

a. Polonium would typically be of submicron (<1.0 μm AMAD) because of its very high specific activity. This factor explains why it vaporizes easily yielding a high vapor pressure for a metal.

b. For plutonium, americium, actinium, and the other alpha emitters it is reasonable to expect a typical particle size of around 1.0 μm. This of course depends on the processes involved. Much of the plutonium particle sizes would follow the general rules discussed in the SM and PP Building discussions.

All references to plutonium-238 was of the mixture ratio identified in the introduction to R Building (above). This mixture also included trace amounts of americium-241 and neptunium-237. Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240 and 241.[127]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for decontamination work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

All radionuclides are ranked according to the degree of concern for uptake and amount of activity for internal dosimetry considerations. Rooms which are referenced to Appendix B for additional radionuclides do not have a ranking in this manual since the ranking is done in Appendix B where all radionuclides are listed. This situation is identified as "see Appendix B for ranking." Rooms where additional information on processing or radionuclides in Appendix B does not effect the ranking are identified as "see Appendix B" only.

Table 3 is a summary of rooms, dates, and radioisotopes for R Building. Please observe that the first block going across in Table 3 is designated for the early polonium program. All "probable" rooms associated with that program are lumped together. The proper word is probable since little information is available as to which rooms were all involved. This arrangement is a deviation from the pattern used for the rest of the table,

and all other tables in this document, where the tables are arranged according to rooms and not a process or program.

** The first block in the table identifies rooms and radionuclides involved in the early polonium program. This listing deviates from the organization used in the remainder of this table and in other tables used in this document.

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
Early work in polonium: **(See previous page) Rooms: R-117 120 127 128 129 130 131 133 143 144 151 152 155 159 160 161 162 167	$AlCl_3$, $BiCl_4$, 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, See Appendix B ..... H-3, Li(D,T), U-238(D,T), Ti(D,T), See Appendix B	1948-1965 1975-PRES
R-110	Po-208,210, ... H-3	1955-1972 1972-PRES
R-111.	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-223, 224,226, Th-228,229,230, Ac & Ra daughters Po-208,210, H-3	1951-1955 1955-1965
R-112	H-3, Li(D,T), U-238(D,T), See Appendix B	1973-1993

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
R-113, 114, 115	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-223, 224,226, Th-228,229,230, (Ac & 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-PRES
R-116	Po-210, Pu-238,239, Po/Be, PoF_2, Po/B, Pu/Be, PuF_2, Pu/B	1956-1961
	Pu-238,239, Pu/Be, 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 & Ra daughters)	1955
	U-234,235,238, Pa-231, Th-230,232 and (Th-232 daughters)	1956-1958
R-120 and (support rooms 119, 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, See Appendix B	1951-1953
	Pa-231, Th-230,232 and (Th-232 daughters), U-234,235,238	1956-1958
	Pu-239, Am-241	1956-1962
	See Appendix B	1960-1962
	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, polonium alloys and compounds .	1959-1979

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
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-PRES
R-128	Po-210, Bi-210, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1954
	PuO_2, PuF_4, Pu-$MoCl_4$, Pu-MoF_4	1965-1978
	H-3, U-238(D,T)	1987-PRES
R-129, 130	Po-210, Bi-210, $Po(NO_3)_2$, $PoCl_2$, Po/Ag, Po/Te	1948-1951
	Ac-227, AcO_2, $Ac(NO_3)_4$, $Ac(C_2O_4)_4$, Ra-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
	See Appendix B	1990-PRES
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 daught., See Appendix B	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-3, U-238, U-238(D,T)	1986-PRES

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
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, mixtures), $Pu(NO_3)_2$, Ac-227, Am-241 . . .	~1969-PRES
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
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)	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
	See Appendix B	1960-1962
	Pu-238,239, PuO_2, U-234,235,238	1968-1975
R-148, 149	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, Po-208, Pa-231	1949-1954
	Fe-59, Al-26, Ca-45, Co-60, Pa-231, Cu-65 Pu-238	1954-1958
	Pu-238, $Pu(C_2O_4)_4$, $Pu(NO_3)_4$,	1960-1968
	Th-230, PuO_2, Pm-146-->149, $U(234)(NO_3)_4$, $U(234)O_2$, Pu/Zr	1970-1980

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
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, See Appendix B	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, Zn-65, Bi-210, Pb-210, Zr-95, Al-26 rare earth elements)	1956-1969
R-159	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, Zn-65, Bi-210, Pb-210, Zr-95, Al-26 rare earth elements)	1956-1969
R-160	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, See Appendix B	1951-1953
R-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, See Appendix B	1951-1953

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
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 & 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 & 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
	See Appendix B	1955-1957
	U-233, Th-229,230,232	1958
	Sr-90, Y88,90,91, Pa-231	1960-1962
	Pa-231,233, Ce-141,144, Am-241, Cm-244, U-233, Th-230,232, Ra-226, Tl-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-PRES
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 & Ra daughters	1949-1954
	U-235,238, See Appendix B	1961-1963
	Pu-238,239,240,241 (compounds, alloys, mixtures), Am-241, Ac-227, Ra-226	1965-1991
R-174, 176	H-3	1970-PRES

Table 3 - R BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
R-197A	Pu-238,239, PuO_2, Cm-244	1970-PRES
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
Crawl Space above R-Bldg	Pu-238,239, Ra-226, Ac-227, Po-210, Th-228, 229,230	1948-PRES
R-CORR-5	Ac-222	1948-1984

Note: All references to plutonium-238 was of the mixture ratio identified in the introduction to R Building. This mixture also included trace amounts of americium-241, neptunium-237, and uranium-234. [128]

Plutonium-239 was over 95% pure with trace amounts of plutonium-240,241.

3.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS

3.2.1 Room R-105, 106 This area had two major programs:

a. (1958 - 1965) This area was used as an unloading station for tanker trucks bringing "stack gas" (helium and tritium) to the site. Other hardware for tritium was also unloaded on that dock. Room R-105 is known as the tank truck unloading station.[129] [130]

The gas was pumped into tanks and taken to SW-8 for recovery processing. Processes were also performed to purify the helium of tritium and deuterium. Radioisotopes of concern and their compounds are: [131] [132]

tritium	tritiated water (HTO)

Note:
- Tritium gas is the major radiological concern.[133]
- Incident - (Tritium, 4/10/58, 8/8/60, 6/11/62)[134]

b. (1965 - 1978) Functioned as an analytical laboratory for the analysis of the metal tritides and the effects of long term storage. A gas synthesis system was used to prepare metal deuteride and tritide salts for X-ray diffraction and other forms of analyses. Operations are similar to R-105. Radioisotopes of concern and their compounds are: [135] [136] [137]

tritium	lithium tritide	uranium-238 tritide

Note: Tritium is the major radionuclide of concern with uranium-238 being second.[138]

3.2.2 Room R-108 These rooms were used in two separate programs.

a. (1948 - 1965) This room was used as a calorimetry research and assay lab to support the Po-208,210 research and development work. Radioisotopes of concern and their compounds are:[139] [140]

polonium-208,210	tritium

1) See Appendix B.

b. (1975 - PRESENT) This room (R-108) has facilities for a tritium recovery including solid tritiated metal compounds, gas recovery, and purification from other tritium handling processes. A "heat-up reactor" is used to drive off tritium. Radioisotopes of concern and their compounds are: [141] [142] [143] [144]

tritium	lithium tritide
uranium-238 tritide	titanium tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[145]

2) Note: R-108 was a consolidation of rooms R-107, R-108, and R-109 in 1973. [146]

3) See Appendix B.

3.2.3 Room R-110 This room was used for two separate programs.

a. (1955 - 1972) This was a support lab giving calorimetry support. Radioisotopes of concern and their compounds are: [147] [148]

polonium-208,210

1) Polonium-210 is the major radionuclide of concern.[149]

b. (1972 - PRESENT) This room is used for preparation of hydrogen and helium mixtures for analytical standards used in mass spectrometry, gas chromatograph, etc.. Radioisotopes of concern and their compounds are: [150] [151] [152]

tritium

3.2.4 Room R-111

a. (1951 - 1955) This room was used for support work to the actinium-227/radium-226 work. The precipitate was processed further in rooms such as this. Radioisotopes of concern and their compounds are: [153] [154] [155] [156]

actinium-227	radium-223,224,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium-227 daughters	radium daughters

1) Actinium-227 was the major radionuclide of concern with radium-226 and thorium-228 both being a close second. All compounds of actinium-227 were highly soluble.[157]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[158] Previous discussions/interviews indicated that only actinium-227 and the related compounds were there.

3) Incident - A chemist was contaminated with actinium-227 and a urine analysis revealed radium-223 in his body. [159]

4) Decontamination work was begun in June, 1953 and extended until 1955 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 were scrubbed twice. [160] [161] [162]

b. (1955 - 1965) Calorimetry, research, and assay work was done to support the polonium-208,210 R&D program. Radioisotopes of concern and their compounds are: [163]

polonium-208,210	tritium

1) Polonium-210 was the major radionuclide of concern with tritium being second.[164]

3.2.5 Room R-112

(1973 - 1993) Nuclear Magnetic Resonance Spectroscopy (NMR)- NMR is used to measure the amounts of deuterium, tritium, and He-3 in liquids and solids for retention and diffusion characteristics in metal tritides. Radioisotopes of concern and their compounds are: [165 166 167]

tritium	lithium tritide	uranium-238 tritide (actually natural uranium)

a. This was a cold lab previous to 1973.[168]

b. See Appendix B.

3.2.6 Rooms R-113, 114, and 115

This area was used in three separate programs.

a. (1951 - 1955) This room was used for support of radium-226/actinium-227 work in the cave (SW-19). The precipitate was taken to rooms such as this for further processing. Radioisotopes of concern and their compounds are:[169 170 171 172 173]

actinium-227	radium-223,224,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium-227 daughters	radium daughters

1) Actinium-227 was the major radionuclide of concern with radium-226 and thorium-228 both being a close second. All compounds of actinium-227 were highly soluble.[174]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[175] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Incident - (Actinium-227 7/22/52)[176]

4) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [177] [178]

b. (1956 - 1961) Neutron Source Program - This program was similar to that in R-116 where research and development was directed at various alternatives for neutron sources. Typically polonium and plutonium-238,239 was used in combination with other elements such as beryllium, fluorine, boron, etc. [179] [180]

polonium-210	plutonium-238,239
polonium-beryllium	plutonium-beryllium
polonium fluoride	plutonium fluoride
polonium-boron	plutonium-boron

1) Polonium-210 was the major radionuclide of concern with plutonium-238 second and plutonium-239 third.[181]

c. (1978 - PRESENT) This area is used for analytical support to research, development, and recovery. Calorimetry was used after 1990 as an evaluation technique in monitoring contamination of equipment with low level tritium. Radionuclide of concern is: [182] [183] [184] [185]

tritium

3.2.7 Room R-116 (A&B)

This area was used for several distinct programs as discussed below.

a. (1956 - 1961) This room was used to produce plutonium/beryllium neutron sources such as those used in "well logging" operations. Pu-238 and Pu-239 was used in conjunction with beryllium as evidenced by the two incidents involving plutonium/beryllium. This process was moved to the Monsanto Plant on Nicholas Road along with the polonium-210 neutron sources. Radioisotopes of concern and their compounds are: [186] [187]

polonium-210	plutonium-238,239
polonium-beryllium	plutonium-beryllium
polonium fluoride	plutonium fluoride
polonium-boron	plutonium-boron

1) Polonium-210 was the major radionuclide of concern with plutonium-238 second and plutonium-239 third.[188]

2) Incidents - (Plutonium/beryllium, 8/19/60, 7/19/61) [189]

3) Pu-238 was used on 3/22/56[190]

b. (1956 - 1962) This room was also used to produce alpha sources by plating various metal substrates. These alpha sources were used as sources for calibration of alpha monitors. This operation was expanded to a section of R-120. It was later moved to SW-219. Radioisotopes of concern and their compounds are: [191]

americium-241 plutonium-239

1) Americium-241 was the major radionuclide of concern with plutonium-239 second.[192]

c. (1960 - 1965) This area is used for analytical support to research, development, and recovery. Calorimetry was the primary evaluation technique used in this area to analyze various aspects of tritium and metal tritides. Radioisotopes of concern and their compounds are: [193] [194] See Appendix B for details.

tritium lithium tritide uranium-238 tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[195]

d. (1965 - PRESENT) This area was a "cold" lab. There are no radionuclides of concern. [196] [197] [198]

3.2.8 Room R-117

(1948 - 1990) This was a vault containing radionuclides in both packaged materials form and sealed sources. Radioisotopes of concern and their compounds are: [199] [200]

plutonium-238 dioxide	plutonium-238 metal
plutonium-238/zirconium alloy	thorium-230
plutonium-238,239 / Be	plutonium-239 metal

polonium-210 / beryllium protactinium-231

a. The ranking of radionuclides are time dependent:[201]

1) Before 1955 protactinium-231 was the major radionuclide of concern.

2) From 1955 - 1965 polonium-210 was the major radionuclide of concern.

3) After 1965 plutonium-238 was the major radionuclide of concern.

3.2.9 Room R-118

This room was used for several projects as discussed below.

a. (1955) This room has been designated as the storage area for all the radioactive materials from the radium and actinium program. Radioisotopes of concern and their compounds are: [202]

actinium-227	radium-223,224,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium-227 daughters	radium daughters

1) Actinium-227 was the major radionuclide of concern with radium-226 and thorium-228 both being a close second. All compounds of actinium-227 were highly soluble.[203]

b. (1956 - 1958) Ionium Work - Starting in 1956 a major effort was underway to separate Th-230 (Ionium) from "airport cake," a raffinate produced by an extraction process of uranium. The "airport cake" was the similar to the Cotter Concentrate used in the 1970's except that it had fewer uranium isotopes and thorium daughter isotopes. Radioisotopes of concern and their compounds are:[204] [205] [206]

uranium-234,235,238	thorium-230,232
protactinium-231	thorium-230,232 daughters

1) Thorium-230 was the major radionuclide of concern with all others a distant second.[207]

3.2.10 Rooms R-120 and support rooms R-118, 119, 121, 123

These rooms were used for a variety of programs:

a. (1948 - 1951) In support for the polonium project a pilot program was developed. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried.[208] [209]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [210]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[211]

b. (1951 - 1953) This room is used for the reduction of actinium-227 from the precipitate in the old cave. Radioisotopes of concern and their compounds are: [212] [213] [214] [215] [216]

actinium-227	actinium nitrate
actinium oxide	actinium oxalate
radium-226	thorium-228,229,230
actinium fluoride	actinium iodide
actinium-227 daughters	

1) Actinium-227 was the major radionuclide of concern with actinium-227 daughters being a close second. Both radium-226 and thorium-228 are a distant third.[217]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[218] Previous discussions/interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [219] [220]

4) See Appendix B.

c. (1956 - 1958) Ionium Work - Starting in 1956 an effort was underway to separate Th-230 (Ionium) from "airport cake," a raffinate produced by an extraction process of uranium. The "airport cake" was the similar to the Cotter Concentrate used in the 1970's except that it had fewer uranium isotopes and thorium daughter isotopes. Radioisotopes of concern and their compounds are:[221] [222] [223]

uranium-234,235,238	thorium-230,232
protactinium-231	thorium-230,232 daughters

1) Thorium-230 was the major radionuclide of concern with all others a distant second.[224]

2) A memo discusses Th-230 on 3/22/56 [225]

3) The Health Physics Quarterly discusses the cleaning up of rooms R-119 and R-121. [226]

d. (1956 - 1962) This room was also used to produce alpha sources by plating various metal substrates. These alpha sources were used as sources for calibration of alpha monitors. This operation was started in R-16 and expanded to a section of R-120. It was later moved to SW-219. Radioisotopes of concern and their compounds are: [227]

americium-241	plutonium-239

1) Americium-241 was the major radionuclide of concern with plutonium-239 second.[228]

e. (1959 - 1979) Metallurgical Analysis of Plutonium Compounds -Work was done primarily with Pu-238, Pu-239, and some Po-210 early in the program, especially in conjunction with the heat source programs. The highly corrosive plutonium-238 compounds demanded alternative exploration. These materials were very fine oxide particles possessing

class Y characteristics since they are retained in the body for long periods of time. Radioisotopes of concern and their compounds are: [229] [230]

plutonium oxalate--------{ $Pu(C_2O_4)_4$ }
plutonium hexanitrate
plutonium nitrate
plutonium dioxide
(high-fired and non-high-fired)
plutonium oxide hydrate
plutonium hydroxide
plutonium tetrachloride
plutonium tetrafluoride--(high neutron flux)
metallic plutonium (elemental)
plutonium/copper
plutonium/selenium
plutonium/zirconium
plutonium/rare earths
vaporized plutonium dioxide
polonium alloys and compounds
tritium-(not normally expected to be there)

1) The ranking of radionuclides are time dependent:[231]

   a) 1959 - 1969 polonium-210 was the major radionuclide of concern. All others are a distant second.

   b) After 1969 plutonium-238 was the major radionuclide of concern. All others are a distant second.

2) Incident - (Pu-238, 7/6/60, 7/3/63, 1/28/71, 8/3/73)[232]

3) Incident - (Tritium, 1/9/63) - radioactivity in water in an air hose.)[233]

f. (1960 - 1962) See Appendix B.

g. (1988 - PRESENT) Room R-120 was decontaminated in 1984-1987 and has been a cold lab since that time. Room R-118 and R-123A were decontaminated from 1985-1990. There are no radionuclides of concern used during that time. [234] [235] [236]

Note: Rooms R-127, 128, 130, 131 (128A, 128B, 128C): These rooms were used for several major programs as discussed below. [237] [238] [239] [240]

a. R-127,128,129,130 were separate rooms as discussed under the respective room number.

b. In the fall of 1954 these four rooms were decontaminated and formed one large room, R-128.

c. From 1965 - 1978 these rooms were used in support of the heat source programs using plutonium-238 as the primary radioisotope.

d. From 1978 - 1988 these rooms were decontaminated and R-130 and R-131 were converted into 128A, 128B, 128C.

e. Since the late 1980's these rooms are used as analytical laboratories performing various analyses on tritiated samples.

3.2.11 Room R-127

This room had several programs as discussed below.

a. (1948 - 1951) In support for the polonium project a pilot program was developed. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried. [241] [242]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [243]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[244]

b. (1952 - 1954) This room was used for an iron sulfide process which was radioactive (gamma). Radionuclide of concern is:

iron-55,59

1) Incident - A chemist left a flask with a saturated salt solution on a hot plate overnight and it shattered. Contamination spread over a 15 foot area. [245]

c. (1956 - 1961) This room contained thermal diffusion columns and was used for helium-3 separation from helium-4 gas. Also involved in the separation process was tritium. The process was moved to HH Building. Radioisotopes of concern are: [246] [247] [248]

tritium

d. (1965 - 1978) Plutonium-Molybdenum Cermet (PMC) program (Heat Source Program). The 43 - 250 μm plutonium dioxide shards were processed and sintered at 1600° in PP Building before being received in R-127. In R-127 the shards were coated with molybdenum by using a molybdenum hexafluoride compound. (The hexafluoride on the plutonium was the source of a huge neutron flux.) Radioisotopes of concern and their compounds are: [249] [250] [251]

plutonium dioxide (heat-treated)
plutonium fluoride
plutonium molybdenum-tetrachloride
plutonium molybdenum-tetrafluoride
(high neutron flux)

1) Plutonium-238 was the major radionuclide of concern with other plutonium radionuclides ranked in order as given in R Building overview.[252]

e. Decontaminated 1981-1983 [253]

f. (1987 - PRESENT) After a renovation program from 1983 - 1987 this room was used as a facility where components would be monitored for radiation. Radioisotopes of concern and their compounds are: [254]

tritium plutonium-239

1) See Appendix B for more information and ranking of radionuclides of concern.

3.2.12 Room R-128

This room had two phases of operations as discussed below.

a. (1948 - 1954) In support for the polonium project a pilot program was developed. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried. [255] [256]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [257]

silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[258]

b. (1965 - 1978) This was an analytical lab supporting the heat source program. Radioisotopes of concern and their compounds were: [259] [260]

plutonium-238 oxide other radionuclides
plutonium-238 compounds and mixtures (fluorides, molybdenum, chlorides, etc.)

1) Plutonium-238 was the major radionuclide of concern. All others are a distant second.[261]

c. Actually decontaminated 1985-1987. [262]

d. (1987 - PRESENT) This room is an analytical laboratory used to perform contaminant and surface area analysis, differential analysis, infrared spectrometry, ion chromatography, etc.. Radioisotopes of concern and their compounds are: [263] [264]

tritium	uranium-238 tritide

Note: Other tritides may have been there but only rarely.

1) Tritium is the major radionuclide of concern with uranium-238 being second.[265]

3.2.13 Room R-129 and R-130

This room was used for a variety of programs as discussed below.

a. (1948 - 1951) In support for the polonium project a pilot program was developed. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried. [266] [267]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [268]

silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[269]

b. (1951 - 1953) This room was used for actinium-227 processing. Radioisotopes of concern and their compounds are: [270] [271] [272] [273]

actinium-227	radium-223,224,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium-227 daughters	radium daughters

1) Actinium-227 was the major radionuclide of concern with radium-226 and thorium-228 both being a close second. All compounds of actinium-227 were highly soluble.[274]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[275] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [276277]

c. (1965 - 1978) This was an analytical lab supporting the heat source program. Th-232 was sometimes used to simulate Pu-238 fuel. Radioisotopes of concern and their compounds were: [278 279 280 281]

plutonium-238 oxide other radionuclides
plutonium-238 compounds and mixtures (fluorides, molybdenum, chlorides, etc.)
plutonium-238 dioxide (cermet and pressed oxide)
thorium-232 (associated with the same compounds and mixtures as the plutonium)

1) Plutonium-238 was the major radionuclide of concern with thorium-232 being a distant second.[282]

d. Decontaminated 1982-1985. [283]

e. (1990 - PRESENT)

1) See Appendix B for ranking.

3.2.14 Room R-131 This room had two programs:

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried. [284285]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [286]

silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[287]

b. (1965 - 1978) This was an analytical lab supporting the heat source program. Special consideration was given to Pu-238 oxygen exchange processing. The desired goal was to remove O-17 and O-18 which resulted in a lower neutron count for the plutonium-oxide. Some heat source support work was also done as evidenced by curium-244 according to the Technical Manual MD-10050. Radioisotopes of concern and their compounds are: [288 289 290]

plutonium-238 dioxide
plutonium-238 compounds and mixtures (fluorides, molybdenum, chlorides, etc.)
curium-244
other possible radionuclides

1) Plutonium-238 was the major radionuclide of concern. All others are a distant second.[291]

c. Decontaminated 1983-1985. [292]

3.2.15 Room R-133

This room was used for a variety of programs as discussed below.

a. (1948 - 1954) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and one of two polonium precipitate processes (silver or the tellurium process) were all tried. [293294]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [295]

silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[296]

b. (1951 - 1953) This room is used for the reduction of actinium-227 from the precipitate in the old cave. Radioisotopes of concern and their compounds are: [297 298 299 300 301]

actinium-227	actinium nitrate
actinium oxide	actinium oxalate
radium-226	thorium-228,229,230
actinium fluoride	actinium iodide
actinium-227 daughters	

1) Actinium-227 was the major radionuclide of concern with actinium-227 daughters being a close second. Both radium-226 and thorium-228 are a distant third.[302]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[303] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [304 305]

4) See Appendix B.

c. (1956 - 1958) Ionium Work - Starting in 1956 a major effort was underway to separate Th-230 (Ionium) from "airport cake," a raffinate produced by an extraction process of uranium. The "airport cake" was the similar to the Cotter Concentrate used in the 1970's except that it had fewer uranium isotopes and thorium daughter isotopes. Radioisotopes of concern and their compounds are:[306 307 308]

uranium-234,235,238	thorium-230,232
protactinium-231	thorium-230,232 daughters

1) Thorium-230 was the major radionuclide of concern with all others a distant second.[309]

d. (1965 - 1978) This was an analytical lab supporting the heat source program. Radioisotopes of concern and their compounds were: [310 311 312]

plutonium-238 dioxide
plutonium-238 compounds and mixtures (fluorides, molybdenum, chlorides, etc.)
curium-244
other possible radionuclides

1) Plutonium-238 was the major radionuclide of concern. All others are a distant second.[313]

3.2.16 Room R-134 This room had two major programs:

a. This area was a cold lab up to 1983. [314]

b. (1986 - PRESENT) This room is an analytical lab used to analyze various aspects of tritium and deuterium gas and metal tritides and deuterides. The primary means of analysis are various spectrometric procedures such as thermal probe mass and Fourier transform infrared spectrometry. It was not until 1988 that radioisotopes were brought into the lab. Radioisotopes of concern and their compounds are: [315 316]

tritium	uranium-238	uranium tritide

Note: Very small amounts of these isotopes.

1) Tritium is the major radionuclide of concern with uranium-238 being second.[317]

3.2.17 Room R-137

This room was used for a variety of programs as discussed below.

a. (1951 - 1953) This room is used for the reduction of actinium-227 from the precipitate in the old cave. Radioisotopes of concern and their compounds are: [318 319 320 321 322]

actinium-227	actinium nitrate
actinium oxide	actinium oxalate

radium-226
actinium fluoride
actinium-227 daughters
thorium-228,229,230
actinium iodide

1) Actinium-227 was the major radionuclide of concern with actinium-227 daughters being a close second. Both radium-226 and thorium-228 are a distant third.[323]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[324] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [325] [326]

4) No "hot work" was done since decontamination was performed.[327]

3.2.18 Room R-140 This room had two major functions:

a. (1950's to the late 1960's) - Early programs consisted of analytical support for the work in R-120 and other production and development areas in R Building. There was an emissions spectrograph using a carbon arc built into a glovebox. Vaporization of all samples results in possibility for uptakes. Radioisotopes of concern and their compounds are the following: [328]

thorium-228,230,232
plutonium-238,239
cesium-137
actinium-227
strontium-90
uranium-234,235,238
polonium-208,209,210
protactinium-231
radium-223,224,226

1) Polonium-210, protactinium-231, radium-226 are equally important with plutonium-238 being a secondary concern.[329]

2) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [330][331]

b. (The late 1960's to the present) - Renovation work was done making ready for the second analytical program.[332] Analysis of plutonium compounds, alloys, and mixtures along with related radionuclide compounds were studied by chemical analysis and emission spectroscopy. A variety of solutions of oxide samples were commonly prepared for these analyses. Vaporization of the compounds from arcing could be the source of some small diameter particulate. [333] [334]

plutonium-238,239,240,241	plutonium nitrates
plutonium alloys and mixtures	:
americium-241	actinium-227

1) Plutonium-238 was the major radionuclide of concern with americium-241 and actinium-227 equally being a secondary concern.[335]

2) Incident - (Pu-238 - 9/27/74)[336]

3.2.19 Room R-142

This room was used for a variety of programs which are discussed below.

a. (1949 - 1953) Radium-Actinium Separation - Radium bromide-226 was off-site irradiated to produce actinium-227 and then a separation process was performed to obtain the desired Ac-227. This was a pilot program for the work done in the Old Cave (SW-19). Radioisotopes of concern and their compounds are: [337]

radium-226	radium carbonate
actinium-227	radium nitrate
radium bromide	actinium oxalate
actinium fluoride	potassium-40
barium nitrate	radon and daughters
thorium-228,229,230	polonium-208,209,210

1) Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a close second. The polonium-208, 209, 210 are all a distant third.[338]

2) Incident - (Radium - 5/4/50)[339]

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [340341]

b. (1956 - 1969) A program was conducted to develop methods to reduce the fissile material content in solutions at both Hanford and Oak Ridge. An optical emissions spectrometer using a carbon arc would vaporize samples of plutonium-238,239 dioxide for analysis. Radioisotopes of concern and their compounds are: [342 343 344]

plutonium-238,239
protactinium-231
thorium-230 daughters
uranium-234,235,238 (natural uranium)
thorium-230

1) Plutonium-239 was the major radionuclide of concern with uranium-234 being the secondary concern.[345 346]

c. (1966 - 1979) This lab provided support for the radioisotopic fuels program. An optical emissions spectrometer using a carbon arc would vaporize samples of plutonium-238,239 dioxide for analysis. Radioisotopes of concern and their compounds are: [347]

plutonium-238,239 dioxide

1) Emphasis changed to plutonium-238 as the major radionuclide of concern with plutonium-239 being secondary.

3.2.20 Rooms R-143 and 144

These rooms have several functions as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [348]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [349]

aluminum chloride
bismuth chloride

silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[350]

b. (1955) These rooms were decontaminated and made a part of R-142.[351]

c. (1972 - 1976) This was the room where the fabrication of the PMC heat source capsules was completed. In PP-144, 147, and 148 the plutonium-238 particles were coated with molybdenum and formed into disks. The PMC disks were encapsulated in R-143 and used for the Pioneer, Viking, and other such heat source programs. Radioisotopes of concern and their compounds are: [352] [353]

plutonium-238 dioxide (fuel forms)

d. This area was D&D'd in 1979-1981. [354]

3.2.21 Rooms R-145 and 147

These rooms were used for a variety of programs including separation programs, heat source programs, and heat source disassembly .

a. (1949 - 1954) This area was used for the initial R&D work for the separation of radium-226 from the K-65 ore. This radium-226 was then irradiated off-site to make the actinium-227. The room was also used to reduce the precipitate from the old cave processing. This room was also used to store crucibles from the reduction of actinium-227. They were stored in a fumehood in R-145. Radionuclide of concern is:[355] [356] [357] [358]

actinium-227	actinium oxalate
actinium oxide	actinium nitrate
radium-226	thorium-228,229,230
barium/radium	barium/radium carbonate[359]

1) Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a close second. [360]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[361] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [362363]

b. (1955 - 1956) Procedures were developed in R-167 to separate protactinium-231 from residues (referred to as raffinates) of previous uranium processing called "Sperry cake." The process was done in both R-145 and also in HH-5 where the separation was done on a larger scale. Radioisotopes of concern were: [364 365 366]

iron-59	aluminum-26	calcium-45
cobalt-60	protactinium-231	copper-65

1) Protactinium-231 was the major radionuclide of concern with all others being a distant second.[367]

2) A memo on 3/22/56 confirmed that Pa-231 work was being done in Room R-145. [368]

c. (1956 - 1959) Chemistry studies of reactor fuels were conducted in this laboratory. Plutonium compounds were studied in thermal processes. Radioisotopes of concern were:[369 370]

plutonium-239 americium-241.

1) Plutonium-239 is the major radionuclide of concern with americium-241 being a distant second.[371]

d. (1960 - 1962) See Appendix B for ranking.

e. (1968 - 1975) This room was used for the Heat Source Program where plutonium molybdenum shards (PMC) were hot pressed into disks and machined to required dimension. This room was also used for the hot pressing of the plutonium dioxide shards into spheres for the Pressed

Plutonium Oxide (PPO) program. Compatibility studies involving assembly and disassembly of heat sources units and "hot" metalographic analysis. Container welding was also done in this area. Radioisotopes of concern are: [372 373 374]

plutonium-238,239 plutonium dioxide
plutonium coated particles, cermet, shards)
uranium-234,235,238

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second and uranium-234 being a third.[375]

2) Incident - (Pu-238, 5/11/61, 6/5/62)[376]

3) Incident - (Pu-238, Pu-239, U-234, 8/26/65)[377]

4) This area was decontaminated from 1979-1981.[378 379]

f. (1982 - PRESENT) These rooms were used for thermal analysis of pyrophoric materials. No radionuclides are used in this area. [380]

3.2.22 Room R-149, also support room R-148

Three phases of work with two renovation programs separating them.

a. (1949 - 1954) These rooms were used for the reduction of actinium-227 compounds from R-145,147 which was part of the old cave work. It was also used for other R&D programs and separation work. Radioisotopes of concern and their compounds are: [381 382 383 384]

actinium-227
actinium oxide
thorium-228,229,230
polonium-208 <---[385]
barium/radium
radium-226
actinium nitrate
protactinium-231
actinium oxalate
barium/radium carbonate[386]

1) Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a distant second because of it being a reduction process. [387]

2) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [388389]

b. (1954 - 1958) Procedures were developed to separate protactinium-231 from residues of previous uranium processing called "Sperry cake." Radioisotopes of concern were: [390 391]

iron-59	aluminum-26
calcium-45	cobalt-60
protactinium-231	copper-65.

1) Protactinium-231 was the major radionuclide of concern with all others being a distant second.[392]

2) (3/22/56) A memo confirming the separation of Pa-231 as the primary goal of this program. [393]

c. In the early 1960's decontamination work was done which made ready for the heat source and the U-234 separation program work. Heat source welding was also done in this area. [394]

d. (1960 - 1968) - Research and development work was done for the Pu-238 heat source program. A whole line of gloveboxes was used for all processes of heat sources research and production. Welding operations for encapsulation in support of the heat source program was done in room R-137. The plutonium-238 used was in the form of Pu-238 metal and Pu-238 dioxide cermets which came from SM-35, 35A, 39 and 60. Radioisotopes of concern and their compounds are: [395 396]

plutonium-238

1) Incidents - (Pu-238, 5/19/60, 6/2/60, 1/16/63, 4/19/65)[397]

a) The incident of 6/2/60 resulted in crawl space contamination.[398]

2) (1961 - 1968) Various SNAP programs and other heat source programs were all supported from this room. All radioisotopes were encapsulated and of no concern to this study. [399]

e. (1970 - 1980) U-234 Separation - U-234 separation from aged Pu-238 (approximately 20 years) was done. A homogeneous oxalate precipitation technique was used along with two cycles of ion exchange on resins. The U-234 was sold to Oak Ridge National Laboratories. The following compounds and isotopes were encountered.[400 401 402 403]

plutonium oxalate--------{ $Pu(C_2O_4)_4$ }
plutonium hexanitrate
plutonium nitrate
thorium-230
promethium-146-->149
uranium-234 oxide
plutonium-238 metal
plutonium-238 dioxide
plutonium/zirconium alloys
nitrate solutions of Pu-238 and U-234

1) Plutonium-238 was the major radionuclide of concern with uranium-234 being secondary.[404]

f. This room was renovated in 1985-1988. [405 406] This area was no longer used as a "hot" area. Analytical equipment was moved in to support "cold" analyses.[407]

3.2.23 Room R-151

This room had a variety of programs as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [408 409]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [410]

silver/polonium
tellurium/polonium
polonium-210
bismuth-210
polonium nitrate
polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[411]

b. (1958 - 1983) Analytical chemistry lab supporting most Pu-238 and Pu-239 work including the Heat Source Program. Aqueous wastes consisted of plutonium-bearing acidic solutions which included nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, hydrochloric and sulfuric acid, and sodium hydroxide were used in leaching and dissolution processes. Radioisotopes of concern and their compounds are: [412 413 414 415]

plutonium-238,239 metal	plutonium-238,239 dioxide
neptunium-237	plutonium hydroxide
plutonium nitrate	plutonium oxalate
plutonium sulfate	plutonium chloride
plutonium fluoride	

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary.[416]

2) EDTA, citrates, ion exchange resins, and other complexing agents were used which acted like chelating agents, causing rapid removal of the plutonium from the uptake compartment.[417]

3) Incident - (Pu-238, 2/11/74)[418]

3.2.24 Room R-152

This room was used for a variety of programs as discussed below.

a. (1948 - 1954) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [419 420]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [421]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[422]

b. (1951 - 1953) This room is used for the reduction of actinium-227 from the precipitate in the old cave. Radioisotopes of concern and their compounds are: [423 424 425 426 427]

actinium-227	actinium nitrate
actinium oxide	actinium oxalate
radium-226	thorium-228,229,230
actinium fluoride	actinium iodide
actinium-227 daughters	

1) Actinium-227 was the major radionuclide of concern with actinium-227 daughters being a close second. Both radium-226 and thorium-228 are a distant third.[428]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[429] Previous discussions/interviews indicated that only actinium-227 and the related compounds were there.

3) Decontamination work was begun in June, 1953 on the hood lines. All hoods that had ever contained radium-226 or actinium-227 have been scrubbed twice. [430 431]

4) See Appendix B.

3.2.25 Room R-155

This room was used for a variety of programs as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [432 433]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [434]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[435]

b. (1956-1969) Research lab for the support of the reactor fuels programs conducted in R-159. The Electron Microprobe was used to help characterize materials through a vaporization technique. The plutonium reactor fuel group explored a variety of uranium and later Pu-239 metal and Pu-239 dioxide compounds for possible application into the fuel program. Also used were Np-237, Am-241, Cm-244 in the metal and oxide form. At least 89 ternary compounds, especially those using cerium, and a multitude of binary compounds/alloys were investigated. Also explored were zirconium compounds. Radioisotopes of concern and their compounds are: [436 437 438 439]

plutonium-239	uranium-235,238
neptunium-237	americium-241
curium-244	

1) Uranium-238 was the major radionuclide of concern with plutonium-239 a secondary concern.[440]

2) Some of the elements combined with the above radionuclides were:

cerium	boron	nickel	cobalt
silicon	aluminum	magnesium	zinc
manganese	copper	gallium	lead
carbon	bismuth	rare earths	zirconium
lithium/beryllium			

Note: The samples used in analyses were small in quantity and activity.

3) This room was renovated in the early 1980's and has not been used since for any radionuclide operation. [441]

Note: R-157, 158, 159, 160, 161 were formerly separate rooms as discussed under the specific room number. However, in the spring of 1955 these rooms were combined into one large room R-159.

3.2.26 Room R-159

This room was used for a variety of programs as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [442] [443]

1) Radioisotopic compounds or alloys resulting from the irradiation process and the R&D work includes: [444]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[445]

b. (1956-1969) The plutonium reactor fuel group explored a variety of uranium and later Pu-239 metal and Pu-239 dioxide compounds for possible application into the fuel program. Also used were Np-237, Am-241, Cm-244 in the metal and oxide form. At least 89 ternary compounds, especially those using cerium, and a multitude of binary compounds/alloys were investigated. Also explored were zirconium compounds. These metal alloys were measured for physical properties including phase diagrams of molten plutonium alloys as potential fuels. Radioisotopes of concern and their compounds are: [446] [447] [448] [449]

plutonium-239	uranium-235,238
neptunium-237	americium-241
curium-244	

1) Uranium-238 was the major radionuclide of concern with plutonium-239 a secondary concern.[450]

2) Some of the elements combined with the above radionuclides were:

cerium	boron	nickel	cobalt
silicon	aluminum	magnesium	zinc
manganese	copper	gallium	lead
carbon	bismuth	rare earths	zirconium
lithium-beryllium			

3) This program also designed the first glass containing plutonium-239 dioxide as a constituent. [451]

4) This room was renovated from 1985 - 1988 and became room 159 A&B. R-159 A is an analytical support room for "cold" analysis only. 159 B is the calcium isotope research room for "cold" analysis only.[452 453 454 455]

3.2.27 Room R-160

This room is used for a variety of programs as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [456 457]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [458]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[459]

b. (1951 - 1953) This room was part of the actinium area. It contained the primary filter for the hoods in R-161.[460 461 462 463]

actinium-227	actinium oxalate

actinium oxide	actinium nitrate
thorium-228,229,230	radium-226

1) Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a close second. [464]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[465] Previous discussions/interviews indicated that only actinium-227 and the related compounds were there.

3) Incident - a chemist wearing an airline mask and protective clothing was found contaminated from an alpha source. The actual source is unknown.[466]

4) See Appendix B.

d. Decontamination work was begun in 1954 and was continuing in 1955. It was difficult to get air contamination levels low enough to reclassify the room. A new concrete floor was put in, several scrubbings, etc. [467]

3.2.28 Room R-161

This room was used for a variety of programs as discussed below.

a. (1948 - 1951) Research and development in support of the polonium project was done. The actual process was never performed here except as bench top studies. Both the electroplate deposition of polonium onto platinum electrode and two polonium precipitate processes (silver and tellurium process) were tried. [468] [469]

1) Radioisotopic compounds or alloys resulting from the off-site irradiation process and the R&D work includes: [470]

aluminum chloride	bismuth chloride
silver/polonium	tellurium/polonium
polonium-210	bismuth-210
polonium nitrate	polonium chloride

2) Polonium-210 was the major radionuclide of concern. All others are a distant second.[471]

b. (1951 - 1953) This room was used for the purification of actinium resulting from the old cave work. It was major lab used for a variety of chemical analysis studies. Radioisotopes of concern and their compounds are: [472 473 474 475 476]

actinium-227	radium-226
actinium oxide	actinium nitrate
thorium-228,229,230	polonium-208,209,210

1) Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a close second. [477]

2) Health Physics Monthly Report spoke of an incident where much contamination existed in the R-Building and that they had been monitoring for actinium-227, thorium-228, and radium-226.[478] Previous discussions / interviews indicated that only actinium-227 and the related compounds were there.

3) Health Physics Report mentioned waste solutions and resins which were high gamma emitters. [479]

4) R-161 was mentioned in several Health Physics Monthly Reports for actinium work. There is also mention of beta/gamma besides the alpha contamination. Only MLM-821 (2/28/53) will be listed for a reference as a typical example for this time period. [480]

5) See Appendix B.

3.2.29 Room R-162

This was an analytical lab used primarily for cold work supporting several programs in R Building. However, three exceptions are discussed below where radionuclides were used in analysis.

a. (1948 - 1951) Decontamination of Bismuth Phosphate Materials - Five shipments of bismuth phosphate materials were received from Hanford which included crib materials and samples from two other stages of the process in the plutonium separation program from irradiated

uranium-238. Purex and Tributyl Phosphate materials from Oak Ridge National Laboratory were also received from a similar program and contained the same radionuclides. A study was done to determine the best procedure for removing the radioactive contaminates. Radioisotopes of concern are: [481] [482] [483]

ruthenium-106	cesium-137
tellurium-121,127	zirconium-93,95
strontium-90	plutonium-238,239
antimony-125	niobium-94
yttrium-88,90,91	rare earths (especially cerium)

1) All were present and were of equal concern.[484]

2) This was the same as the program in R-167 and R-168 except that this room received the residue from that process and monitored for remaining activity, developed methodology for further decontamination for that study. [485]

b. (1950) Separation work with plutonium-238 and 239 was done for only a short time with some materials source from Hanford. Radioisotopes of concern are: [486]

plutonium-238,239

1) Both were present and were of equal concern.[487]

c. 1958 - 1959) This analytical lab was used for studies in uranium-233, 235 and 238. No production or processing work was done other than analytical work. Radionuclides of concern are: [488] [489]

uranium-233,235,238

1) All were present and were of equal concern.[490]

3.2.30 Room R-166

(1961 - 1968) This was a radiochemical analytical lab for bench top work using polonium-210. Radionuclides of concern are: [491]

polonium-210

3.2.31 Room R-167

(1949-1987) Research and development of separation techniques and characterization studies for various radioisotopes were done over the years. The specific programs are discussed below.

a. (1948 - 1951) Decontamination of Bismuth Phosphate Materials -Five shipments of bismuth phosphate materials were received from Hanford which included crib materials and samples from two other stages of the process in the plutonium separation program from irradiated uranium-238. Purex and Tributyl Phosphate materials from Oak Ridge National Laboratory were also received from a similar program and contained the same radionuclides. A study was done to determine the best procedure for removing the radioactive contaminates. The actual production program was performed in SW-13 (SW-1B) the following year. Radioisotopes of concern are: [492 493 494]

ruthenium-106	cesium-137
tellurium-121,127	zirconium-93,95
strontium-90	plutonium-238,239
yttrium-88,90,91	antimony-125
rare earths (especially cerium)	niobium-94

1) All were present and were of equal concern.[495]

2) It was a ferrous sulfide process and used adsorption and/or coprecipitation followed by clarification of fission products with ferrous sulfide, ferrous hydroxide and calcium phosphate.

b. (1949 - 1952) A bench-scale process for the separation and recovery of Pu-239 was made by neutron irradiation of uranium metal in production reactors at other DOE sites. Fission products of concern are:

iodine-131	cesium-137
cerium-144	strontium-90
technetium-99	xenon-133
yttrium-88,90,91	plutonium-239
uranium-234,235,238	

1) Plutonium-239 was the major radionuclide of concern with natural uranium (234,235,238) being secondary.

c. (1954 - 1955) Procedures were developed to separate protactinium-231 from residues (referred to as raffinates) of previous uranium processing called "Sperry cake." The actual process was done in R-145 and in HH-5. Radioisotopes of concern were: [496] [497]

iron-55,59	aluminum-26
calcium-45	cobalt-60
protactinium-231	copper-65

1) Protactinium-231 was the major radionuclide of concern with all others being a distant second.[498]

2) This work was similar to that done in R-145 and R-147.[499]

d. (1955 - 1957) See Appendix B for ranking.

e. (1958) Uranium-233 and daughters were received and divided into small lots for research use. No description of actual lab procedures were discussed for this lab. Radioisotopes of concern and their compounds are:[500]

uranium-233	thorium-229,230,232

1) Uranium-233 was the major radionuclide of concern with all others being a distant second.[501]

f. (1960 - 1962) This room was used for the isotopic separation of strontium-90 and yttrium-90 through a variety of techniques. Radioisotopes of concern are: [502] [503]

strontium-90	yttrium-88,90,91
protactinium-231	

1) Strontium-90 was the major radionuclide of concern with yttrium-90 .being a secondary concern.[504]

g. (1956 - 1987) This lab was used for additional work with the isotopic separation of protactinium-231,233 giving the purest possible end

product. Characterization and analysis of cerium 141 and 144, americium-241 and protactinium-231 was also done. Radioisotopes of concern are: [505] [506] [507]

protactinium-231,233	cerium-141,144
americium-241	curium-244
uranium-233	thorium-230,232
radium-226	thallium-208

1) Protactinium-231 was the major radionuclide of concern with all others being a close second. Minimal quantities were used and the risk was considered low for all radionuclides.[508]

2) A memo on 3/22/56 discusses the Pa-231 work in R-167.[509]

3) Incident - (Cm-244, 7/8/83)[510]

3.2.32 Room R-168

(1958) This room was used for the study of physical properties of aqueous uranium-238 salts such as uranium fluoride and uranium oxide. After this function it was never again used for radionuclide work. Radioisotopes of concern and their compounds are: [511]

uranium-238 fluoride	uranium-238 oxide

3.2.33 Room R-169 (A,B,C)

This room also had two major programs.

a. (1960 - 1980) - This area was used as a radio-counting room to determine the activities of the various radioisotopes used in R Building. Radioisotopes of concern are: [512]

thorium-230,232	uranium-234,235,238
plutonium-238,239	polonium-208,209,210
cesium-137	protactinium-231
actinium-227	radium-223,224,226

1) Polonium-210 was the major radionuclide of concern with plutonium-238 being secondary.[513]

2) These are low level analytical samples.

b. (1980 - PRESENT) The isotopic separation of uranium radioisotopes, especially U-235 and U-238, using a chloride complex separation technique has been conducted. Much work also was done on promethium-147. Currently ion exchange resins are being used with calcium-45 for calcium separation analysis. [514515]

uranium-235,238	promethium-147
calcium-45	

1) Uranium-238 was the major radionuclide of concern with uranium-235 being secondary.[516]

3.2.34 Room R-170

(1960 - 1964) This room was used for mass spectrometry using uranium-238 and calcium. This was also used as a health physics counting room. After 1964 this room was a cold laboratory. Radioisotopes of concern and their compounds are: [517]

uranium-238	calcium-45

1) Uranium-238 was the major radionuclide of concern.[518]

3.2.35 Rooms R-171, 172

These rooms housed a variety of programs which are as follows:

a. (1949 - 1954) This room was used in support of the radium-226 and actinium-227 work done in SW-19 (old cave). See rooms R-145, 147, and 149. Radionuclide of concern is: [519 520 521 522 523]

actinium-227	radium-223,224,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium-227 daughters	radium daughters

1) Actinium-227 was the major radionuclide of concern with radium-226 and thorium-228 both being a close second. All compounds of actinium-227 were highly soluble.[524]

2) Incident - (Radium, 6/27/51)[525]

b. (1955 - 1960) This area was a cold laboratory doing differential thermal analysis for phase diagram work. There are no radionuclides of concern.[526 527]

c. (1961 - 1963) This room was used for research and development involving welding and brazing containers. Radioisotopes of concern and their compounds are: [528]

uranium-235,238

1) See Appendix B for ranking.

d. Mass Spectroscopy Lab - (1965 - 1991) These rooms were used for the analysis of Pu-238 compounds, alloys, and mixtures. A variety of solutions of oxide samples were commonly prepared for these analyses. Vaporization of the compounds from arcing could be the source of small diameter particulate. [529 530]

plutonium-238,239,240,241 (compounds and mixtures/alloys)
americium-241 actinium-227 radium-226

1) Plutonium-238 was the major radionuclide of concern with all others being a distant second.[531]

3.2.36 Room R-174, 176

(1970 - PRESENT) Analytical support laboratory for cold work. The tritium incident, indicating the presence of tritium, would have been a rare occurrence. Radioisotope of concern is:[532]

tritium

a. Incident - (Tritium, 9/8/78)[533]

3.2.37 Room R-197A

(1970 - PRESENT) This room is used for the packaging of radionuclides for shipment. Radioisotopes of concern are: [534] [535]

plutonium-238,239
curium-244
plutonium dioxide

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary.[536]

3.2.38 Room R-198

(1956 - 1982) This room was called the Decontamination "A" lab and was used to clean contaminated equipment from R-Building including respirators. Radioisotopes of concern and their compounds are: [537]

plutonium-238,239
uranium-234,235,238
lithium tritide
polonium-210
plutonium oxide
uranium tritide
americium-241
promethium-146-->149
tritium
plutonium fluoride
polonium fluoride
tritiated organics
plutonium nitrate
curium-244
actinium-227
neptunium-237

a. Plutonium-238 was the major radionuclide of concern with actinium-227 being a secondary concern.[538]

b. This room was decontaminated from 1985-1990. [539]

3.2.39 The crawl space above R Building has been contaminated with many of the isotopes used and studied in this building. In the latter 1970's/early 1980's the loose material was covered/encapsulated with plastic.[540] Some believe the radioisotopic contamination was removed in the crawl space above each lab which was renovated. The crawl space above R-140 was never decontaminated. Radioisotopes of concern and their compounds are:[541] [542]

plutonium-238,239
actinium-227
radium-226
polonium-210

thorium-228,229,230

a. Plutonium-238 was the major radionuclide of concern with actinium-227 being a secondary concern and radium-226 being tertiary.[543]

3.2.40 R-Corr 5

This was the operational access corridor for the hotside of R-Building. This area was decontaminated from 1985 - 1988. [544]Incident - (Ac-227, 1/31/89)[545]

3.2.41 See Appendix B A for R Building rooms **R-108, 111, 112, 120, 127, 129, 130, 133, 137, 145, 149, 152, 160, 161, 167, 171, 172.**

4. SM BUILDING

4.1 OVERVIEW

Special Metallurgical (SM) Building was constructed in 1960 and became operational in 1961. It was originally designed for the reception of a liquid plutonium nitrate mixture from the Savannah River Plant (SRP) which was used in a variety of programs, mainly the heat source projects. SM Building also housed recovery processing, waste treatment facilities, research and development, and analytical laboratory support activities.

Solutions of plutonium nitrate mixture [$Pu(NO_3)_4$] were received for use in SM Building until about 1964 when powdered plutonium dioxide [PuO_2] was received. The mixture shown below accounted for 99.9% plutonium received from SRP according to MLM-1564 (AEC Research and Development Report), page 31.

1E-4% Pu-236
80.2% Pu-238
15.9% Pu-239
3.0% Pu-240
0.6% Pu-241
0.1% Pu-242

Note: MLM-1564 also makes reference to other mixtures.

All references to plutonium-238 was of the mixture ratio identified in the introduction above. This mixture also included trace amounts of americium-241 and neptunium-237. [546]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

Extremely high neutron flux from Pu-238 in its association with water and fluorine compounds in SM Building will necessitate its consideration and perhaps inclusion in the internal dose assessments.

The term "high-fired" is sometimes used which implies that the plutonium compound has been heated in a plasma torch process such that the lung solubility class is definitely a "Y" or perhaps even a "YY." The term "non-high-fired" implies an absence of such heating and in extreme cases, where indicated, a lung solubility class of "W" or even a "D" may exist where there is high solubility.

Although a multitude of incidents occurred in the SM Building, none were listed because they were all from plutonium-238. It was already mentioned in the introduction to the document that only radioisotopes, other than plutonium-238, would be listed for PP and SM Buildings.

A ranking of radionuclides according to the degree of concern for uptake and internal dosimetry consideration, as was done in HH and R Building, was NOT done in PP Building since all radionuclides were plutonium. The mixture of plutonium isotopes as shown above will dictate the ranking of radionuclides to be concerned with in all incidents and internal dosimetry dose calculations.

Table 4 is a summary of rooms, dates, and radioisotopes for SM Building.

Table 4 - SM BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE 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, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, 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, $Pu(C_2O_4)_4$, See Appendix B	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, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, Pu(OH), PuF_4, $PuCl_4$	1961-1965
	$Pu(NO_3)_4$, $Pu(NO_3)_4.5H_2O$, PuO_2, $PuO_2.Xh_2O$, $Pu(C_2O_4)_4$, Pu(OH)	1965-1967
SM-34	$Pu(NO_3)_4$, 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, $Np(SO_4)_2$, PuF_4, $Np(NO_3)_4$, UO_2, $U(SO_4)_2$, UF_4	1963-1967
SM-35,35A	$Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, 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, $PuO_2.Xh_2O$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1965-1967
SM-38 (SM-1)	$Pu(NO_3)_4$, 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, $Np(SO_4)_2$, PuF_4, $Np(NO_3)_4$, UO_2, $U(SO_4)_2$, UF_4 $Pu(NO_3)_4.5H_2O$,	1963-1967
	$Pu(NO_3)_6$, PuO_2, $Pu(C_2O_4)_4$, $Pu(O_2)$	1965-1970
SM-39	$Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, 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, $PuO_2.Xh_2O$, $Pu(C_2O_4)_4$, $Pu(OH)_4$	1965-1967

Table 4 - SM BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
SM-58, 59(A&B)	$Pu(NO_3)_4$, 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, $Np(SO_4)_2$, PuF_4, $Np(NO_3)_4$, 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

Note: All references to plutonium was of the mixture ratio identified in the introduction above. This mixture also included trace amounts of americium-241, neptunium-237, and uranium-234. [547]

4.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS

4.2.1 Room SM-1: This room had a double function.

a. (1961 - 1962) This was the original Pu-238 liquid waste treatment facility for both high and low risk waste water. The high-risk aqueous wastes were processed for possible plutonium recovery but this procedure was terminated in late 1962. The plutonium aqueous high-risk waste recovery operations was moved into the processing area of SM Building. The low-risk waste water was treated similar to the processes used in WD Building. The low-risk waste water was precipitated, coagulated, filtered, and the sludge is solidified so it can be shipped off-site for disposal. The supernatant from the clarifier was filtered, neutralized to the proper Ph and released into a drainage ditch. Radioisotopes of concern and their compounds are:

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide
plutonium fluoride

b. (1962 - 1967) Removal of the high-risk waste treatment equipment enabled the establishment of a support lab for the operations in SM Building. The treatment of low-risk waste as discussed above and the preparation of off site packaging for low-risk waste precipitate and high-risk liquid waste were all done in this area. Radioisotopes of concern and their compounds are:

plutonium nitrate pentahydrate
plutonium hexanitrate plutonium nitrate
plutonium dioxide plutonium oxide hydrate
(high-fired and non-high-fired) plutonium hydroxide
plutonium oxide hydrate and oxalate
thorium nitrate thorium hydroxide
thorium dioxide thorium oxide hydrate

4.2.2 Room SM-2

(1961 - 1967) Maintenance lab where tools are used for opening containers with radioactive materials. Radioisotopes of concern and their compounds are:

plutonium dioxide.

4.2.3 Room SM-3, 10

(1961-1967) These were special research and development labs where plutonium in various sizes (sub micron to over 20 microns) were used. The compounds of plutonium were diverse as is illustrated by the listing which follows. The solubility states also varied from a very soluble class "w," almost a class "d," up to the traditional class "Y" for the plutonium oxides. Radioisotopes of concern and their compounds are:

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate

a. See Appendix B.

4.2.4 Room 20

(1961 - 1967) This was a measurement and counting lab and contained only sealed sources which emitted neutron and gamma radiation. Only external dose would be acquired in this room. There are no radionuclides of concern.

4.2.5 Room SM-21

(1961 - 1967) This room had two functions which were carried on simultaneously. They are as follows:

a. This room was an analytical lab for physical measurements and studies of plutonium and related heat source activities. Thorium-232 was often used to simulate plutonium because the physical characteristics are similar. Complexing agents such as EDTA and citrates were used which caused rapid depletion of plutonium from the body. They acted like chelating agents. Radioisotopes of concern and their compounds are: [548]

plutonium dioxide thorium-232 dioxide

b. This room also was operated as a storage area for radioactive materials.

4.2.6 Room SM-26

(1961 - 1968) The SM Building vacuum system is contained in this room. This system enabled equipment housed within gloveboxes to operate under vacuum conditions when procedures dictated that environment. Radioisotopes of concern and their compounds are: [549]

plutonium dioxide -------(high-fired and non-high-fired)
plutonium oxide hydrate and oxalate
plutonium nitrate plutonium hydroxide
plutonium fluoride

4.2.7 Room SM-27, 28

These were research and development rooms supporting the activities of SM-35 and 39. Two programs were supported by SM-27,28 which are as follows:[550]

a. (1961 - 1965) Plutonium Metal Production - A process which converted the plutonium nitrate into metallic plutonium. Metallic plutonium was used in the SNAP (Space Nuclear Auxiliary Power) units during the early 1960's. This process was terminated in the mid-1960's in favor of the microsphere process which had a more stable product and was less susceptible to contamination. The steps in the process resulted in the following possible exposures: [551]

plutonium oxalate	plutonium (elemental)
plutonium nitrate pentahydrate	plutonium tetrachloride
plutonium hexanitrate	plutonium nitrate
plutonium dioxide	plutonium oxide hydrate
(high fired and non)	plutonium hydroxide

plutonium tetrafluoride--(high neutron flux)

1) The airborne plutonium particulate was of varied sizes (submicron to 20 μm) with much of it being less than 1.0 μm.

2) Highly soluble, low heat non-oxide compounds resulted from the first several steps in the process. This equates to a lung solubility class of "W" or even a "D." Only small quantities of plutonium dioxide (Class Y) were inadvertently formed as a result of the breakdown of plutonium oxalate by its own heat generation. The lung solubility was on the W side of the class Y for the plutonium oxides since little sintering was involved. Midway through the process a reduction bomb was used with the charge attaining 1,200°C. Metallic plutonium resulted with the residue going to waste or recovery streams. It is concluded that there could have been small quantities of class Y materials arising from this program. [552 553]

3) In addition to the traditional plutonium concerns there is the extremely high neutron flux resulting from plutonium tetrafluoride. This must not be overlooked as a dosimetry calculation for plutonium incidents from 1963 - 1965.

b. (1965 - 1967) Microsphere Process - The "microsphere" process was developed which produced plutonium dioxide spheres with a diameter of 50 to 250 microns. This process circumvented the neutron problem with PuF_4 by using plutonium dioxide. The material went through several steps including being crushed, sieved, sintered, and then entered a plasma torch process forming "microspheres." The ceramic spheres were chemically and thermally stable and essentially free from loose contamination. The steps in the process resulted in the following possible exposures: [554 555]

plutonium dioxide
plutonium hydroxide
plutonium nitrate pentahydrate
plutonium oxalate
plutonium oxide hydrate
plutonium nitrate

1) There was a quantity of very fine particulate material produced from the crushing and sizing process. Much airborne material was submicron in size. [556]

2) The plasma torch process was used to make the microspheres. Significant quantities of plutonium dioxide were vaporized from this process which produced extremely fine particulates. [557]

3) The lung solubility class was varied since there would be class D or W for the first few steps where nitrates and oxalate are involved, a weak class Y where oxides are formed but no heating, and then definite class Y after the heating processes since the plutonium dioxide was much less soluble in tissue fluids after sintering. [558]

4.2.8 Room SM-34

(1963 - 1967) This was a recovery process room where solid and liquid recoverable wastes were processed. Aqueous wastes consisted of plutonium-bearing acidic solutions which included nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. These were accumulated in holding tanks in SM-1. Caustic wastes were generated when ammonium hydroxide was used to precipitate plutonium from the solution. The solutions contained nitrate, sulfate, and fluoride ions, and as such formed various compounds with the available plutonium, americium, neptunium and uranium. These waste compounds were minuscule in quantity, as compared to the plutonium dioxide. Recoverable aqueous wastes were sent back to the processing lines and the nonrecoverable wastes were treated in SM-1 as discussed above. Radioisotopes of concern and their compounds are: [559] [560]

plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

a. Solid waste processing consisted of washing and leaching of the glove box wastes with the aid of ultrasonic cleaning equipment. Combustible wastes generated in glove boxes were incinerated. Materials containing recoverable plutonium were dissolved in a mixture of nitric and hydrofluoric acid or underwent fusion with pyrosulfate. Glass fiber filters were dissolved in a hydrofluorinator and the acidic solutions containing plutonium were sent to the plutonium recovery process. The above list of radionuclide compounds were likely.

4.2.9 Rooms SM-35, 35A

These were the major rooms, along with SM-39, for the production processes in the SM Building. Two programs are discussed below: [561]

a. (1961 - 1965) Plutonium Metal Production - A process which converted the plutonium nitrate into metallic plutonium. Metallic plutonium was used in the SNAP (Space Nuclear Auxiliary Power) units during the early 1960's. This process was terminated in the mid-1960's in favor of the microsphere process which had a more stable product and was less susceptible to contamination. The steps in the process resulted in the following possible exposures: [562]

plutonium oxalate	plutonium hydroxide
plutonium nitrate pentahydrate	plutonium (elemental)
plutonium hexanitrate	plutonium nitrate
plutonium dioxide	plutonium oxide hydrate
(high fired and non)	plutonium tetrachloride

plutonium tetrafluoride--(high neutron flux)

1) The airborne plutonium particulate was of varied sizes (submicron to 20 μm) with much of it being less than 1.0 μm.

2) Highly soluble, low heat non-oxide compounds resulted from the first several steps in the process. This equates to a lung solubility class of "W" or even a "D." Only small quantities of plutonium dioxide (Class Y) was inadvertently formed as a result of the breakdown of plutonium oxalate by its own heat generation. The lung solubility was on the W side of the class Y for the plutonium oxides since little sintering was involved. Midway through the process a reduction bomb was used with the charge attaining 1,200°C. Metallic plutonium resulted with the residue going to waste or recovery streams. It is concluded that there could have been small quantities of class Y materials arising from this program. [563] [564]

3) In addition to the traditional plutonium concerns there is the extremely high neutron flux resulting from plutonium tetrafluoride. This must not be overlooked as a dosimetry calculation for plutonium incidents from 1963 - 1965.

b. (1965 - 1967) Microsphere Process - The "microsphere" process was developed which produced plutonium dioxide spheres with a diameter of 50 to 250 microns. This process circumvented the neutron problem with PuF_4 by using plutonium dioxide. The material went through several steps including being crushed, sieved, sintered, and then entered a plasma torch process forming "microspheres." The ceramic spheres were chemically and thermally stable and essentially free from loose contamination. The Microsphere Process did not terminate in 1967 but was moved to the PP Building where it continued. Radioisotopes of concern and their compounds are the following: [565] [566]

plutonium dioxide
plutonium hydroxide
plutonium nitrate pentahydrate
plutonium oxalate
plutonium oxide hydrate
plutonium nitrate

1) There was a quantity of very fine particulate material produced from the crushing and sizing process. Much airborne material was submicron in size. [567]

2) The plasma torch process was used to make the microspheres. Significant quantities of plutonium dioxide was vaporized from this process which produced extremely fine particulates. [568]

3) The lung solubility class was varied since there would be class D or W for the first few steps where nitrates and oxalate are involved, a weak class Y where oxides are formed but no heating, and then definite class Y after the heating processes since the plutonium dioxide was much less soluble in tissue fluids after sintering. [569]

4.2.10 Room SM-38

This room was used for two major functions as discussed below:

a. (1963 - 1967) Recovery process room where solid and liquid recoverable wastes were processed. Aqueous wastes consisted of plutonium-bearing acidic solutions which included nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. These were accumulated in holding tanks in SM-1. Caustic wastes were generated when ammonium hydroxide was used to precipitate plutonium from the

solution. The solutions contained nitrate, sulfate, and fluoride ions, and as such formed various compounds with the available plutonium, americium-241, neptunium-237 and uranium-234. These waste compounds were minuscule in quantity, as compared to the plutonium dioxide. Recoverable aqueous wastes were sent back to the processing lines and the nonrecoverable wastes were treated in SM-1 as discussed above. Radioisotopes of concern and their compounds are: [570] [571]

plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

1) Solid waste processing consisted of washing and leaching of the glove box wastes with the aid of ultrasonic cleaning equipment. Combustible wastes generated in glove boxes were incinerated. Materials containing recoverable plutonium were dissolved in a mixture of nitric and hydrofluoric acid or underwent fusion with pyrosulfate. Glass fiber filters were dissolved in a hydrofluorinator and the acidic solutions containing plutonium were sent to the plutonium recovery process. The above list of radionuclide compounds were likely.

b. (1965 - 1970) U-234 Separation - A pilot program was developed for the initial separation of U-234 <u>only</u> from aged Pu-238. A tri-butyl solvent extraction and ion exchange method was used. This was an isotope sold to Oak Ridge National Laboratory. The following compounds and isotopes were encountered. [572] [573] [574]

plutonium oxalate	plutonium-238 oxide
plutonium hexanitrate	plutonium nitrate
uranium oxide	

1) This whole process was moved to R-149 for the actual production.

4.2.11 Room SM-39

This was the major room, along with SM-35 and 35A, for the production processes in the SM Building. Two major programs are discussed below:[575]

a. (1961 - 1965) Plutonium Metal Production - A process which converted the plutonium nitrate into metallic plutonium. Metallic plutonium was used in the SNAP (Space Nuclear Auxiliary Power) units during the early 1960's. This process was terminated in the mid-1960's in favor of the microsphere process which had a more stable product and was less susceptible to contamination. The steps in the process resulted in the following possible exposures: [576]

plutonium oxalate	plutonium hydroxide
plutonium nitrate pentahydrate	plutonium (elemental)
plutonium hexanitrate	plutonium nitrate
plutonium dioxide	plutonium oxide hydrate
(high fired and non)	plutonium tetrachloride

plutonium tetrafluoride--(high neutron flux)

1) The airborne plutonium particulate was of varied sizes (submicron to 20 μm) with much of it being less than 1.0 μm.

2) Highly soluble, low heat non-oxide compounds resulted from the first several steps in the process. This equates to a lung solubility class of "W" or even a "D." Only small quantities of plutonium dioxide (Class Y) was inadvertently formed as a result of the breakdown of plutonium oxalate by its own heat generation. The lung solubility was on the W side of the class Y for the plutonium oxides since little sintering was involved. Midway through the process a reduction bomb was used with the charge attaining 1,200°C. Metallic plutonium resulted with the residue going to waste or recovery streams. It is concluded that there could have been small quantities of class Y materials arising from this program. [577] [578]

3) In addition to the traditional plutonium concerns there is the extremely high neutron flux resulting from plutonium tetrafluoride. This must not be overlooked as a dosimetry calculation for plutonium incidents from 1963 - 1965.

b. (1965 - 1967) Microsphere Process - The "microsphere" process was developed which produced plutonium dioxide spheres with a diameter of 50 to 250 microns. This process circumvented the neutron problem with PuF_4 by using plutonium dioxide. The material went through several steps including being crushed, sieved, sintered, and then entered a plasma torch process forming "microspheres." The ceramic spheres were chemically and thermally stable and essentially free from loose contamination. The Microsphere Process did not terminate in 1967 but was moved to the PP Building where it continued. Radioisotopes of concern and their compounds are the following: [579] [580]

plutonium dioxide
plutonium hydroxide
plutonium nitrate pentahydrate
plutonium oxalate
plutonium oxide hydrate
plutonium nitrate

1) There was a quantity of very fine particulate material produced from the crushing and sizing process. Much airborne material was submicron in size. [581]

2) The actual plasma torch process used to make the microspheres was not performed in these rooms but was located in SM-60. Significant quantities of plutonium dioxide was vaporized from this process which produced extremely fine particulates. [582]

3) The lung solubility class was varied since there would be class D or W for the first few steps where nitrates and oxalate are involved, a weak class Y where oxides are formed but no heating, and then definite class Y after the heating processes since the plutonium dioxide was much less soluble in tissue fluids after sintering. [583]

4.2.12 Rooms SM-58, 59A, and 59B

(1963 - 1967) These were recovery process rooms where solid and liquid recoverable wastes were processed. Aqueous wastes consisted of plutonium-bearing acidic solutions which included nitric and hydrofluoric acids, hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. These were accumulated in holding tanks in SM-1. Caustic wastes were generated when ammonium hydroxide was used to precipitate plutonium from the solution. The solutions contained nitrate, sulfate, and fluoride ions, and as such formed

various compounds with the available plutonium, americium-241, neptunium-237 and uranium-234. These waste compounds were minuscule in quantity, as compared to the plutonium dioxide. Recoverable aqueous wastes were sent back to the processing lines and the nonrecoverable wastes were treated in SM-1 as discussed above. Radioisotopes of concern and their compounds are: [584] [585]

plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

b. Solid waste processing consisted of washing and leaching of the glove box wastes with the aid of ultrasonic cleaning equipment. Combustible wastes generated in glove boxes were incinerated. Materials containing recoverable plutonium were dissolved in a mixture of nitric and hydrofluoric acid or underwent fusion with pyrosulfate. Glass fiber filters were dissolved in a hydrofluorinator and the acidic solutions containing plutonium were sent to the plutonium recovery process. The above list of radionuclide compounds were likely.

c. Room 59B was also used for waste treatment where some of the process discussed under SM-1 were done.

4.2.13 Room SM-60

(1965 - 1967) This room had only one important function and that was to perform the actual plasma torch process used to make the microspheres. Significant quantities of plutonium dioxide was vaporized from this process which produced extremely fine particulates. Most all particle size was submicron with a class "y" solubility. Radionuclide of concern is: [586]

plutonium dioxide

4.2.14 Rooms SM-61, 62

(1961 - 1967) These rooms were analytical labs for physical measurements and studies of plutonium and related heat source activities. Thorium-232

was often used to simulate plutonium because the physical characteristics are similar. Complexing agents such as EDTA and citrates were used which caused rapid depletion of plutonium from the body. They acted like chelating agents. Radioisotopes of concern and their compounds are: [587]

plutonium dioxide Thorium-232 dioxide

4.2.15 Environmental concerns include the area under and surrounding the SM building which is contaminated with Pu-238 from the storage of plutonium materials in tanks which leaked. Thorium and radium concentrations were also reported for surface soil readings.

4.2.16 See Appendix B for SM Building **Room SM-10**.

5. SW BUILDING

5.1 OVERVIEW

SW Building is similar to R Building in that it consists of many laboratories engaged in a variety of research, development, analytical, recovery, enrichment, 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, uranium-234 separation program, and the tritium programs. The tritium programs include the tritium enrichment, effluent capture, process development, component evaluation, scrap recovery and tritium waste solidification. [588]

All references to plutonium-238 was of the mixture ratio identified below. This mixture also included trace amounts of americium-241 and neptunium-237.[589] This information was obtained from MLM-1564 (AEC Research and Development Report), page 31.

1E-4% Pu-236
80.2% Pu-238
15.9% Pu-239
3.0% Pu-240
0.6% Pu-241
0.1% Pu-242

Note: MLM-1564 also makes reference to other mixtures.

Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241. [590]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

With the completion of the NCDPF Building in 1967/1968 the Tritium Research, Development, and Testing Program was undertaken which extends to the present time. Most of the NCDPF building is part of the SW Building complex and contains rooms designated for the Tritium program. [591] [592]

Tritiated water and vacuum pump oil were found in most all SW Building rooms. It is also known that some tritides and tritiated solvents were so poorly metabolized that the biological half-times were in the order of hours. This was not true for uranium tritides. [593] [594] [595]

Tritiated ammonia (NH_3) is to be expected in boxlines, piping systems, and gas storage tanks. The biological half-times could be in terms of hours. [596]

All radionuclides are ranked according to the degree of concern for uptake and amount of activity for internal dosimetry considerations. Rooms which are referenced to Appendix B for additional radionuclides do not have a ranking in this manual since the ranking is done in Appendix B where all radionuclides are listed. This situation is identified as "see Appendix B for ranking." Rooms where additional information on processing or radionuclides in Appendix B does not effect the ranking are identified as "see Appendix B" only.

Nickel carbonyl has been identified in several incident reports. This gas mixture is NOT radioactive but it is highly toxic. It should be disregarded in internal dosimetry analysis.

The following listing of rooms with construction dates will enable the reader to match rooms with dates and rooms which have more than one room number. For example SW-1A is an area number which could refer to several rooms as listed below. To gain an overview of these rooms in SW Building and to correlate the dates of "reported programs" with construction dates the following list of rooms and dates is provided:[597]

5.1.1 Original SW Complex (1950): [598]

a. SW-1A: This includes SW-19 (Old Cave), also 19A, 19B, 18, 17.

b. SW-1B: This includes SW-13, also 14, 15, 16, 16A, 16B.

c. SW-142, also 136, 137, 138, 139, 140.

d. SW-20 and SW-22 (New Cave), also 20A, 20B, 20D, 20E, 22A

e. SW-2, also 2A, 3, 4, 5.

5.1.2 Hot Gas Facility (1957): [599]

a. SW-8, also 6, 6A, 7, 9.

5.1.3 Ceramics Facility (1958): [600]

a. SW-205, also 202(A-->G), 203, 204

5.1.4 Disassembly and Surveillance (1960): [601]

a. SW-208

5.1.5 SW-1C: Second Floor Addition and Mechanical Room on first floor (1960):[602]

a. SW-210, also support rooms 201A, 209, 210A, 210B.

b. SW-23 (mechanical equipment room)

5.1.6 Change House (1961): [603]

a. SW-108, also SW-105, 106, 107, 108, 109, 110, 111, 112, 113, 115, 117, 118, 122, 124, 125, and 127.

5.1.7 North Alterations / Second Floor Addition and a Two Story Support Building (1961): [604]

a. SW-129, 130, 131, 132, 133, 134, 135.

b. SW-211 and SW-219, also support rooms Sw-212, 213, 214, 215, 217, 218, and 220.

5.1.8 Nuclear Component Development and Pre-Production Facility (NCDPF) (1965): [605]

a. SW-147, 148, 150, and 152, also support rooms SW-146, 147A, 149, 151, 153, 153(A-C), 154, 155, and 156.

b. SW-238 and SW-240, also SW-225, 226, 227, 228, 229(A-D), 230, 231, 232, 233, 234, 235, 236, 237, and 241.

5.1.9 Addition To Existing SW-9 (1967): [606]

a. SW-10

5.1.10 Surveillance and Environmental Test Facility (1969): [607]

a. SW-20C and SW-21 and 21A

5.1.11 Cooling Tower and Chiller (1972): [608]

a. SW-242 and SW-243

5.1.12 Impact Test Facility (1975): [609]

a. SW-21 and SW-21A

b. SW-200

5.1.13 Thorium Facility (1976): [610]

a. SW-128 and SW-128A

Table 5 is a summary of rooms, dates, and radioisotopes for SW Building.

Table 5 - SW BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
SW-2	H-3	1973-PRES
SW-8	H-3, Xe (all isotopes)	1957-1960
	H-3	1958-PRES
	H-3, U(238)(D,T), Li(D,T), Ba(D,T), Ti(D,T)	1960-1985
	H-3	1963-PRES
SW-9	See Appendix B	1965-PRES
	U(D,T), Li(D,T), U/Al(D,T) See Appendix B	1989-PRES
SW-10	H-3	1967-1972
SW-13, 11, 12, 14, 15, 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
	See Appendix B.	1959-1965
	H-3, U(D,T), LI(D,T), LiO(D,T), See Appendix B	1959-1978
	See Appendix B.	1964-1967
	H-3, U-238, U(D,T), See Appendix B. .	1968-PRES
	See Appendix B.	1969-1975
	See Appendix B.	1975-1978
SW-19	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, radon and daughters	1951-1953
	See Appendix B.	1962-1988
	H-3, Ra daughters, See Appendix B . .	1973-PRES
SW-20, 21	H-3	1961-1973

Table 5 - SW BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
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
	See Appendix B	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, AcO_2, $Ac(NO_3)_2$, ...	1964-1968
	Th-230,232, U-234,235,238, Pa-231, Ac-227, Ra-223,224,226, $Ac(NO_3)$, AcO_2.	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
	See Appendix B	1959-1969
	See Appendix B	1962-1967
	H-3, U-238, U(D,T), See Appendix B .	1969-1985
SW-146, 147	H-3, U-238, U(D,T)	1967-1985
	Tritiated stainless steel.	1985-PRES

Table 5 - SW BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
SW-149, 149A	All radionuclides in SW Building . . . . H-3, HTO, tritiated organics . . . . . . H-3, HTO, tritiated organics	1965-1968 1969-PRES 1980-PRES
SW-150, 152	H-3, U-238(D,T), See Appendix B. . . . See Appendix B	1968-PRES 1973-PRES
SW-200	H-3.	1958-PRES
SW-202	Po-210 . . . . . . H-3.	1958-1962 1963-PRES
SW-205	H-3.	1958-PRES
SW-208	H-3, U-238(D,T), See Appendix B . . . . H-3, U-238(D,T), See Appendix B	1965-1989 1989-PRES
SW-210	H-3, U(238)(D,T), See Appendix B . . .	1968-1989
SW-219	Pu-238/Be, Pu-239/Be, Am-241, Pu-239 . . . . . . Po-210, Pu-238,239 . . . . . . H-3. . . . . . See Appendix B . . . . . . H-3, U-238(D,T), See Appendix B. . . .	 1962-1965 1966-1971 1968-1978 1968-1980 1985-PRES
SW-231	H-3, HTO	1970-PRES
SW-238,240	H-3, U-238(D,T), U-238, See Appendix B	1968-PRES

Note: All references to plutonium-238 was of the mixture ratio identified in the introduction to SW Building above. This mixture also included trace amounts of americium-241, neptunium-237, and uranium-234. Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241. [611]

5.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC PROGRAMS IN SW BUILDING

5.2.1 Room SW-2

This area had two major functions as discussed below.

a. (1950 - 1972) This was an equipment support room containing a ventilation system. It was a "cold" area with no possibility of uptakes. [612]

b. (1973 - PRESENT) Mass spectrometry often associated with the Tritium Analysis Meter (TAM). Radionuclide of concern is: [613]

tritium

5.2.2 Room SW-8

This room has been involved in a variety of programs as discussed below.

a. (1957 - 1960) Isotope separation of various gases such as xenon, helium, tritium, and carbon. This process was moved to HH Building. Radioisotopes of concern and their compounds are: [614] [615]

xenon (all isotopes) tritium

1) Tritium was the major radionuclide of concern with xenon radionuclides being secondary.[616]

b. (1958 - PRESENT) This area has been involved in tritium enrichment, recovery process technology, and the processing and containment of tritium-contaminated scrap from all of Mound and also scrap generated by other DOE sites. Radionuclide of concern is: [617] [618] [619]

tritium

c. (1960 - 1985) Enrichment of tritium was accomplished through a thermal diffusion process where hydrogen isotopes were separated into protium, deuterium, and tritium. This process was discontinued in 1985. The solid scrap recovery line was established for tritium recovery. This was discontinued in 1978 because an improved recovery system was

established in R-108. The thermal diffusion columns still remain but are partially decontaminated and are awaiting further decontamination operations. The solid recovery equipment was removed by 1980. Radioisotopes of concern and their compounds are: [620] [621]

tritium	uranium-238 tritide
lithium tritide	titanium tritide
barium tritide	calcium tritide

(many other metal tritides possibly tried.)

1) Tritium was the major radionuclide with uranium-238 being second. All others are a distant third. [622]

2) See Appendix B.

d. (1963 - PRESENT) In 1963 experimentation with the Effluent Removal System (ERS) began, which became operational in 1965. Purged gas from gloveboxes, fumehoods, and room air from maintenance operations were subjected to a process which removed all particulates and liquid droplets of mercury and pump oil. The remaining effluent is oxidized to form HTO from the tritiated gas and tritiated organics. The HTO vapor went through a dryer (molecular sieve) where a water/gas separation occurred.

1) In theory the reclaimed HTO water is sent to the Tritium Aqueous Waste Recovery System (TAWRS) in room T-63 of T Building. However, TAWRS has only operated for one year, as discussed under room T-63.

2) For all but one year (1989-1990) the condensed HTO effluent is taken to SW-149 where it is packaged for burial.

3) Radionuclide of concern is: [623] [624]

tritium

4) Incidents - (Tritium, 6/7/61, 7/23/72, 3/13/73, 7/18/73)[625]

5.2.3 Room SW-9

This room was used for two functions as discussed below.

a. (1965 - PRESENT) The Hydraulic Pressing System was used for pressing filters, powders, and explosive actuators. Energetic materials are involved along with some radionuclides. [626] [627] Early work also used an Electron Beam (EB) welder to seal containers holding tritium. [628]

   1) See Appendix B for ranking.

b. (1989 - PRESENT) This area was remodeled to provide gloveboxes for storing tritiated materials. See Appendix B of additional information. Radioisotopes of concern and their compounds are the following:[629] [630]

   uranium tritide
   uranium aluminum tritide
   lithium oxide tritide
   lithium tritide
   lithium hydroxide tritide

   1) Tritium was the major radionuclide with uranium-238 being second. All others are a distant third. [631]

   2) See Appendix B.

5.2.4 Room SW-10

(1967 - 1972) A research lab doing characterization studies of vanadium, uranium-238, palladium in a tritide form. The metals were NOT radioactive with only tritium being a concern from an internal dosimetry perspective. Radionuclide of concern is: [632]

tritium

5.2.5 Room SW-13 and supporting rooms SW-11, 12, 14, 15, 16 (Area SW-1B)

a. (1951 - 1953) Decontamination of Bismuth Phosphate Materials -Five shipments of bismuth phosphate materials were received from Hanford which included crib materials and samples from two other stages of the process in the plutonium separation program from irradiated uranium-238. Purex and Tributyl Phosphate materials from Oak Ridge National

Laboratory were also received from a similar program and contained the same radionuclides. A study had been done in R-162 and R-167 for the best process to use, and a pilot plant was tested in HH building before the actual decontamination production process in SW-13 (SW-1B). Radioisotopes of concern are: [633 634 635 636]

ruthenium-106	cesium-137	antimony-125
tellurium-121,127	zirconium-93,95	niobium-94
strontium-90	plutonium-238,239	
yttrium-88,90,91	rare earths (especially cerium)	

1) All radionuclides were of equal concern.[637]

2) It was a ferrous sulfide process and used adsorption and/or coprecipitation followed by clarification of fission products with ferrous sulfide, ferrous hydroxide and calcium phosphate. Feed lines would often break spilling solution with high gamma activity. [638]

b. (1955) Thorium-232 Refinery Program (Monex) - In 1955 A pilot program for the extraction of Th-232 from Brazilian Monazite sludge, thorium oxalate, and sulfate sludge residues was begun in room SW-1B. However, the research was canceled after four months.[639 640]

1) Warehouse #15 stored 1,650 tons of this material which was already received. It was highly corrosive and continually leaked through the barrels causing much contamination. In 1961 Building 21 stored the material in silo form until 1975.

2) Over 34 isotopes were identified from the feedstock of this program with most being nonradioactive. Radioisotopes of concern and their compounds are: [641 642]

thorium-232,228	radium-228,224
uranium-238	thorium-232 daughters (especially thallium-208)

a) Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. However, when considering the quantity of radionuclides, and not activity, 99% of the mass of radionuclides are thorium-232.[643]

c. (1956) The protactinium-231 purification process which was begun in HH Building was moved to this area in the spring of 1956 to take advantage of the existing equipment from the thorium project discussed above. It uses the residues (referred to as raffinates) from a previous uranium processing called "Sperry cake." The work was completed by June of the same year. Radioisotopes of concern were: [644] [645]

iron-55,59	aluminum-26	calcium-45
cobalt-60	protactinium-231	copper-65

1) Protactinium-231 was the major radionuclide of concern with all others a distant second.[646]

d. (1959 - 1978) Gas Synthesis System - Tritium and deuterium research and development was conducted with gas synthesis systems in association with various metals. Research and characterization of metal tritides such as depleted uranium tritide, lithium tritide. The characterizations included pressure-composition-temperature relationships between the isotopes of hydrogen and various metals. (i.e. how much hydrogen a metal will hold at various temperatures and pressures.) Radioisotopes of concern and their compounds are: [647]

uranium tritide	lithium tritide
tritium	lithium hydroxide tritide
uranium-238	

1) Tritium is the major radionuclide of concern with uranium-238 being second.[648]

2) Incident - (tritium, 8/27/64)[649]

3) See Appendix B.

e. (1959 - 1965) See Appendix B for ranking.

f. (1964 - 1967) See Appendix B for ranking.

g. (1969 - 1975) See Appendix B for ranking.

h. (1975 - 1978) See Appendix B for ranking.

i. (1968 - PRESENT) Metallurgical analysis is used to analyze radionuclides and metal tritide samples by cutting items into sections and examining using a variety of techniques. Radioisotopes of concern and their compounds are: [650] [651]

tritium	uranium-238	uranium tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[652]

2) Incident - (Tritium, 8/28/85)[653]

3) See Appendix B.

5.2.6 Room SW-19 (Old Cave) - This area had a variety of programs as discussed below.

a. (1951 - 1953) Radium-Actinium Separation - Radium-226 bromide was irradiated at another facility to produce actinium-227 and then a separation process was done in SW-19 to obtain the desired Ac-227 in a compound form. The actinium-227 compound was then taken to R-Building for further processing. High and low risk materials were drained in a concrete channel with a sump at each end which pumped to a treatment facility in an adjoining room. This area was so hot with radium and radon residue that it has been filled over with several feet of gravel and concrete. By 1957 the area was filled over with concrete for radioactive protection purposes. Some of the radionuclides and compounds encountered would be: [654] [655] [656]

radium-226	radium carbonate
actinium-227	radium nitrate
radium bromide	actinium oxalate
actinium fluoride	potassium-40
radon and daughters	thorium-228,229,230

1) Actinium-227, radium-226, and thorium-228 were the major radionuclides of concern. All compounds of actinium-227 were highly soluble.[657]

2) Large quantities of particulate were generated in the area of the evaporator especially during drumming operations. [658]

3) MLM-736 (7/31/52) discusses some of the decontamination problems they encountered. [659]

4) Initial discussion / interviews with previous workers indicated that work went on from about 1950 to 1955 but Health Physics Monthly Information Reports from the spring of 1953 onward indicate that cleanup and decontamination operations were being done. Clean up operations were completed by the first quarter of 1959. [660][661] [662]

b. (1962 - 1988) See Appendix B for ranking.

c. (1973 - PRESENT) This laboratory was then used to store tritium contaminated metal specimens left over from previous operations. At present this area still used for storage although decontamination operations are being planned. A high radon and daughters background exists as a result of the earlier work. Radioisotopes of concern and their compounds are: [663]

tritium radon and daughters

1) See Appendix B for ranking.

5.2.7 Room SW-20, 21

(1961-1973) Component evaluation and environmental testing which includes thermal and shock testing. Radioisotopes of concern and their compounds are: [664]

tritium

1) Incident -(Tritium, 9/24/86)[665]

5.2.8 Room SW-22: "New Cave" and Laboratory Area

This area was used for several research projects relating to plutonium, uranium, thorium, protactinium, and other elements staring in 1960 and extending through to about 1988. See SW-140 for similar work. A variety of programs were conducted which included the following: [666]

a. (1966 - 1975) Thorium-229 Separation Program - Part of "rare isotope program" where thorium-229 was separated from aged uranium-233 and

its daughters. A chloride complex separation technique was used in the process. Radioisotopes of concern are: [667 668 669 670]

uranium-232,233	thorium-228,229
radium-224,225	actinium-225
francium-221	astatine-217

thorium-228 daughters (especially thallium-208)

1) (1975 - 1981) The process was altered where U-233 was the precursor of the process. [671]

2) Uranium-232,233 and thorium-228 daughters, especially thallium-208 are all equally major radiological concerns.[672]

b. (1970 - 1979) Support of Cotter Concentrate program - The processing of pitchblende ore to recover uranium, at another site, left a residue which contained many isotopes, some of which were of value to DOE. This concentrate was processed by a repeating cycle of dissolution in acids and precipitating to obtain small quantities of Pa-231 and Th-230. The cycle included an organic-phosphate extraction and an aqueous stage which implies that uptakes might be processed in the body like a chelating agent. Radioisotopes of concern and their compounds are: [673 674 675 676 677]

thorium-230,232	uranium-234,235,238
actinium-227	protactinium-231
radium-223,224,226	actinium nitrate
actinium oxide	

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity. [678]

2) Fourteen elements besides those isotopes listed above are also contained in the Cotter Concentrate as listed on page 2-71 of CERCLA, VOL. 7, July 1992. There is no indication that these fourteen additional elements are radioactive.

c. (1976 - 1979) A process was done to retrieve the polonium-209 and lead-206 from the old polonium work done earlier on the Mound site. Radionuclides of concern include the following:

polonium-208,209,210 polonium-210 daughters

1) Polonium-210 daughters are the major radionuclide of concern.[679]

d. (1984 - 1986) See Appendix B for ranking.

5.2.9 Room SW-128, 129, 130, 134

These rooms are support rooms for SW-22 and SW-140 (New Cave). They have been "cold" areas throughout their existence. No processing was ever done in these rooms.

a. (1970 - 1979) These rooms were a staging area for the 55 gallon drums of Cotter Concentrate in the 1970's. Because spills and leaks from the drums were possible the radionuclides of concern would be all that existed in the Cotter Concentrate as listed below. [680 681 682 683]

thorium-230,232 uranium-234,235,238
actinium-227 protactinium-231
radium-223,224,226

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity.[684]

2) Fourteen elements besides those isotopes listed above are also contained in the Cotter Concentrate as listed on page 2-71 of CERCLA, VOL. 7, July 1992. There is no indication that these fourteen additional elements are radioactive.

5.2.10 Room SW-132: This room had the following functions:

a. (1970 - 1979) Support of Cotter Concentrate program. SW-132 allowed personnel to get behind the fumehoods in SW-140 and give support to the programs in that room. The Cotter Concentrate was processed by a repeating cycle of dissolution in acids and precipitating to obtain small quantities of Pa-231 and Th-230. The cycle included an organic-phosphate extraction and an aqueous stage which implies that uptakes might be processed in the body like a chelating agent. Radioisotopes of concern and their compounds are: [685 686 687]

thorium-230,232 uranium-234,235,238

actinium-227 protactinium-231
radium-223,224,226 actinium nitrate
actinium oxide

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity.[688]

2) Fourteen elements besides those isotopes listed above are also contained in the Cotter Concentrate as listed on page 2-71 of CERCLA, VOL. 7, July 1992. There is no indication that these fourteen additional elements are radioactive.

3) Incident - (Ac-227, 10/30/78)[689]

b. (1976 - 1979) A process was done to retrieve the polonium-209 and lead-206 from the old polonium work done earlier on the Mound site. Radionuclides of concern include the following:

polonium-208,209,210 polonium-210 daughters

1) Polonium-210 daughters are the major radionuclide of concern.[690]

c. Room SW-132 was cleaned up after this and no longer used for hot work.[691]

5.2.11 Rooms SW-136 and SW-137

(1964 - 1979) These rooms were used to get materials into the hot cell which was part of SW-140. Although these rooms were not used for production they did possess the capabilities of contamination and spills. Radioisotopes of concern and their compounds are: [692] [693] [694]

thorium-230,232 uranium-234,235,238
actinium nitrate protactinium-231
radium-223,224,226 actinium-227
actinium oxide

a. The radionuclides of major concern are time dependent since the time span include several major programs with diverse emphasis on radionuclides.[695]

1) Early radiological concerns included thorium-228, radium-226, and actinium-227.

2) Later programs made thorium-228, protactinium-231, and natural uranium (234, 235, 238) the major radionuclide concerns.

5.2.12 Room SW-140

"New Cave" and Laboratory Area - (Includes HOT CELL and ANALYTICAL) along with supporting rooms SW-132, 136, 137: SW-140 was the primary room consisting of a "hot" side with fumehoods and two ion exchange columns. The "analytical" side was used to obtain disintegration counts using alpha, gamma, proportional counters, etc See SW-22 for similar work. This room was used for a variety of programs as discussed below.

a. (1964 - 1968) Actinium-227 as both an oxide and nitrate was processed in a separation procedure to acquire a pure radionuclide. It was a much smaller operation than was done in the "old cave" area (SW-19) where Ac-227 was separated from irradiated Radium-226. No radium was involved in this operation. Radioisotopes of concern and their compounds are: [696] [697]

actinium-227 actinium oxide actinium nitrate

1) Actinium-227 was the major radionuclide. It is very soluble and could be found in varied chemical compounds.[698]

b. (1970 - 1979) This room was used to support the Cotter Concentrate program which was similar to the activities done in SW-22. This concentrate was processed by a repeating cycle of dissolution in acids and precipitating to obtain small quantities of Pa-231 and Th-230. The cycle included an organic-phosphate extraction and an aqueous stage which implies that uptakes might be processed in the body like a chelating agent. Radioisotopes of concern and their compounds are:[699] [700] [701] [702]

thorium-230,232	uranium-234,235,238
actinium-227	protactinium-231
radium-223,224,226	actinium nitrate
actinium oxide	

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity.[703]

2) Fourteen elements besides those isotopes listed above are also contained in the Cotter Concentrate as listed on page 2-71 of CERCLA, VOL. 7, July 1992. There is no indication that these fourteen additional elements are radioactive.

c. (1976 - 1979) A process was done to retrieve the polonium-209 and lead-206 from the old polonium work done earlier on the Mound site. Radionuclides of concern include the following:

polonium-208,209,210 polonium-210 daughters

1) Polonium-210 daughters are the major radionuclide of concern.[704]

5.2.13 Room SW-142: - Several programs as discussed below.

a. (1950 - 1961) Analytical lab used to support the polonium program. Also supported the "Old Cave" program. Radioisotopes of concern and their compounds are:[705] [706]

radium-226	radium carbonate
actinium-227	radium nitrate
radium bromide	actinium oxalate
actinium fluoride	potassium-40
polonium-208,209,210	radon and daughters
thorium-228,229,230	

1) Probable major radionuclides of concern are radium-226, actinium-227, thorium-228, and polonium-210 which can all be considered equally. This ranking is only assumed and is based upon ranking of programs contemporary with this period of time.

b. (1959 - 1969) See Appendix B for ranking.

c. (1962 - 1967) See Appendix B for ranking.

d. (1969 - 1985) Metallurgical analysis is used to analyze radionuclides and metal tritide samples by cutting item into sections and examining using

a variety of techniques. The mercury used for pumping often became contaminated with tritium. Radioisotopes of concern and their compounds are: [707 708 709 710]

tritium	uranium-238
uranium tritides	tritiated mercury oxide

1) See Appendix B for ranking.

2) Incidents - (Tritium, 11/20/64, 8/28/85)[711]

3) Incident - (Mercury, 1/25/65)[712]

a) The mercury was used in pumping/transferring tritium. [713]

e. (1985 - 1988) Decontamination work in preparation for a new lab which never became operational.

5.2.14 Rooms SW-146, 147 - The following functions were done in these rooms.

a. (1967 - 1985) This was a metrology lab used for the inspection of materials, measurement, and smoothness determination. SW-146 was also an X-ray room which used cobalt-60 as it source. Radionuclides of concern and their compounds are:[714]

tritium	uranium-238
uranium-238 tritide	

1) Tritium was the major radionuclide of concern with uranium-238 being secondary.[715]

b. (1985 - PRESENT) A surveillance program consisting of pressure burst testing systems. Radioisotopes of concern and their compounds are: [716] [717]

tritiated stainless steel (contaminated)

1) tritiated stainless steel is very stable in the body.[718]

5.2.15 Room SW-149 and 149A

This area has always been involved in the handling of radionuclides as discussed below.

a. (1965 - 1968) This was a decontamination lab used to decontaminate parts. Surface contamination consisted of the following possible radionuclides: [719]

all radionuclides contained in SW Building

1) Tritium was the major radionuclide of concern with all other radionuclides a distant second.[720]

b. (1969 - PRESENT) SW-149 (only) was used to receive, store, analyze, and solidify waste water and oil which were contaminated with tritium. Monitoring of liquid waste through calorimetry was a common procedure. Radioisotopes of concern and their compounds are: [721]

tritium
tritiated water (HTO)
tritiated organics (oils)

1) Tritium was the major radionuclide of concern.[722]

c. (~1980 - PRESENT) SW-149A (only) was built to receive, assay, and package waste tritiated oil and water. After the development of a practical method to recover tritium from water the FWCU (Feedwater Cleanup System) was installed in SW-149A. Its purpose was to remove chemical impurities from water before it was fed into the recovery process in T-63. Radioisotopes of concern and their compounds are: [723] [724] [725]

tritium
tritiated water (HTO)
tritiated organics (oils)

1) Tritium was the major radionuclide of concern.[726]

5.2.16 Rooms SW-150 and 152

These are the major labs used for the following program:

a. (1968 - PRESENT) Gas Synthesis System - Tritium and deuterium research and development was conducted with gas synthesis systems in association with various metals. Research and characterization of metal tritides such as depleted uranium tritide. The characterizations included pressure-composition-temperature relationships between the isotopes of hydrogen and various metals. (i.e. how much hydrogen a metal will hold at various temperatures and pressures.) Similar to the work done in SW-13 during this period of time. Radioisotopes of concern and their compounds are: [727] [728]

tritium uranium-238 tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[729]

2) See Appendix B.

b. (1973 - PRESENT) See Appendix B for ranking.

5.2.17 Room SW-200

1958 - PRESENT) This has been an environmental testing lab. It also contains a mechanical convection (oven system), hydraulic burst testing, and storage. Radioisotopes of concern and their compounds are: [730] [731]

tritium

5.2.18 Room SW-202

Large counting room used to support two phases of operations at Mound.

a. (1958 - 1962) Large counting room supporting polonium operations. Radioisotopes of concern and their compounds are: [732] [733]

polonium-210

1) Incident - (Po-210, 8/11/61)[734]

b. (1963 - PRESENT) This room has been used to support many operations in the SW Building. All counting in recent years has been low level counting such as for Health Physics work. There is low probability of any radiological uptake with the only radionuclide of concern being: [735] [736]

tritium

5.2.19 Room SW-205

1958 - PRESENT) Analytical lab using mass spectrometry often associated with the Tritium Analysis Meter (TAM). Radionuclide of concern is:[737] [738]

tritium

5.2.20 Room SW-208

This room had a variety of programs as discussed below.

a. Room SW-208: (1965 - 1989) This room contained a walk-in hood system where tritium containing units were received and the tritium was removed. The tritium was transported to SW-8 where it entered the thermal diffusion columns for processing.

   1) Function testing on the tritium containing units was also done in this room (1965 - 1968). [739] [740] [741]

   tritium uranium-238 tritide

   2) See Appendix B for ranking.

b. Room SW-208: (1989 - PRESENT) This room diminished its activities and only operated a glovebox line which was used for function testing of components. Walk-in-hood has not been used since 1989. The components sometimes become contaminated with tritium. Radioisotopes of concern and their compounds are: [742] [743]

tritium uranium-238 tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[744]

2) See Appendix B.

5.2.21 Room SW-210

This room had two programs as discussed below.

a. Room SW-210: (1960 - 1968) This room was a plastics room where a plastics potting program existed. Radionuclide work in this room did not begin until 1969. [745]

b. Room SW-208, 210: (1968 - 1989) These labs contained a "walk-in-hood" system which was used for extensive function and component testing of systems. Radioisotopes of concern and their compounds are: [746] [747]

tritium	uranium-238 tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[748]

2) Room SW-210: After 1989 this room shut down completely. [749]

3) See Appendix B.

5.2.22 Room SW-219

Several programs were conducted in this room as discussed below.

a. (1962 - 1965) This was a plutonium-238,239 neutron source production area used to manufacture neutron sources. These sources were then sent to T-61 and later to T-227 for calibration. Done during this same time was the alpha source plating on various metal substrates which were used as sources for calibration. This operation was moved to this room from R-116 and R-120 where it was first done. Radioisotopes of concern and their compounds are: [750] [751] [752]

plutonium-238/beryllium	plutonium-239/beryllium
americium-241	plutonium-239

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 second and americium-241 being third.[753]

b. (1966 - 1971) This area was used for a neutron source verification program. Polonium-210 beryllium, plutonium-238 and 239 beryllium neutron sources were monitored for conformance to specification. Radioisotopes of concern and their compounds are: [754]

polonium-210 plutonium-238,239

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 secondary.[755]

c. (1968 - 1978) This was an analytical lab for hydride and tritide analysis. Radioisotopes of concern and their compounds are: [756]

tritium

d. (1968 - 1980) See Appendix B for ranking.

e. (1980 - 1984) Decontamination work included equipment tear-out and new equipment installation.

f. (1985 - PRESENT) A boxline system was installed to perform stockpile evaluation of gas transfer systems. This area does the same tasks as SW-208. Radionuclide of concern: [757]

tritium uranium-238 tritide

1) Tritium is the major radionuclide of concern with uranium-238 being second.[758]

2) See Appendix B.

5.2.23 Room SW-231

(1970 - PRESENT) Initially a staging area for waste drums, it became a support room for SW-150. This room contains dryers to collect the tritiated condensate. Radioisotopes of concern and their compounds are: [759] [760]

tritium tritiated water (HTO)

a. Incident - (Tritium, 7/28/72)[761]

5.2.24 Rooms SW-238, 240

(1968 - PRESENT) These are labs for the development of system prototypes, component testing, welding operations, and calorimetry. Simulation testing of long term storage and environmental concerns are also done. Radioisotopes of concern and their compounds are: [762] [763]

uranium tritide	tritium
uranium-238	

a. Tritium is the major radionuclide of concern with uranium-238 being second.[764]

b. See Appendix B.

5.2.25 There is contaminated soil under the SW building. Radionuclides of concern are:[765]

tritium	radium-226
radon-22	thorium-230,232
cesium-137	strontium-90
plutonium-238	

5.2.26 Recent inquiries into the degree of contamination of **crawl spaces above SW Building** have revealed very little contamination and radioactivity in those areas.[766]

5.2.27 See Appendix B for SW Building rooms: SW-8, 9, 13, 19, 22, 142, 150, 152, 208, 210, 219, 238, 240.

6. T-BUILDING

6.1 OVERVIEW

T-Building was host to a multitude of research, development, and production programs with various radioisotopes. The two major radionuclide programs are the polonium and the tritium programs. From 1949 to 1973 polonium-210 programs included a processing and separation program, a fuels research and development program, neutron source program, and a variety of other research, development, and production programs with polonium. This work was all done on the first and second floors of T-Building.

An extensive renovation program from 1966 through 1968 prepared the way for additional polonium fuels research and development.[767] However, government funding was radically reduced and most all renovations were not used as anticipated. T-Building was essentially dormant from 1969 till about 1972 because of a loss of this funding. Decontamination work was done from 1971 through 1973 on the polonium-210 processing area.[768] Activity resumed with the tritium programs in the mid 1970's.[769]

A variety of other activities have been done in T-Building such as nondestructive testing, environmental testing, gamma and mass spectroscopy, calorimetry, neutron activation analysis, and safeguards R&D.

All references to plutonium-238 was of the mixture ratio identified below. This mixture also included trace amounts of americium-241 and neptunium-237.[770] This information was obtained from MLM-1564 (AEC Research and Development Report), page 31.

1E-4% Pu-236
80.2% Pu-238
15.9% Pu-239
3.0% Pu-240
0.6% Pu-241
0.1% Pu-242

Note: MLM-1564 also makes reference to other mixtures.

Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241. [771]

All analytical labs and support rooms for the polonium-210 program from 1949 to about 1973 probably had the following radionuclides and compounds which were common to the polonium processing: [772]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
aluminum chloride	bismuth chloride
polonium chloride	polonium nitrate

1) Exceptions to this would have been T-248 through T-259 which had very pure polonium handled in this area.

The abundant use of tritium in T-Building and the reactivity of tritium with other materials makes tritium an isotope of concern.

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

All radionuclides are ranked according to the degree of concern for uptake and amount of activity for internal dosimetry considerations. Rooms which are referenced to Appendix B for additional radionuclides do not have a ranking in this manual since the ranking is done in Appendix B where all radionuclides are listed. This situation is identified as "see Appendix B for ranking." Rooms where additional information on processing or

radionuclides in Appendix B does not effect the ranking are identified as "see Appendix B" only.

Nickel Carbonyl has been identified in several incident reports. It is a highly poisonous gas mixture but is NOT radioactive. It should be disregarded in internal dosimetry analysis.

Table 6 is a summary of rooms, dates, and radioisotopes for T-Building.

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
T-1W, 2W, 4E	See Appendix B	1965-1987
T-5W	H-3, HTO . . . . . . 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: All were encapsulated	1955-PRES
T-8	Po-210.	1949-1965
T-9, 9A	H-3, Pu-238(encapsulated)	1987-PRES
T-13	Po-210.	1949-1953
T-15B	Neutron generator producing many possible radionuclides from surface of materials present	1963-PRES
T-16A	H-3, tritiated organics	1984-PRES
T-18	Neutron generator producing many possible radionuclides from surface of materials present	1963-PRES
T-19, 19A	Pu-238,239, H-3, Co-60, Ir-192, Fe-55, Ra-226, Am-241, Cd-109: All were encapsulated. . . . . . H-3, tritiated organics	1985-PRES 1985-PRES
T-20	Never went hot.	1985-PRES
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, Zn-65, Cr-55, V-52, Ga-70,72, Cs-137, Sr-90, Se-75, Ag-112, Te-121-->134?, Hg-203 . . . . . . Pu-238,239 (encapsulated)	1949-1969 1979-PRES

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
T-25, 26	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-PRES
T-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-PRES
T-28,29,30,31, 32,33,34,35	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
	See Appendix B.	1985-PRES
T-37	H-3, U-238(D,T), Pu-238(encapsulated), tritiated organics.	1985-PRES
T-40	H-3, Pu-238(encapsulated)	1985-PRES
T-41	H-3	1985-PRES
T-46	Po-210.	1949-1969
T-48, 49, 50	H-3, U-238(D,T), See Appendix B	1983-PRES

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
T-53	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-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-PRES
T-58	H-3, ...	1985-PRES
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-238(D,T)	1985-PRES
	H-3, ...	1985-PRES
T-61, 61A	Po-210, Pu-238,239.	1960-1963
	Po-210.	1964-1966
	H-3, U-238(D,T)	1973-PRES
T-63	H-3, HTO.	1973-PRES

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
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-PRES
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-PRES
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-PRES
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-PRES
T-234	H-3, See Appendix B	1988-PRES

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
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-PRES
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, Pu238,239(encapsulated).	1985-PRES
T-238	H-3, Pu-238(encapsulated)	1985-PRES
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, See Appendix B.	1949-1958
	Po-208,209,210, rare earth polonides, See Appendix B.	1966-1969
T-248-->T-259	Po-210.See Appendix B	1949-1965
	(T-257 only) - Orphan sources	1993-PRES
T-260	Po-210, See Appendix B.	1949-1969
	Po-208,209,210, rare earth polonides, See Appendix B.	1966-1969

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
T-266, 267	Po-210, Bi-209,210, See Appendix B. . . . . Po-208,209,210, rare earth polonides, See Appendix B. . . . . . H-3, U-238(D,T)	1949-1969 1963-1966 1988-PRES
T-270	Po-210, Bi-209,210, See Appendix B.	1949-1963
T-274	External dose only . . . . . . 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 . . . . . . H-3, U-238(D,T)	1948-1971 1966-1969 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	Po-210, Am-241.See Appendix B . . . . . . Po-210 . . . . . . Po-210, Bi-209,210	1949-1964 1962-1969 1964-1969
T-300A	Orphan Sources; sources left in containers.	
T-307	Po-210 . . . . . . H-3, ...	1949-1964 1972-PRES
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 . . . . . . Pu-238,239,240,241, Pm-147, U-233,235, Am-241, H-3 . . . . . . Pu-238,239(encapsulated).	1949-1969 1969-1983 1986-PRES

Table 6 - T-BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATE USED
T-311	Po-210. . . . . . Pu-238,239 (encapsulated)	1949-1969 1986-PRES
T-319	Pu-238,239,240,241, Pm-147, U-233,235, Am-241, H-3, HTO	1949-PRES
Please Note: T-43,44,48,50, 57,58,59, Corridor-51	These rooms have high fixed radiation from the old polonium program. Radioisotopes of concern are: Co-60, Cs-137, Sr-90.	

Note: All references to plutonium-238 was of the mixture ratio identified in the introduction to T-Building above. This mixture also included trace amounts of americium-241,neptunium-237, and uranium-234. Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241. [773]

6.2 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS

6.2.1 Room T-1W: (1965 - 1987) See Appendix B for ranking.

6.2.2 Room T-2W: (1965 - 1987) See Appendix B for ranking.

6.2.3 Room T-4E: (1965 - 1987) See Appendix B for ranking.

6.2.4 Room T-5W: This room had several functions as discussed below.

a. (1956 - 1962) This room was used to store heavy water (D_2O). Radioisotopes of concern and their compounds are: [774]

tritium	tritiated water (HTO)

1) Tritium gas was the major radionuclide of concern. [775]

b. (1963 - 1974) This was a file storage area. There were no radioisotopes of concern. [776]

c. (1975 - 1982) This room was used to house the early catalytic exchange column for enriching HTO. Radioisotopes of concern and their compounds are: [777]

tritium	tritiated water (HTO)

1) Tritium gas was the major radionuclide of concern. [778]

d. (1987 - FUTURE) The Tritium Effluent Reduction Facility (TERF) is part of the "Tritium Recycle and Enrichment System." It will replace ERS in SW-8 which will no longer function when TERF is fully on line. However, they will both operate until TERF is fully checked out. To date it has never had tritium in TERF system. [779]

1) Other support rooms for TERF are T-2W, T-241, and T-242. [780]

6.2.5 Room T-5E: (1955 - PRESENT) This room is used for non destructive testing using X-ray techniques and radiography techniques. Radioisotopes of concern and their compounds are: [781] [782]

plutonium-238,239	tritium

cobalt-60	iridium-192
iron-55,59	radium-226
americium-241	cadmium-109

(Note: These radioisotopes are all encapsulated or doubly contained.)

a. Tritium was the major radionuclide of concern with plutonium-238 being second and plutonium-239 third.[783]

6.2.6 Room T-8: (1949 - 1965) This room was used for hot side maintenance in the "low risk" section of T-Building. This should not be confused with the "hot maintenance" in the "high risk" section (T-53). Radioisotopes of concern and their compounds are: [784]

polonium-210

6.2.7 Room T-9 or 9A: (1987 - PRESENT) The Nuclear Measurement Laboratory provides the Final Leak Check and Calorimetry of tritium containing vessels. Doubly encapsulated plutonium-238 heat standards are used for calorimetry calibration. This is a support room to the activities in room T-40. Minimum standards must be met for radiation and contamination before items are permitted in the room such that it provides a man-safe environment. Radioisotopes of concern and their compounds are.[785] [786] [787]

tritium	plutonium-238 (encapsulated)

a. Tritium was the major radionuclide of concern with plutonium-238 being second.[788]

6.2.8 Room T-13: (1949 - 1953) This room is used as a decontamination room for polonium-210 contaminated equipment. Radionuclides of concern are: [789]

polonium-210

a. Health Physics report discussed the decontamination work which was done in making ready for other programs. [790]

6.2.9 Room T-15B: (1963 - PRESENT) This room is used for neutron irradiation of materials with a neutron accelerator source. Although most materials are nonradioactive, the effects of using neutron radiation in the analyses may

produce radionuclides on the surfaces of materials and equipment in the room. Therefore, it is uncertain what radionuclides may exist in this room.[791 792 793]

6.2.10 Room T-16A: (1984 - PRESENT) This room is used for the compaction of LSA waste collected from change rooms, shoe covers, general work areas, etc This trash does not contain off gassing materials. Radioisotopes of concern and their compounds are: [794]

tritium	tritiated organics

a. Tritium gas was the major radionuclide of concern. [795]

6.2.11 Room T-18: (1963 - PRESENT) This room is used as a counting lab for neutron and gamma radiation from the neutron activation analysis done in room T-15B.[796 797 798]

6.2.12 Room T-19, T-19A: These room have two functions as discussed below.

a. (1985 - PRESENT) These rooms are used for X-ray and non-destructive inspection and testing in support of production, process engineering, and R&D efforts. Radioisotopes of concern and their compounds are:[799 800]

plutonium-238,239	tritium
cobalt-60	iridium-192
iron-55	radium-226
americium-241	cadmium-109

(**Note:** These radioisotopes are all encapsulated)

1) Tritium was the major radionuclide of concern with plutonium-238 being second and plutonium-239 third.[801]

b. Room T-19: (1985 - PRESENT) This room is also used to package the LSA waste and hold until it was transferred out of T-Building. The abundant use of tritium in T-Building and the extreme reactivity of tritium with other materials makes tritium an isotope of great concern. Most forms of tritium resulting in an uptake are HT, HTO, and tritiated contaminants of water, oils, and alcohols (methanol and ethanol), and other solvents. Radioisotopes of concern and their compounds are: [802 803]

tritium tritiated organics

1) Tritium gas was the major radionuclide of concern. [804]

6.2.13 Room T-20: (1985 - PRESENT) There are no radionuclides of concern.[805 806 807]

6.2.14 Room T-22: The following functions were done in this room.

a. (1949 - 1969) This room is part of the east filter bank system (E-31A and 41) supporting the polonium operations contained in the gloveboxes. This would also include the radionuclide impurities from the dissolving operation. Radioisotopes of concern and their compounds are:[808 809 810 811]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[812]

b. (1979 - PRESENT) This room is a Safeguards verification facility lab containing calorimetric, thermal neutron, and gamma-ray spectroscopy systems. The operations include assay of nuclear materials for heat emissions by calorimetry and isotopic composition using gamma-ray spectroscopy. The results of these analysis gives the gram-value and isotope identification of the assays. R&D is also done for improvements of measurement techniques. Radioisotopes of concern and their compounds are: [813 814]

plutonium-238,239 (encapsulated)

1) Plutonium-239 was the major radionuclide of concern with plutonium-238 being second. [815]

6.2.15 Rooms T-25 and T-26: These rooms had two functions as discussed below.

a. (1949 - 1969) This area is part of the east filter bank system (E-31A and 41) supporting the polonium operations which would also include the radionuclide impurities in the air from the dissolving operation. Radioisotopes of concern and their compounds are: [816 817 818 819]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[820]

b. (1979 - PRESENT) These areas are counting rooms in support of the lab in T-22. Radioisotopes of concern and their compounds are: [821]

plutonium-238,239 (encapsulated)

1) Plutonium-239 was the major radionuclide of concern with plutonium-238 being second. [822]

6.2.16 Room T-27: This room had two functions as discussed below.

a. (1949 - 1969) This room is part of the east filter bank system (E-31A and 41) supporting the polonium operations which would also include the radionuclide impurities in the air from the dissolving operation. Radioisotopes of concern and their compounds are: [823 824 825 826]

iron-55,59	silicon-31

cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[827]

b. (1979 - PRESENT) This room is used for unpackaging of radionuclides for use in T-22. Radioisotopes of concern and their compounds are: [828]

plutonium-238,239 (encapsulated)

1) Plutonium-239 was the major radionuclide of concern with plutonium-238 being second. [829]

6.2.17 Rooms T-28, 29, 30, 31, 32, 33, 34, 35

(1949 - 1969) These rooms are part of the east filter bank system (E-31A and 41) supporting the glovebox operations. This would also include the radionuclide impurities from the dissolving operation. Radioisotopes of concern and their compounds are: [830] [831] [832] [833]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[834]

6.2.18 Room T-36, T-36A: These rooms have two functions as discussed below.

a. (1949 - 1969) These rooms are part of the east filter bank system supporting the polonium operations which would also include the radionuclide impurities in the air from the dissolving operation. Radioisotopes of concern and their compounds are: [835 836 837 838]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-12	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[839]

b. (1985 - PRESENT) See Appendix B for ranking.

6.2.19 Room T-37

(1985 - PRESENT) This room is an alternate route for tritium entry into and out of T-Building. It is also used for special packaging and unpackaging when procedures, other than those in T-237,238, are normally done. This room is also used as a decontamination laboratory for decontamination equipment which becomes contaminated with tritium. Radioisotopes of concern and their compounds are: [840 841]

tritium	plutonium-238 (encapsulated)
uranium-238 tritide	tritiated organic solvents such as oil and alcohol (methanol and ethanol)

a. Tritium was the major radionuclide of concern with uranium-238 being second and plutonium-238 third.[842]

6.2.20 Room T-40

(1985 - PRESENT) The Nuclear Measurement Laboratory provides the final leak check and Calorimetry of tritium containing vessels. Doubly encapsulated plutonium-238 heat standards are used for calorimetry calibration. This room also has bubblers, scintillation counters, and electronic equipment to collect and do a final check on the tritium containers. Minimum standards must be met for contamination before items are permitted in the room such that it provides a man-safe environment. Radioisotopes of concern and their compounds are.[843 844 845]

tritium plutonium-238 (encapsulated)

a. Tritium was the major radionuclide of concern with plutonium-238 being second.[846]

6.2.21 Room T-41

(1985 - PRESENT) This room is a lab used for mass spectrometry for inventory purposes and impurity analysis. This room has similar functions as room T-58. Radioisotopes of concern and their compounds are:[847 848 849]

tritium

6.2.22 Room T-46

(1949 - 1969) This was a decontamination laboratory. Radioisotopes of concern and their compounds are:[850]

polonium-210

6.2.23 Room T-48, T-49, T-50

(1983 - PRESENT) T-48 and T-50 are glovebox labs and T-49 is an access corridor to both T-48 and T-50. T-48 and T-50 contain gas preparation systems used to handle large quantities of tritium. Room T-49 is an access

corridor for equipment maintenance. Radioisotopes of concern and their compounds are: [851 852 853 854 855]

tritium (tritiated pump oil)	uranium-238 tritide

a. Tritium was the major radionuclide of concern with uranium-238 being second.[856]

b. See Appendix B.

6.2.24 Room T-53

(1949 - 1969) This was a "hot maintenance" room which functioned as a machine and repair shop servicing the hot polonium areas in T-Building. Radioisotopes of concern and their compounds are: [857 858 859]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[860]

6.2.25 Room T-54A, 55A, 55: This area had two functions as discussed below.

a. (1949 - 1958) This area took the dissolved aluminum can residue, which was in a aqueous chloride acid solution form, and sent it to HH Building for processing through a 4-inch pyrex line contained within a 6-foot diameter concrete tunnel. The dissolved bismuth slug residue (also in an aqueous chloride acid solution form) was also sent to HH Building for processing through a separate 4-inch pyrex line contained within the same 6-foot diameter concrete tunnel. Both waste streams had high

degrees of beta and gamma radiation from the irradiated impurities in the aluminum can and in the bismuth metal. Gamma and beta emitting radioisotopes resulting from irradiated impurities in the aluminum can and bismuth include: [861 862 863]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[864]

b. (1958 - 1969) Pumping of the acidic solutions of the aluminum can residue and bismuth slug residue to HH Building was discontinued in 1958. Room 54A contained two large vats which were used for the hydrolysis process exactly like that previously done in HH Building. The sludge was solidified, placed in barrels, and packaged for an off-site burial ground. The aqueous remains were sent to WD Building. Radioisotopes of concern and their compounds are: [865 866 867]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[868]

6.2.26 Room T-57: This room was used for two programs as discussed below.

a. (1949 - 1971) This room was used for the dissolving of the aluminum can with hydrochloric acid. The impurities in the can resulted in gamma and beta emitting radioisotopes. This HCl was drained away and new hydrochloric acid along with nitric acid was used to dissolve the bismuth slug containing polonium-210. Denitration and scrubbing of gases were also done in this room. Radioisotopes of concern and their compounds are: [869 870 871 872 873]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[874]

2) Incident - T-57 (8/28/68, Po-210) [875]

b. (1985 - PRESENT) Hydrogen Isotope Separation System (HISS) is part of the "Tritium Recycle and Enrichment System." Because of the size of the equipment the system extends through the floors up into T-274. It is a tritium enrichment system that employs low-temperature distillation as the separation process. The HISS enriches the tritium and the tritium enriched stream is transferred to the Thermal Diffusion Facility (TDF) in T-59. The distillate is returned to the ERS (later TERF). No waste stream is generated by the HISS. Radioisotopes of concern and their compounds are: [876 877 878]

tritium

6.2.27 Room T-58: This room was used for two programs as discussed below.

a. (1949 - 1969) This is the "basement" to the chemical operations room which is only five feet high. It had no real function except providing access to pipes. There were no radionuclides of concern. [879]

b. (1985 - PRESENT) This room is a lab used for mass spectrometry for inventory purposes, impurity analysis, and high accuracy analysis in support of the tritium program. This room has similar functions as T-41. Radioisotopes of concern and their compounds are: [880 881 882]

tritium

6.2.28 Room T-59: This room has had a variety of functions as discussed below.

a. (1949 - 1969) This room was used for the dissolving of the aluminum can with hydrochloric acid. The impurities in the can resulted in gamma and beta emitting radioisotopes. This Hcl was drained away and new hydrochloric acid along with nitric acid was used to dissolve the bismuth slug containing polonium-210. Denitration and scrubbing were also done in this room. These functions were identical to those done in T-57 during the period 1949-1964. T-59 was emptied and decontaminated in 1971. It was not put back into operation with polonium. Radioisotopes of concern and their compounds are: [883 884 885 886 887]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[888]

b. (1985 - PRESENT) Thermal Diffusion Facility (TDF) is part of the "Tritium Recycle and Enrichment System." No waste stream is generated by this process although raffinate gas is sent to ERS. The radionuclide of concern are: [889 890 891]

tritium uranium-238 tritide

1) Tritium was the major radionuclide of concern with uranium-238 being a distant second.[892]

c. (1985 - PRESENT) This room is also used to open welded containers by a laser operation. [893 894]

tritium

6.2.29 Room T-61, T-61A: This room had two programs as discussed below.

a. (1960 - 1963) This area was used to calibrate the various neutron sources which included polonium-210/beryllium, plutonium-238/beryllium, and plutonium-239/beryllium. Radioisotopes of concern and their compounds include: [895]

polonium-210 plutonium-238,239

a. Polonium-210 was the major radionuclide of concern with plutonium-238 being second and plutonium-239 third.[896]

b. (1964 - 1966) This area was used to store and test the assembled DART and Poodle Thrusters. The polonium-210 was all encapsulated so there was little likelihood of uptakes. Radioisotopes of concern and their compounds are: [897 898 899]

polonium-210

c. (1973 - PRESENT) Tritium Recovery Column (TRC) is part of the "Tritium Recycle and Enrichment System." Low concentrations of tritium mixed with hydrogen gas are sent from TAWRS to a single column cryogenic distillation system. The gas is stored on uranium beds resulting in UT_3 formation. The distillate from the TRC is returned to the TAWRS, and the still bottom is the feedstock to the HISS. There is

no waste stream generated by the TRC system. Radioisotopes of concern and their compounds are: [900 901 902 903]

tritium uranium-238 tritide

1) Tritium was the major radionuclide of concern with uranium-238 being a distant second.[904]

6.2.30 Room T-63

(1973 - PRESENT) Tritium Aqueous Waste Recovery System (TAWRS) is part of the "Tritium Recycle and Enrichment System." It was on line in 1989, but was shut down after 6 months. It has not been in operation since. Since HTO is abundant in this system it represents an area of high uptake possibility. The tritium gas from this process was transferred to the Tritium Recovery Column (TRC). Radioisotopes of concern and their compounds are:[905 906 907 908]

tritium tritiated water

a. Tritiated water was the major radionuclide of concern with tritium gas being secondary.[909]

6.2.31 Rooms T-72, 73, 74, 75 and T-92, 93, 96, 97, 98

(1949 - 1969) These rooms are part of the west filter bank system (E-21 and 22) supporting the polonium operations. Radioisotopes of concern and their compounds are: [910 911 912 913]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a. Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[914]

6.2.32 Room T-99: This room has two functions as discussed below.

a. (1947 - PRESENT) This room houses exhaust fans for a major portion of T-Building. This was part of the original design of the building. Radioisotopes of concern is:[915]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[916]

b. (1984 - PRESENT) Effluent Removal System (ERS), part of the "Tritium Recycle and Enrichment System," is actually located in SW-8 Building but has pipes entering T-Building through T-99 which connect to all tritium processing gloveboxes, vacuum pumps, etc. in T-Building. Radioisotope of concern is: [917] [918] [919]

tritium

6.2.33 Rooms T-100, 102, 103, 104

(1949 - 1969) These rooms are an extension of the west filter bank system (E-31B) supporting the process area on the hot side. This would also include the radionuclide impurities in the air from the dissolving operation. Radioisotopes of concern and their compounds are: [920] [921] [922] [923]

iron-55,59	silicon-31
cobalt-60	lead-209

tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a. Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[924]

b. Rooms T-100 and T-102 are actually used for the exhausting system. T-103 and T-104 are not used but only have the exhausting system passing through these rooms.

c. (1962 - 1972) These rooms were cleaned up and D&D.

d. (1972 - PRESENT) These rooms are support areas for T-61 and T-63. Radionuclide of concern is: [925]

tritium

6.2.34 Room T-208A

(1947 - PRESENT) All of these rooms were used for X-ray and non-destructive inspection and testing in support of production, process engineering, and R&D efforts. [926] [927]

plutonium-238,239	tritium
cobalt-60	iridium-192
iron-55	radium-226
americium-241	cadmium-109
polonium-210	

Note: All these radioisotopes are encapsulated.

a. Tritium was the major radionuclide of concern with plutonium-238 being second and plutonium-239 third.[928]

6.2.35 Room T-229

This room is used for the following functions:

a. (1963 - 1964) This area was used to calibrate the various neutron sources which included polonium-210/beryllium, plutonium-238/beryllium, and plutonium-239/beryllium. Radioisotopes of concern and their compounds include: [929]

polonium-210 plutonium-238,239

1) Polonium-210 was the major radionuclide of concern with plutonium-238 being second and plutonium-239 third.[930]

b. (1978 - 1988) This room was used for the calibration of monitors used in the uranium mill tailing and site surveillance. Special concern was the radon monitoring. A small amount of radium was used as a source and the radionuclides of concern would be all the daughter products of radium-226. [931]

radon-222 polonium-210,214,218
bismuth-214 lead-210,214
radium-226

1) Radium-226 was the major radionuclide of concern with all others a distant second.[932]

c. (1989) Was D&D'd.[933]

d. (1989 - PRESENT) These rooms are used for calorimetry and use only encapsulated radionuclides. Radioisotopes of concern and their compounds are: [934] [935]

plutonium-238,239 (encapsulated)

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [936]

6.2.36 Room T-234: This room had two functions as discussed below.

a. (1947 - 1972) This was a storage area for reagent chemicals in the polonium-210 process. There were no radionuclides of concern.[937]

b. (1988 - PRESENT) This room is used for a tritium processing operation. Radioisotopes of concern and their compounds are: [938]

tritium

c. See Appendix B for ranking.

6.2.37 Room T-236 (dock)

This dock was used for two programs as discussed below.

a. (1949 - 1973) During the Po-210 operation the irradiated bismuth slugs were unloaded here and then stored in the pool in T-237. Radioisotopes of concern and their compounds are: [939] [940]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[941]

b. (1985 - PRESENT) This is a dock where LSA waste is transferred out of T-Building. It is also where plutonium-238,239 (encapsulated) is received and shipped. Radioisotopes of concern and their compounds are:[942] [943] [944]

tritium	plutonium-238,239

uranium-233,235,238 (encapsulated)

1) Tritium was the major radionuclide of concern with plutonium-238 being a distant second and plutonium-239 third.[945]

6.2.38 Room T-237

This room was used for two major programs as discussed below.

a. (1949 - 1971) Room T-237 was the location of the pool where the irradiated bismuth slugs were deposited when received from Hanford, or other reactor sites. The short half-life radionuclides (impurities in aluminum can and in the bismuth slug) lost some of their activity and more importantly more of the bismuth-210 was transformed into polonium-210, thus enriching the slug. Radioisotopes of concern and their compounds are: [946 947 948 949]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[950]

2) Incident - T-237 (9/28/64, Po-210) [951]

b. (1985 - PRESENT) This room is used for packaging, unpackaging, shipping, and receiving of radioactive materials into T-Building. Common tritium items are commercial tritium sales containers and tritium shipping containers. Common plutonium-238 items include products used in heat sources and calorimetry heat standards for calibration. Radioisotopes of concern and their compounds are: [952 953]

tritium plutonium-238 (encapsulated)

1) Tritium was the major radionuclide of concern with plutonium-238 being a distant second.[954]

2) Incident - (Pu-238, 10/17/86)[955]

6.2.39 Room T-238: This room has the following function:

a. (1985 - PRESENT) This room is used for packaging, unpackaging, shipping, and receiving of radioactive materials into T-Building. Common tritium items are commercial tritium sales containers and tritium shipping containers. Common plutonium-238 items include products used in heat sources and plutonium materials used in processing, calorimetry heat standards for calibration. Radioisotopes of concern and their compounds are: [956] [957]

tritium plutonium-238 (encapsulated)

1) Tritium was the major radionuclide of concern with plutonium-238 being a distant second.[958]

2) Incident - (Pu-238, 10/17/86)[959]

6.2.40 Room T-242

This room had a double function for the polonium neutron source program.

a. (1949 - 1964) This room contained a storage pool for the neutron sources produced in T-277 and T-279. Radioisotopes of concern and their compounds are:

polonium-210

1) Incident - T-242 (10/20/60, Po-210) [960]

b. (1949 - 1960) This area was used to calibrate the polonium-210/beryllium neutron sources produced in T-277 and T-279. This calibration procedure was moved to T-61 and later to T-227. Radioisotopes of concern and their compounds include: [961]

polonium-210

6.2.41 Room T-243

This room was used for two functions as discussed below.

a. (1956 - 1982) This room is the second floor of T-5W. See T-5W for the discussion. Radioisotopes of concern and their compounds include: [962]

tritium tritiated water (HTO)

1) Tritiated water is the major radionuclide of concern with tritium gas being secondary.[963]

b. (1987 - FUTURE) The Tritium Effluent Reduction Facility (TERF) is part of the "Tritium Recycle and Enrichment System." It will replace ERS in SW-8 which will no longer function when TERF is fully on line. However, they will both operate until TERF is fully checked out. To date tritium has never been in the TERF system. [964]

6.2.42 Room T-245: This room had two functions as discussed below.

a. (1949 - 1969) This room was used to store spare parts for polonium process operations. All radionuclides were encapsulated. radioisotopes of concern are:[965]

polonium-210

b. (1968 - 1974) This room was used to store plutonium-238 heat sources. All radionuclides were encapsulated. Radioisotope of concern is:

plutonium-238

6.2.43 Room T-246: This room has two functions as discussed below.

a. (1949 - 1972) This room was a "cold" support lab. There were no radionuclides of concern. [966] [967]

b. (1972 - 1980) This lab used laser photo chemistry in the support of tritium control development. Radionuclides are: [968] [969]

tritium

6.2.44 Room T-247

This room had two important functions as discussed below.

a. (1949 - 1958) This room was a research lab. Radioisotopes of concern and their compounds are:[970 971 972 973]

polonium-210

1) See Appendix B.

b. (1958 - 1966) This room was decontaminated and opened to the cold side of T-Building for a new project.[974]

c. (1966 -1969) This room was a fuel metallurgical compatibility lab for the SNAP-29 program where melting points, encapsulation material compatibility studies and related R&D work were done. Radioisotopes and compounds of concern are: [975 976]

polonium-208,209,210 rare earth polonides

1) See Appendix B for ranking.

6.2.45 Room T-248 --> T-259

These rooms had two functions as discussed below.

a. (1949 - 1965) These rooms were part of the Y-Line work which produced a polonium containing component. Radioisotopes of concern and their compounds are:[977 978 979 980]

polonium-210

1) Rooms T-257 and T-258 had induction heaters used primarily for the recovery of polonium from platinum gauzes. The heaters were also used in filling special orders.[981]

2) See Appendix B.

3) Incident - T-251 (11/17/54, polonium-210) [982]

4) Incident - T-254 (5/26/60, polonium-210) [983]

b. (1966 - 1969) These rooms were renovated to be part of the polonium fuels program (SNAP-29) but never went hot. There are no radionuclides of concern.[984] [985]

c. (1972 - 1992) These rooms were used for support of the heat source program and did not contain radionuclides.

d. Room T-257: (1993 - PRESENT) This room is used to store the "Orphan Sources" before being shipped to PP Building, room PP-113. Gamma ray spectroscopy is used to make some determination as to the contents of the sources before shipping to PP Building. No sources are removed from their containers so possibility of an incident is remote. Radionuclides are in the process of being determined. [986] [987] [988]

6.2.46 Room T-260: This room had the following functions:

a. (1949-1969) Microassay Room - This room was used to prepare samples for microassay from the polonium-210 process lines. The samples were then entered into room T-307 through ports in the walls to measure activity. Radioisotopes of concern and their compounds were:

polonium-210

1) See Appendix B.

b. (1966 - 1969) POLONIUM ISOTOPIC FUELS PROGRAM - A portion of the original T-260 was renovated and became the primary room used for the development of the POODLE and SNAP-29 high specific-power isotopic fuel forms for NASA's space program. Polonium was combined with fine particles of rare earth metals (<44 micron) in a porous refractory metal matrix. In addition, rare earth polonides were prepared for property measurements and characterization studies, material compatibility studies, as well as for fuel encapsulation. These compounds were highly pyrophoric. Radioisotopes of concern and their compounds are: [989] [990]

polonium-208,209,210 rare earth polonides

1) See Appendix B for ranking.

2) Incident - T-260 (8/22/68, polonium-210, Box 10) [991]

6.2.47 Room T-266, 267, 268

These rooms were used for several programs as discussed below.

a. (1949 - 1969) This area was used for the polonium processing steps after the initial dissolution and concentration steps. Radioisotopes of concern and their compounds are: [992 993 994 995]

polonium-210 bismuth-209,210

1) Polonium-210 was the major radionuclide of concern with all others a distant second.[996]

2) Room T-266 had high contamination from the changing of the gloves. There were high urine readings of Po-210 from 9/49 - 2/50.[997] polonium (incident-1966)[998]

3) Incident - T-266 (10/30/64, polonium-210, Glovebox #5) [999]

4) See Appendix B.

b. (1963 - 1966) The south side of this room was used temporarily for polonium fuel development for the Poodle Thruster fuel program until the old Y-Lines were renovated. Upon completing the renovation of the Y-Line area all fuel work was discontinued in this room and moved to the designated new areas (T-260, 247). Radioisotopes of concern and their compounds are: [1000]

polonium-208,209,210 rare earth polonides

1) See Appendix B for ranking.

c. (1966 - 1968) This room was renovated as part of the T-Building Modification Project FY-1966 through FY-1968. [1001 1002]

d. (1970 - 1973) This room was decontaminated.

e. (1988 - PRESENT) Tritium Engineering and Development Lab (TEDL) used this room to conduct experiments with new types of tritium concepts, tritium processing hardware, tritium containment concepts and hardware, and tritium instrumentation, isotopic separation processes, new metal hydride pumping concepts, and microballoons used in the fusion program at other DOE sites. A variety of tritiated compounds could be found there along with the uranium beds which are used for the storage of tritium. Radioisotopes of concern and their compounds are:[1003 1004 1005 1006]

tritium uranium-238 tritide

1) Tritium was the major radionuclide of concern with uranium-238 being a distant second.[1007]

2) See Appendix B.

6.2.48 Room T-270

(1949 - 1963) This area was used for the polonium processing steps after the initial dissolution and concentration steps. Radioisotopes of concern and their compounds are: [1008 1009 1010 1011]

polonium-210 bismuth-209,210

a. Polonium-210 was the major radionuclide of concern with all others being a distant second.[1012]

b. Room T-270 had high contamination from the changing of the gloves. There were high urine readings of Po-210 from 9/49 - 2/50.[1013]

c. Incident - T-270 (10/12/67, polonium-210) [1014]

d. See Appendix B.

6.2.49 Room T-274

This room was used for several projects as discussed below:

a. (1948 -1971) This room was used to load the aluminum can containing the bismuth slug into a slanting tube which extended into rooms T-57

and T-59 where the dissolving occurred. The slugs were brought from the pool (T-237) in a shielded container. There was little chance of an uptake although much beta and gamma radiation was received as an external dose. This room also contained the hydrochloric, nitric, and formic acid used in rooms T-57 and T-59. See rooms T-57 or T-59 for possible radionuclides found in the aluminum can and bismuth slug. [1015] [1016]

b. (1966 - 1969) The NW corner of this room was used for the development of new methods of processing the bismuth slugs. Intentions were to get away from the aqueous methodology and gear up for larger quantities of polonium. Radionuclides of concern are those irradiated impurities in the bismuth slug and the aluminum can:[1017]

iron-55,59	cobalt-60
lead-209	zinc-65
chromium-55	gallium-70,72
cesium-137	selenium-75
bismuth-210	antimony-124
tellurium-121-->134?	mercury-203
polonium-208,209,210	tin-121
silicon-31	vanadium-52
strontium-90	silver-112

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1018]

c. (1986 - PRESENT) Hydrogen Isotope Separation System (HISS) is part of the "Tritium Recycle and Enrichment System." Because of the length of the distillation columns the system extends through the floor down into T-57. It is a tritium enrichment system that employs low-temperature distillation as the separation process. The distillate is returned to the ERS. No waste stream is generated by the HISS. Radioisotopes of concern and their compounds are: [1019] [1020]

tritium	uranium-238 tritide

1) Tritium was the major radionuclide of concern with uranium-238 being a distant second.[1021]

6.2.50 Rooms T-275 and T-276

(1949 - 1969) These were the chemical operations rooms where an elevated operating platform was used to access valves and doors by remote operations. This was used to access the operations in T-57 and T-59 and there were usually no radionuclides except when small spills occurred. These two rooms were above the basement room T-58 but below the second floor room T-274. Radioisotopes of concern and their compounds are:[1022 1023 1024 1025]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

a) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1026]

6.2.51 Room T-277 and T-279

These rooms were used for a variety of programs as discussed below.

a. (1949 - 1967) The polonium neutron source program primarily used beryllium, although research was also done with boron, lithium, and other metals. All commercial neutron source work began to be phased out around 1961 although some remained until 1964. Most of the work was moved to the Monsanto, Nicholas Road plant and the Poodle program began to be moved in. Radioisotopes of concern and their compounds are: [1027 1028 1029]

polonium-210	americium-241 [1030]

1) See Appendix B for ranking.

2) Incident - T-277 and 279 (11/27/56, 11/11/60 polonium-210) [1031]

b. (1962 - 1969) This room was also used to pack and ship polonium produced in the P & E lines (T-266 and T-270) to universities and other contractors. Radioisotopes of concern and their compounds are: [1032]

polonium-210

c. (1963 - 1965) The Poodle Heat Source program was located in this room along with work being done in T-260, T-61, and T-61A. Assembly of the Poodle Thruster fuel capsules was accomplished in this area. The polonium-210 heat sources were already encapsulated so that little danger existed from uptakes. The assemblies were then taken to T-61 and T-61A. [1033] [1034]

1) Poodle thruster using polonium-210 was demonstrated in 1965. [1035]

d. (1964 - 1969) A corner of this room was used for the development of new methods of processing the bismuth slugs. Radioisotopes of concern and their compounds include: [1036]

polonium-210 bismuth-209,210

1) Polonium-210 was the major radionuclide of concern with all others being a distant second. [1037]

6.2.52 Room T-300A

This area is used to store the "Orphan Sources" before being shipped to PP Building, room PP-113. Gamma ray spectroscopy is used to make some determination as to the contents of the sources before shipping to PP Building. No source is removed from its container, so possibility of an incident is remote. Radionuclides of concern are uncertain.[1038] [1039] [1040]

6.2.53 Room T-307

This room was used for several functions as discussed below.

a. (1949 - 1964) This room was used for low geometry alpha counters to monitor the purity of the polonium-210 deposition on the platinum

micro-gauzes/foils. All samples entered this room through little ports in the walls. Little opportunity for an incident existed. Radioisotopes of concern and their compounds are: [1041] [1042]

polonium-210

b. (1964 - 1972) This was a bioassay analysis lab where polonium-210 and plutonium-238,239 samples were counted for low level environmental readings.

c. (1972 - 1980) Metals such as tantalum, niobium, and stainless steel were diffused with helium-3 which also may contain trace quantities of tritium. Measurements of the retention of the helium was made in this area. This is considered a cold lab. Radioisotopes of concern and their compounds are: [1043] [1044]

tritium

d. (1980 - PRESENT) This room provides facilities and equipment for the research, development, design, calibration, fabrication, and maintenance of tritium monitors. There was less than 1000 curies in this room at any one time and it was stored in fumehoods. Tritium monitors are tested with all gaseous waste discharged to ERS. Sample preparations of tritium are made in this room. Radioisotopes of concern and their compounds are: [1045]

tritium

6.2.54 Room T-310

This room was used for several functions as discussed below.

a. (1949 - 1969) This room was used as an assay lab for the polonium processing work. Samples were taken from the dissolving chambers (T-57 and T-59) and the P&E Lines (T-266, T-270) and contained radionuclides from the impurities in the aluminum cans and the bismuth as well as polonium. Radioisotopes of concern and their compounds are: [1046] [1047]

iron-55,59	silicon-31
cobalt-60	lead-209

tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-110m,112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1048]

2) This room also contained a storage vault (T-310A) for the processed polonium-210. [1049]

3) Incident - T-310A (12/16/60, polonium-210) [1050]

b. (1969 - 1983) This room is a calorimetric measurement and application facility which contains heat standards and sources. These facilities are used to verify contents for shipping and receiving and to do leak checking. All radionuclides are encapsulated. Radioisotopes of concern and their compounds are: [1051] [1052] [1053]

plutonium-238,239,240,241	promethium-147
uranium-233,235	americium-241
tritium	

1) Plutonium-238 is the major radionuclide of concern with tritium being second and plutonium-239 being third.[1054]

c. (1986 - PRESENT) This room is used for calorimetry and uses only encapsulated radionuclides. Radioisotopes of concern and their compounds are: [1055] [1056]

plutonium-238,239 (encapsulated)

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [1057]

6.2.55 Rooms T-311: This room had several functions as discussed below.

a. (1949 - 1969) This room was used as a lab to prepare (decontaminate) samples from T-310 and make ready for calorimetry which is adjacent to this room. Radioisotopes of concern and their compounds are: [1058] [1059]

polonium-210

1) Incident - T-311 (11/1/67, polonium-210) [1060]

b. (1986 - PRESENT) This room is used for calorimetry and use only encapsulated radionuclides. Radioisotopes of concern and their compounds are: [1061] [1062]

plutonium-238,239 (encapsulated)

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [1063]

6.2.56 Room T-319

(1949 - PRESENT) This room performs calorimetric measurements and contains heat standards and sources. These facilities are used to verify contents for shipping and receiving and to do leak checking. All radionuclides are encapsulated. Radioisotopes of concern and their compounds are:[1064] [1065] [1066]

plutonium-238,239,240,241	promethium-147
uranium-233,235	americium-241
tritium	

a. Plutonium-238 is the major radionuclide of concern with tritium being second and plutonium-239 being third.[1067]

6.2.57 The following room-floors have a high "fixed" radiation potential because of pipes and sumps from the old polonium program. These include T-43, T-44, T-48, T-50, T-57, T-58, T-59, and corridor-51. The radioisotopes of concern in this area are:[1068]

cobalt-60	cesium-137

strontium-90

a. Cobalt-60 is the major radionuclide of concern with cesium-137 being second and strontium-90 third.[1069]

b. Incident - T-Corridor-20 (10/20/61, Po-210) [1070]

6.2.58 See Appendix B for T-Building rooms T-1W, 2W, 4E, 36, 36A, 48, 49, 50, 234, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 266, 267, 268, 269, 270, 271, 277, 279.

7. WD AND WDA BUILDINGS

7.1 WD OVERVIEW

WD Building became operational in February of 1949 and is the central facility for the treatment of liquid radioactive wastes at Mound. A low level alpha waste water system existed from its inception with alpha waste water sources being SW, R, PP, SM, HH, T, B, and H Buildings. The alpha waste water was pre-treated for solid waste/sludge before arriving at WD Building when SM and PP were operational. The pretreatment has been discontinued. Upon arriving at WD Building the waste water is precipitated, coagulated, filtered, and the sludge is solidified so it can be shipped off-site. The supernatant from the clarifloculator is filtered, neutralized to the proper pH, monitored to ensure below standard, and released into the Great Miami River. [1071]

All references to plutonium-238 was of the mixture ratio identified below. This mixture also included trace amounts of americium-241 and neptunium-237, uranium-234.[1072] This information was obtained from MLM-1564 (AEC Research and Development Report), page 31.

1E-4% Pu-236
80.2% Pu-238
15.9% Pu-239
3.0% Pu-240
0.6% Pu-241
0.1% Pu-242

Note: MLM-1564 also makes reference to other mixtures.

Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241. [1073]

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation.

All radionuclides are ranked according to the degree of concern for uptake and amount of activity for internal dosimetry considerations. Rooms which are referenced to Appendix B for additional radionuclides do not have a ranking in this manual since the ranking is done in Appendix B where all radionuclides are listed. This situation is identified as "see Appendix B for ranking." Rooms where additional information on processing or radionuclides in Appendix B does not effect the ranking are identified as "see Appendix B" only.

7.2 WDA OVERVIEW

The WDA alpha waste water treatment facility was constructed in 1966 as an annex onto the WD Building for the treatment of plutonium waste water from the SM and PP Buildings. The facility was designed as both a high-risk drumming station and a low-risk waste water treatment system. The WDA facility replaced the waste treatment facility in SM-1. In August of 1967, the low-risk waste water facility was first used in conjunction with the WTS (Waste Transfer System) pipeline. The high-risk portion of the pipeline was not operational until April 1968. In 1970, the WDA facility was placed in standby status when the polonium operations diminished in activity and the larger WD facility was renovated for the treatment of plutonium waste water.

The Beta Waste water Treatment System began in 1967 with the tritiated waste water sources being SW, R, and HH Buildings. A simple process was used which blended the tritiated water with raw water such that the final concentration was below the acceptable level. This waste water was discharged into disposal pipes where further dilution resulted from other non-tritiated streams uniting in the same disposal pipe as all was transferred to the Great Miami River. This method of disposal terminated in 1971 when a tanker truck loading facility became operational and hauled the tritium waste water to an off-site disposal site. [1074]

In March of 1973 the beta treatment system became operational using ceramic tile pipes. Low-level tritium-contaminated liquid wastes, primarily from shower and decontamination operations in the SW and T-Buildings, are transported to the WDA facility. In about 1977 the pipes were changed to doubly enclosed above ground pipelines. Solidification of all beta waste water in 55-gallon drums is done which is then shipped off-site. [1075]

Table 7 is a summary of rooms, dates, and radioisotopes for WD Building.

Table 7 - WD/WDA BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
WD-1, 8, 101, 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.	1949-1958
	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 radioisotopes, 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-238(D,T), U-235,238,239, Pu-238,239 Am-241, Rn-222, Po-208,209,210,214,218 & Po-210 daughters, Bi-210,214, Pb-210,214, Ra-223,224,226 & Ra daughters, U(D,T), Li(D,T), U/Al(D,T).	1973-PRES
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

Table 7 - WD/WDA BUILDING

ROOMS	RADIONUCLIDES AND RELATED COMPOUNDS	DATES USED
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 $Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, PuO_2, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, $Pu(OH)_4$, PuF_4, $PuCl_4$, (also nitrate, sulfate, and fluoride compounds of Am-241, Np-237, and U-234)	1966-1970
	H-3	1967-PRES
WDA-112	Pu-236,238,239,240,241 $Pu(NO_3)_4.5H_2O$, $Pu(NO_3)_6$, PuO_2, $Pu(C_2O_4)_4$, $Pu(O_2).5H_2O$, $Pu(OH)_4$, PuF_4, $PuCl_4$, (also nitrate, sulfate, 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-PRES
WD-PENT-HOUSE	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-PRES

Note: All references to plutonium-238 was of the mixture ratio identified in the introduction to WD Building above. This mixture also included trace amounts of americium-241, neptunium-237, and uranium-234. Plutonium-239 used in the various projects was over 95% pure with trace amounts of plutonium-240,241.[1076]

Note: Polonium was no longer processed after 1973.

7.3 RADIONUCLIDES ASSOCIATED WITH SPECIFIC ROOMS

7.3.1 Room WD-1

This room contained the sand filters for water leaving the chlarifloculators in the polonium water treatment process. The treated waste water was then sent to the effluent tanks where, after monitoring for activity, was released to the Great Miami River. 1980 two "bone-char" column filters were installed in this room along with 1-micron high filtering system used to ensure proper effluent waste water. The sludge from the chlarifloculators was also drummed in this room. Because of the drumming operations this room was also highly contaminated. Radioisotopes of concern and their compounds are:

a. (1949-1958) This is the location for the polonium water treatment coming from T-Building. Radioisotopes of concern were/are: [1077] [1078] [1079]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1080]

2) The northern side of WD building was contaminated by an overflow of WD influent tanks containing polonium 210 and cobalt-60. [1081]

b. (1949 - 1990) Aqueous waste from operations in R and SW Buildings also contained a multitude of radionuclides. Decontamination operations of plutonium facilities are also responsible for alpha waste water. Radionuclides from aqueous waste include the following: [1082]

americium-241	protactinium-231
actinium-227	radium-223,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium bromide	actinium fluoride
potassium-40	barium nitrate
uranium-234,235,238	plutonium-238,239 (plus others)
polonium-208,209,210	neptunium-237
tritium	rare earth isotopes
uranium oxide	tellurium-121-->134?
uranium-234,235,238	iron-55,59
tritiated octane	cesium-137
cobalt-60	strontium-90

1) Polonium-210 was the major radionuclide of concern with tritium and plutonium-238 being equally a secondary concern. Actinium-227 and protactinium-231 would be equally a distant third.[1083]

2) Note: Major processing of actinium ceased by 1953 but clean-up continued until 1960.

3) See Appendix B.

c. (1955) A pilot project for the thorium-232 (Monex process) program was initiated in the spring of 1955 but was cancelled in May, 1955. Although some thorium sludge (Brazilian Monazite) was placed in WD Building, no processing was done. Possible radionuclides of concern, if leaking occurred were: [1084 1085 1086]

thorium-228,232	radium-224,228
uranium-238	

1) Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. [1087]

2) The thorium sludge was removed in the first quarter of 1956.[1088]

d. (1961 - 1974) Operations in the SM Building resulted in low level aqueous wastes consisting of plutonium-bearing ACIDIC solutions which included nitric and hydrofluoric acids. Other constitutes include hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. BASIC waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Radionuclides contained in the plutonium mixture received from SRP such as Am-241, Np-237, and U-234 were in the form of cations. Anions of nitrate, sulfate, and fluoride were also present which often formed compounds with the radionuclides. [1089]

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary. [1090]

2) See Appendix B.

e. (1974 - 1979) Acid waste from the processing of Cotter Concentrate was sent to WD Building by a waste line and also transported by drum. Radioisotopes of concern and their compounds are: [1091] [1092]

thorium-230,232	uranium-234,235,238
plutonium-238,239	radium-223,224,226
actinium-227	protactinium-231

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity. [1093]

c. (1980 - PRESENT) Two tanks used for bone-char filtration were installed in this room along with another "high filtering system used to ensure proper effluent waste water.

7.3.2 Room WD-8

This room, along with WD-101, was the main facility for waste water treatment. Two 60,000 gallon chlarifloculator tanks used for processing extended through the floor of WD-101 into the basement which is WD-8. This room also contained the pump for putting the chemicals used for treatment into chlarifloculators. Pumps for removing the sludge from the chlarifloculators are also located there. The following major programs were supported by these rooms:

a. (1949-1958) This is the location for the polonium water treatment coming from T-Building. Radioisotopes of concern were/are: [1094] [1095] [1096]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1097]

2) The northern side of WD building was contaminated by an overflow of WD influent tanks containing polonium 210 and cobalt-60. [1098]

b. (1949 - 1990) Aqueous waste from operations in R and SW Buildings also contained a multitude of radionuclides. Decontamination operations of plutonium facilities are also responsible for alpha waste water. Radionuclides from aqueous waste include the following: [1099]

americium-241	protactinium-231
actinium-227	radium-223,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium bromide	actinium fluoride

potassium-40	barium nitrate
uranium-234,235,238	plutonium-238,239 (plus others)
polonium-208,209,210	neptunium-237
tritium	rare earth isotopes
uranium oxide	tellurium-121-->134?
uranium-234,235,238	iron-55,59
tritiated octane	cesium-137
cobalt-60	strontium-90

1) Polonium-210 was the major radionuclide of concern with tritium and plutonium-238 being equally a secondary concern. Actinium-227 and protactinium-231 would be equally a distant third.[1100]

Note: Major processing of actinium ceased by 1953 but clean-up continued until 1960.

2) See Appendix B.

c. (1955) A pilot project for the thorium-232 (Monex process) program was initiated in the spring of 1955 but was cancelled in May, 1955. Although some thorium sludge (Brazilian Monazite) was placed in WD Building, no processing was done. Possible radionuclides of concern, if leaking occurred were: [1101] [1102] [1103]

thorium-228,232	radium-224,228
uranium-238	

1) Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. [1104]

2) The thorium sludge was removed in the first quarter of 1956.[1105]

d. (1961 - 1974) Operations in the SM Building resulted in low level aqueous wastes consisting of plutonium-bearing ACIDIC solutions which included nitric and hydrofluoric acids. Other constitutes include hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. BASIC waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Radionuclides contained in the plutonium mixture received from SRP such as Am-241, Np-237, and U-234 were in the form

of cations. Anions of nitrate, sulfate, and fluoride were also present which often formed compounds with the radionuclides. [1106]

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary. [1107]

2) See Appendix B.

e. (1974 - 1979) Acid waste from the processing of Cotter Concentrate was sent to WD Building by a waste line and also transported by drum. Radioisotopes of concern and their compounds are: [1108] [1109]

thorium-230,232	uranium-234,235,238
plutonium-238,239	radium-223,224,226
actinium-227	protactinium-231

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity. [1110]

7.3.3 Room WDA-9

(1973 - PRESENT) This room had the pumps for the two influent holding tanks for tritium waste water. This tritium waste water was sent to WDA-110 for solidified and drumming for off-site deposition. Radionuclides of concern are: [1111]

radon-222	polonium-208,209,210,214,218
bismuth-210,214	lead-210,214
radium-223,224,226	uranium tritide
tritium	uranium-235,238,239

plutonium-238,239	lithium tritide
americium-241	aluminum/uranium tritide
polonium-210 daughters	radium daughters
any radionuclide used in T and SW Bldg.	

a. Tritium is the major radionuclide of concern with any others be a distant second. Residuals are possible as evidenced by the plutonium incident. [1112]

7.3.4 Room WDA-10

(1961 - 1974) This room had two 400 gallon holding tanks for high level influent coming from SM and PP Buildings by way of the pumping station in Building 42. Operations in the SM Building resulted in aqueous wastes consisting of high activity, plutonium-bearing ACIDIC solutions which included nitric and hydrofluoric acids. Other constitutes include hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. BASIC waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Radionuclides contained in the plutonium mixture received from SRP such as Am-241, Np-237, and U-234 were in the form of cations. Anions of nitrate, sulfate, and fluoride were also present which often formed compounds with the radionuclides. This room was used to solidify and drum the waste. Radionuclides of concern are: [1113]

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

a. Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary. [1114]

b. This room was highly contaminated and often necessitated bubble suit use because of leaking drums and splattering of waste. Vapors carried

radionuclides all over the room. A corncobb absorbant was used for most of this period of time and the waste would settle out in the bottom of the drums. A plastic liner was used in the metal drums but would often tear. The acidic waste would quickly corrode the drum and leaking was common. Polyethylene drums were later used. This room was a mess![1115]

c. A high risk filter bank was also located in this room. It is still needed because this room is so hot.

7.3.5 Room WD-101

This room along with WD-8 was the main facility for waste water treatment. Two 60,000 gallon chlarifloculator tanks used for processing extended through the floor of WD-101 into the basement which is WD-8. This room also contained the inffluent tanks used for receiving the waste water, and then through chemicals pumped in from WD-8 and aggitation, the water was treated before being sent to the chlarifloculators for precipitation. The following major programs were supported by these rooms:

a. (1949-1958) This is the location for the polonium water treatment coming from T-Building. Radioisotopes of concern were/are: [1116] [1117] [1118]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1119]

2) The northern side of WD building was contaminated by an overflow of WD influent tanks containing polonium 210 and cobalt-60. [1120]

b. (1949 - 1990) Aqueous waste from operations in R and SW Buildings also contained a multitude of radionuclides. Decontamination operations of plutonium facilities are also responsible for alpha waste water. Radionuclides from aqueous waste include the following: [1121]

americium-241	protactinium-231
actinium-227	radium-223,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium bromide	actinium fluoride
potassium-40	barium nitrate
uranium-234,235,238	plutonium-238,239 (plus others)
polonium-208,209,210	neptunium-237
tritium	rare earth isotopes
uranium oxide	tellurium-121-->134?
uranium-234,235,238	iron-55,59
tritiated octane	cesium-137
cobalt-60	strontium-90

1) Polonium-210 was the major radionuclide of concern with tritium and plutonium-238 being equally a secondary concern. Actinium-227 and protactinium-231 would be equally a distant third.[1122]

Note: Major processing of actinium ceased by 1953 but clean-up continued until 1960.

2) See Appendix B.

c. (1955) A pilot project for the thorium-232 (Monex process) program was initiated in the spring of 1955 but was cancelled in May, 1955. Although some thorium sludge (Brazilian Monazite) was placed in WD Building, no processing was done. Possible radionuclides of concern, if leaking occurred were: [1123] [1124] [1125]

thorium-228,232	radium-224,228
uranium-238	

1) Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. [1126]

2) The thorium sludge was removed in the first quarter of 1956.[1127]

d. (1961 - 1974) Operations in the SM Building resulted in low level aqueous wastes consisting of plutonium-bearing ACIDIC solutions which included nitric and hydrofluoric acids. Other constitutes include hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. BASIC waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Radionuclides contained in the plutonium mixture received from SRP such as Am-241, Np-237, and U-234 were in the form of cations. Anions of nitrate, sulfate, and fluoride were also present which often formed compounds with the radionuclides. [1128]

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary. [1129]

2) See Appendix B.

e. (1974 - 1979) Acid waste from the processing of Cotter Concentrate was sent to WD Building by a waste line and also transported by drum. Radioisotopes of concern and their compounds are: [1130] [1131]

thorium-230,232	uranium-234,235,238
plutonium-238,239	radium-223,224,226
actinium-227	protactinium-231

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity. [1132]

7.3.6 Room WD-104

(1949 - PRESENT) This is the lab for monitoring of waste water effluents and treatment processes. Radionuclides of concern are:

a. (1949-1958) This is the location for the polonium water treatment coming from T-Building. Radioisotopes of concern were/are: [1133] [1134] [1135]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate

1) Polonium-210 is the major radionuclide of concern with zinc-65 being a distant second. All others are a distant third.[1136]

2) The northern side of WD building was contaminated by an overflow of WD influent tanks containing polonium 210 and cobalt-60. [1137]

b. (1949 - 1990) Aqueous waste from operations in R and SW Buildings also contained a multitude of radionuclides. Decontamination operations of plutonium facilities are also responsible for alpha waste water. Radionuclides from aqueous waste include the following: [1138]

americium-241	protactinium-231
actinium-227	radium-223,226
actinium oxide	actinium nitrate
actinium oxalate	thorium-228,229,230
actinium bromide	actinium fluoride
potassium-40	barium nitrate
uranium-234,235,238	plutonium-238,239 (plus others)
polonium-208,209,210	neptunium-237
tritium	rare earth isotopes
uranium oxide	tellurium-121-->134?

uranium-234,235,238	iron-55,59
tritiated octane	cesium-137
cobalt-60	strontium-90

1) Polonium-210 was the major radionuclide of concern with tritium and plutonium-238 being equally a secondary concern. Actinium-227 and protactinium-231 would be equally a distant third.[1139]

2) Note: Major processing of actinium ceased by 1953 but clean-up continued until 1960.

3) See Appendix B.

c. (1955) A pilot project for the thorium-232 (Monex process) program was initiated in the spring of 1955 but was cancelled in May, 1955. Although some thorium sludge (Brazilian Monazite) was placed in WD Building, no processing was done. Possible radionuclides of concern, if leaking occurred were: [1140] [1141] [1142]

thorium-228,232	radium-224,228
uranium-238	

1) Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. [1143]

2) The thorium sludge was removed in the first quarter of 1956.[1144]

d. (1961 - 1974) Operations in the SM Building resulted in low level aqueous wastes consisting of plutonium-bearing ACIDIC solutions which included nitric and hydrofluoric acids. Other constitutes include hydroxylamine, sodium carbonate, ferrous sulfamate, and sodium hydroxide used in leaching and dissolution processes. BASIC waste was generated when ammonium hydroxide was used to precipitate plutonium from the solution. Radionuclides contained in the plutonium mixture received from SRP such as Am-241, Np-237, and U-234 were in the form of cations. Anions of nitrate, sulfate, and fluoride were also present which often formed compounds with the radionuclides. [1145]

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate

plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary. [1146]

2) See Appendix B.

e. (1974 - 1979) Acid waste from the processing of Cotter Concentrate was sent to WD Building by a waste line and also transported by drum. Radioisotopes of concern and their compounds are: [1147] [1148]

thorium-230,232	uranium-234,235,238
plutonium-238,239	radium-223,224,226
actinium-227	protactinium-231

1) Thorium-230 was the major radionuclide of concern with over 95% of the activity. [1149]

7.3.7 Room 107 and basement

(1976 - 1981) This area used an ultra filtration concept and sometimes reverse osmosis to remove the following radioisotopes from waste water. This was a historical operation which has been discontinued. The equipment has been dismantled and removed. [1150] [1151]

cesium-137	americium-241
uranium-235,238	neptunium-237

a. These were all in trace amounts and are of equally little concern.[1152]

7.3.8 Room WD-108

(1949 - 1981) This room had a stack with filter which was highly contaminated. It was removed in 1981. Radionuclides of concern are:

uranium-234	americium-241
neptunium-239	plutonium-236,238,239,240,241,242
plutonium dioxide	plutonium nitrate
plutonium sulfate	plutonium fluoride
americium oxide	americium nitrate
americium sulfate	americium fluoride
neptunium oxide	neptunium nitrate
neptunium sulfate	neptunium fluoride
uranium oxide	uranium nitrate
uranium sulfate	uranium fluoride

7.3.9 Room WD-110

This room had the following functions:

a. Room WDA-110 (1966 - 1970) The WDA alpha waste water treatment facility replaced the low-risk waste treatment facility in SM-1 in August of 1967. The facility was designed as both a high-risk drumming station and a low-risk waste water treatment system for PP Building. The high-risk waste water treatment became operational in April 1968. In 1970 the WDA facility ceased its alpha waste water operations with the larger WD facility having been renovated for the treatment of plutonium waste water. Radioisotopes and compounds of concern are: [1153] [1154]

plutonium nitrate pentahydrate	plutonium-hydroxide
plutonium-hexanitrate	plutonium-nitrate
plutonium-dioxide	plutonium-oxide hydrate
(high-fired and non-high-fired)	
plutonium-tetrachloride	
plutonium-tetrafluoride	

(also nitrate, sulfate, and fluoride compounds of Am-241, Np-237, and U isotopes)

b. Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [1155]

7.3.10 Room WDA-110

(1967 - PRESENT) The Beta Waste water Treatment System began in 1967 with the low-level tritium contaminated liquid wastes from shower and decontamination operations in the SW Building being transported to the WDA facility in doubly enclosed above ground pipelines. Drums of liquid waste water from T-Building comes to WDA. The tritiated water was diluted with raw water such that the final concentration was below the acceptable level. This beta waste water was discharged into disposal pipes to the Great Miami River. This method of disposal terminated in 1971 when a tanker truck loading facility became operational and hauled the tritium waste water to an off-site disposal site. In March of 1973 all beta waste water was solidified in 55-gallon drums and then was shipped off-site. Radioisotopes of concern and their compounds are: [1156]

tritium

a. See Appendix B for ranking.

7.3.11 Room WDA-112

Two major phases of analytical work were done for the separation of radioisotopes from the waste water.

a. (1966 - 1979) Much work was done with Pu-238 and Pu-239 in development of techniques for separation of these radioisotopes from waste water. Additional radioisotopes were also encountered. Radioisotopes of concern were: [1157]

plutonium-236,238,239,240,241,242	polonium-210
plutonium nitrate pentahydrate	iodine-131
plutonium-hexanitrate	plutonium-nitrate
plutonium-dioxide	plutonium-oxide hydrate
(high-fired and non-high-fired)	plutonium-hydroxide
plutonium-tetrachloride	uranium-232,234,238
plutonium-tetrafluoride	cobalt-60

(also nitrate, sulfate, and fluoride compounds of Am-241, Np-237, and U-234)

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [1158]

2) Incident - (Pu-238, 8/1/77)[1159]

b. (1980 - 1984) (perhaps some time before 1980) much work was done with cesium-137 in separation techniques from waste water. A major spill occurred during this time with this radioisotope. Radioisotope of concern is: [1160]

cesium-137

7.3.12 Room WDA-113

(1979 - 1994) This room was used for the storage of radionuclides used in analytical work. These radionuclides were part of the Orphan Source program which were removed in 1994. Radioisotopes of concern were: [1161 1162 1163]

cesium-137	cobalt-60
iodine-131	plutonium-238,239

a. Plutonium-238 was the major radionuclide of concern with cesium-137 being second. [1164]

7.3.13 Room WDA 118 A&B

This room is used for incineration of waste. Two programs were initiated as discussed below. Two Cyclone incinerators were used to burn waste.

a. (1977 - 1981) WDA-118A: A laboratory scale Cyclone incinerator was used to perform tests by spiking the waste before burning. Less than 10 mCi of radioactive material was purchased to be used in the testing. The incinerator was removed in 1981. Radioisotopes of concern and their compounds are: [1165]

cobalt-60	cesium-137
iodine-131	strontium-90

1) All are equally of little concern. [11661167]

b. (1975 - 1985) WDA-118B: A large Cyclone incinerator was actually used to burn wastes for two years in addition to testing. Most work was done

with plutonium although one set of experiments were conducted using tritium. The incinerator was removed in 1990. Radioisotopes of concern and their compounds are: [1168]

plutonium-238,239 tritium

1) Plutonium-238 was the major radionuclide of concern with plutonium-239 being second. [1169]

c. (1981 - PRESENT) Room 111B contains a "glass-melter furnace" which consumes ion-exchange resins and scintillation fluid. This system is in place but is not currently in operation. Some of the radionuclides of concern would be: [1170] [1171] [1172]

cobalt-60	cesium-137
manganese-54	strontium-90

1) All were of equal importance. [1173]

7.3.14 Room WD-Penthouse

(1949 - PRESENT) This area houses the filterbank for WD and WDA Buildings. Any radionuclide in the building is likely to have found its way up to the penthouse. Radionuclides of concern are:[1174]

thorium-230,232	uranium-234,235,238
plutonium-238,239	radium-223,224,226,228
actinium-227	protactinium-231
cesium-137	americium-241
neptunium-237	tritium
polonium-208,209,210	tellurium-121-->134?
cobalt-60	iron-55,59
strontium-90	

a. Incident - (Pu-238, 11/12/75)[1175]

7.3.15 Tanks/WDA

Incident - (Pu-238, 5/26/72)[1176]

7.3.16 Cleaning of tanks and equipment in WD Building occurred several times as discussed below which would give opportunity for incidents and uptakes. Radionuclides of concern could have been any of the above, especially those mentioned with WD-1 and WD-101.[1177] [1178]

a. (1953) WD Influent Tanks / Tank "A": Decontamination of actinium in this tank was started in March, 1953. [1179]The Tank A was completed in May, 1953 and the decontamination work on tank B was started in May, 1953. [1180]Tank B was completed in July, 1953 and Tank C was started in July, 1953.[1181]

b. (1954) The overflow tanks on the sand filters were cleaned in 1954.

c. (1956) The clariflocculator tanks were emptied, cleaned, and painted.

d. (1958) The influent tanks were again cleaned and repaired.

e. (1964) The large influent tanks were sandblasted and painted along with the clariflocculators.

8. ENDNOTES AND REFERENCES

Note: The dates given here represent the date the person was contacted, and not when he was employed.

1. Paul Lamberger, 10/93, Specialist, Senior-1

2. William Eckenrode, 8/93, Master Engineering Technician for HH Building

3. Paul Lamberger, 10/93, Specialist, Senior-1

4. Reed Watkins, 2/94, Retired, HH Building Employee

5. Dick Vallee, 3/94, Vice President EG&G Mound

6. William Eckenrode, 8/93, Master Engineering Technician for HH Building

7. Dave Jones, 2/94, Research Technician in HH Building

8. Reed Watkins, 2/94, Retired, HH Building Employee

9. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

10. William Eckenrode, 8/93, Master Engineering Technician for HH Building

11. Charles Eck, 2/94, Retired 1975

12. Dave Jones, 2/94, Research Technician

13. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;75

14. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 8.

15. Memo on 1/1/56 discussing Pa-231 separation being set up in HH Building.

16. Quarterly Health Physics Report, October through December 1956, 1/15/57, page 10.

17. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

18. Joe Garner, 1/94, Supervisor Health Physics

19. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;58-60

20. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 7.

21. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 4, 7.

22. Separation of Protactinium from Uranium Residues, Murrell Salutsky, Kenneth Shaver, Andrew Elmlinger, Mary Lou Curtis, Journal of Inorganic Nuclear Chemistry, Pergamon Press Ltd., London, 1956, Vol. 3, page 289-295.

23. Paul Figgins, 11/93, Senior Research Specialist

24. Ranking was by Paul Figgins, 1/95

25. William Eckenrode, 8/93, Master Engineering Technician for HH Building

26. Paul Lamberger, 10/93, Specialist, Senior-1

27. Reed Watkins, 2/94, Retired, HH Building Employee

28. Dick Vallee, 3/94, Vice President EG&G Mound

29. William Eckenrode, 8/93, Master Engineering Technician for HH Building

30. Dave Jones, 2/94, Research Technician in HH Building

31. Reed Watkins, 2/94, Retired, HH Building Employee

32. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

33. William Eckenrode, 8/93, Master Engineering Technician for HH Building

34. Charles Eck, 2/94, Retired 1975

35. Dave Jones, 2/94, Research Technician

36. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;75

37. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 8.

38. Memo on 1/1/56 discussing Pa-231 separation being set up in HH Building.

39. Quarterly Health Physics Report, October through December 1956, 1/15/57, page 10.

40. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

41. Joe Garner, 1/94, Supervisor Health Physics

42. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;58-60

43. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 7.

44. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 4, 7.

45. Separation of Protactinium from Uranium Residues, Murrell Salutsky, Kenneth Shaver, Andrew Elmlinger, Mary Lou Curtis, Journal of Inorganic Nuclear Chemistry, Pergamon Press Ltd., London, 1956, Vol. 3, page 289-295.

46. Paul Figgins, 11/93, Senior Research Specialist

47. Ranking was by Paul Figgins, 1/95

48. Paul Lamberger, 10/93, Specialist, Senior-1

49. CERCLA, Vol. 7, Waste Management, Weston Inc., 7/92, page 2;6-9

50. Paul Lamberger, 11/93, Specialist, Senior-1

51. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

52. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/63, page 8

53. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

54. CERCLA, Vol. 7, Waste Management, Weston Inc., 7/92, page 2;6-8

55. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

56. Dick Vallee, 3/94, Vice President EG&G Mound

57. Reed Watkins, 2/94, Retired, HH Building Employee

58. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

59. Reed Watkins, 2/94, Retired, HH Building Employee

60. Paul Lamberger, 10/93, Specialist, Senior-1

61. CERCLA, Vol. 7, Waste Management, Weston Inc., 7/92, page 2;6-9

62. Paul Lamberger, 11/93, Specialist, Senior-1

63. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

64. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/63, page 8

65. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

66. CERCLA, Vol. 7, Waste Management, Weston Inc., 7/92, page 2;6-8

67. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

68. Dick Vallee, 3/94, Vice President EG&G Mound

69. Reed Watkins, 2/94, Retired, HH Building Employee

70. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

71. Paul Figgins, 11/93, Senior Research Specialist

72. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

73. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

74. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

75. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

76. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

77. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

78. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

79. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

80. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

81. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

82. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

83. Dick Colvin, 1/94, Analytical Technician

84. Ronald Sohn, 1/94, Previous PP Building Manager

85. Ronald Sohn, 1/94, Previous PP Building Manager

86. Incident #462 - Colvin, Dick., 4/6/87, Pu-239, 240, PP-113

87. Ronald Sohn, 1/94, Previous PP Building Manager

88. Toby Elswick, 6/95, Manager Plutonium Operations / Tritium Production

89. Toby Elswick, 6/95, Manager Plutonium Operations / Tritium Production

90. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

91. Ron Daily, 6/95, Manager of Radiological Instrumentation

92. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

93. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

94. Ernest Johnson, 10/93, Specialist, Heat Source Production

95. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

96. Ernest Johnson, 10/93, Specialist, Heat Source Production

97. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Operations

98. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Operations

99. Ernest Johnson, 10/93, Specialist, Heat Source Production

100. Ernest Johnson, 10/93, Specialist, Heat Source Production

101. Don Rogers, 9/93, Senior Fellow

102. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

103. Ernest Johnson, 10/93, Specialist, Heat Source Production

104. Toby Elswick, 11/93, Manager Plutonium Operations / Tritium Production

105. Don Rogers, 9/93, Senior Fellow

106. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

107. Toby Elswick, 6/95, Manager Plutonium Operations / Tritium Production

108. Toby Elswick, 6/95, Manager Plutonium Operations / Tritium Production

109. Don Rogers, 9/93, Senior Fellow

110. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Operations

111. Ernest Johnson, 10/93, Specialist, Heat Source Production

112. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Operations

113. Toby Elswick, 10/93, Manager Plutonium Operation / Tritium Production.

114. Paul Figgins, 11/93, Senior Research Specialist

115. Toby Elswick, 10/93, Manager Plutonium Operation / Tritium Production.

116. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

117. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

118. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

119. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

120. Toby Elswick, 8/93, Manager Plutonium Operations / Tritium Production

121. Ernest Johnson, 10/93, Specialist, Heat Source Production

122. Paul Figgins, 11/93, Senior Research Specialist

123. MLM-1564, AEC Research and Development Report, page 31

124. Tom Flanagan, 9/93, Specialist ES&H

125. Don Hobrock, 10/93, Senior Fellow

126. Doug Draper, 10/93, Manager RAM

127. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

128. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

129. MLM-MU-59-62-0001, Quarterly Health Physics Report, October through December 1958, 2/2/59, page 8.

130. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 9.

131. Tom Flanagan, 1/94, Specialist ES&H

132. Earl Johns, 2/94, Supervisor of Tritium System Operations

133. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

134. Incident #584 - Murphy, E., 4/10/58, tritium, R-105
No incident # - Phillips, Robert, 8/8/60, tritium, R-105
" - Barnett, D., 6/11/62, " "

135. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 221-222

136. Tom Flanagan, 1/94, Specialist ES&H

137. Jack Melke, 2/94, Senior Development Engineer

138. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

139. Joe Garner, 1/94, Supervisor Health Physics

140. Earl Johns, 2/94, Supervisor of Tritium System Operations

141. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 203-208

142. Tom Flanagan, 1/94, Specialist ES&H

143. Earl Johns, 2/94, Supervisor of Tritium System Operations

144. MLM-MU-59-64-0001, Quarterly Health Physics Report, January through March 1959, 4/29/59, page 4.

145. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

146. Earl Johns, 2/94, Supervisor of Tritium System Operations

147. Tom Flanagan, 1/94, Specialist ES&H

148. Paul Figgins, 2/94, Senior Research Specialist

149. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

150. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 208-214

151. Dave Billing, 2/94, Manager of SW Building

152. Earl Johns, 2/94, Supervisor of Tritium System Operations

153. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

154. Joe Garner, 1/94, Supervisor Health Physics

155. Paul Figgins, 2/94, Senior Research Specialist

156. Ralph Watrous, 4/94, Chemist

157. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

158. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

159. MLM-821, Health Physics Monthly Information Report, 2/28/53, page 4.

160. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

161. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

162. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

163. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

164. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

165. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 222-224

166. Tom Flanagan, 1/94, Specialist ES&H

167. Albert Attalla, 2/94, Analytical Specialist

168. Albert Attalla, 2/94, Analytical Specialist

169. Joe Garner, 1/94, Supervisor Health Physics

170. Paul Figgins, 2/94, Senior Research Specialist

171. MLM-736, Health Physics Information Report, 7/31/52, page 5.

172. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

173. Ralph Watrous, 4/94, Chemist

174. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

175. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

176. Incident, 7/22/52, Watrin, Joe Garner, T. Eyles, Actinium-227, R-114

177. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

178. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

179. Tom Flanagan, 9/93, Specialist ES&H

180. Paul Figgins, 9/93, Senior Research Specialist

181. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

182. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 220-221

183. Tom Flanagan, 1/94, Specialist ES&H

184. Mike Deaton, 1/94, Function Testing Supervisor

185. Jack Melke, 2/94, Senior Development Engineer

186. Joe Garner, 1/94, Supervisor Health Physics

187. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 8.

188. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

189. Incident #519, 8/19/60, Charles Wells, Pu&Be-13, R-116A
Incident #336, 7/19/61, Charles Wells, Pu&Be-13, R-116B

190. Memo on 3/22/56 discusses the use of Pu-238 in room R-116

191. Martin Hertz, 4/94, Senior Research Chemist

192. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

193. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 220-221

194. Don Rogers, 2/94, Senior Fellow

195. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

196. Calvin Love, 2/94, Senior Research Specialist

197. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 222-224

198. Albert Attalla, 2/94, Analytical Specialist

199. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

200. Don Rogers, 2/94, Senior Fellow

201. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

202. MLM-1044, Quarterly Health Physics Report, January through March 1955, 4/12/55, page 6.

203. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

204. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 7.

205. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 4, 7.

206. Paul Figgins, 11/93, Senior Research Specialist

207. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

208. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

209. Joe Garner, 4/94, Supervisor Health Physics

210. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

211. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

212. MLM-736, Health Physics Information Report, 7/31/52, page 5

213. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

214. Joe Garner, 4/94, Supervisor Health Physics

215. Paul Figgins, 2/94, Senior Research Specialist

216. Ralph Watrous, 4/94, Chemist

217. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

218. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

219. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

220. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

221. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 7.

222. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 4, 7.

223. Paul Figgins, 11/93, Senior Research Specialist

224. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

225. Memo on 3/22/56 discusses the use of Th-230 in room R-120

226. MLM-MU-58-68-0001, Quarterly Health Physics Report, April through June 1958, 8/11/58, page 8.

227. Martin Hertz, 4/94, Senior Research Chemist

228. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

229. Don Rogers, 9/93, Senior Fellow

230. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

231. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

232. Incident #518, 7/6/60, Miller, R., Pu-238, R-120
#240, 7/3/63, Boggs, R., " "
#078, 1/28/71, Breakall, K., " "
#311, 8/3/73, Chadwell, C., " "

233. Incident #264 - Apple, H., 1/9/63, Tritium, R-123

234. John Gill, 2/94, Science Fellow

235. Tom Flanagan, 2/94, Specialist ES&H

236. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 14, 52

237. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

238. Doug Draper, 10/93, Manager RAM

239. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 6-8

240. MLM-1028, Quarterly Health Physics Report - October through December 1954, 1/5/55, page 7.

241. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

242. Joe Garner, 4/94, Supervisor Health Physics

243. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

244. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

245. MLM-809, Health Physics Monthly Information Report, 1/31/53, page 5.

246. Dick Vallee, 3/94, Vice President EG&G Mound

247. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 9.

248. Parameters of Thermal Diffusion Columns, Proceedings of the Symposium on Isotope Separation, Amsterdam, 1957, G.R. Grove, K.W. Foster, and R.E. Vallee, page 462-470.

249. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

250. Don Rogers, 9/93, Senior Fellow

251. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

252. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

253. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 52

254. Tom Flanagan, 1/94, Specialist ES&H

255. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

256. Joe Garner, 4/94, Supervisor Health Physics

257. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

258. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

259. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

260. Don Rogers, 2/94, Senior Fellow

261. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

262. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 14, 52

263. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 224-229

264. Tom Flanagan, 1/94, Specialist ES&H

265. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

266. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

267. Joe Garner, 4/94, Supervisor Health Physics

268. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

269. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

270. MLM-736, Health Physics Information Report, 7/31/52, page 5.

271. Joe Garner, 1/94, Supervisor Health Physics

272. Paul Figgins, 2/94, Senior Research Specialist

273. Ralph Watrous, 4/94, Chemist

274. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

275. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

276. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

277. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

278. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

279. Don Rogers, 2/94, Senior Fellow

280. Joe Garner, 1/94, Supervisor Health Physics

281. Tom Flanagan, 1/94, Specialist ES&H

282. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

283. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 52

284. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

285. Joe Garner, 4/94, Supervisor Health Physics

286. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

287. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

288. Don Rogers, 9/93 & 2/94, Senior Fellow

289. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

290. Paul Figgins, 2/94, Senior Research Specialist

291. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

292. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 52

293. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

294. Joe Garner, 4/94, Supervisor Health Physics

295. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

296. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

297. MLM-736, Health Physics Information Report, 7/31/52, page 5

298. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

299. Joe Garner, 4/94, Supervisor Health Physics

300. Paul Figgins, 2/94, Senior Research Specialist

301. Ralph Watrous, 4/94, Chemist

302. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

303. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

304. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

305. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

306. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 7.

307. MLM-MU-58-65-0001, Quarterly Health Physics Report, January through March 1958, 5/7/58, page 4, 7.

308. Paul Figgins, 11/93, Senior Research Specialist

309. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

310. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

311. Don Rogers, 2/94, Senior Fellow

312. Memo of 3/22/56 discusses the use of Th-230 in room R-133

313. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

314. Richard Carlson, 1/94, Senior Research Chemist

315. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 237-238

316. Steve Tentman, 1/94, Senior Development Engineer

317. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

318. MLM-736, Health Physics Information Report, 7/31/52, page 5

319. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

320. Joe Garner, 4/94, Supervisor Health Physics

321. Paul Figgins, 2/94, Senior Research Specialist

322. Ralph Watrous, 4/94, Chemist

323. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

324. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

325. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

326. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

327. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, Tom Flanagan, and Bob Myers.

328. Paul Figgins, 11/93, Senior Research Specialist

329. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

330. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

331. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

332. Doug Draper, 10/93, Manager RAM

333. Paul Figgins, 11/93, Senior Research Specialist

334. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

335. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

336. Incident #086 - Barnhart, B., 9/27/74, Pu-238, R-140

337. Joe Garner, 1/94, Supervisor Health Physics

338. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

339. Incident #428 - Goode, J., 5/4/50, Radium, R-142

340. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

341. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

342. Joe Garner, 1/94, Supervisor Health Physics

343. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

344. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

345. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

346. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

347. Laurie Brehm, 2/94, Lab Technician

348. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

349. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

350. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

351. Quarterly Health Physics Report, July through September 1955, 10/25/55, page 7.

352. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

353. Don Rogers, 2/94, Senior Fellow

354. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 52

355. Joe Garner, 4/94, Supervisor Health Physics

356. Paul Figgins, 2/94, Senior Research Specialist

357. MLM-736, Health Physics Information Report, 7/31/52, page 4,5.

358. Ralph Watrous, 4/94, Chemist

359. Fractionation of Barium-Radium Mixtures as Chromates, Murrell Salutsky, Joseph Stites, A.W. Martin, November, 1953

360. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

361. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

362. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

363. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

364. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;61

365. Joe Garner, 4/94, Supervisor Health Physics

366. Lerroy Jones, 4/94, Director of Research and Development

367. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

368. Memo on 3/22/56, talks about microcurie quantities of Pa-231 being handled.

369. Paul Figgins, 1/94, Senior Research Specialist

370. MLM-MU-58-68-0001, Quarterly Health Physics Report, April through June 1958, 8/11/58, page 7.

371. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

372. Don Kelly, 10/93, Heat Source Program Manager

373. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

374. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

375. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

376. Incident #019, 5/11/61, E. Bousquet, Pu-238 Oxide, R-145/147
#023, 6/5/62, Ray Steinmeyer, plutonium, R-145

377. No incident # - Redding, Phil, 8/26/65, Pu-238, 239, U-234, R-145

378. Doug Draper, 10/93, Manager RAM

379. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 52

380. Charles Brown, 2/94, Chemist

381. Joe Garner, 4/94, Supervisor Health Physics

382.382. Paul Figgins, 2/94, Senior Research Specialist

383. MLM-736, Health Physics Information Report, 8/31/52, page 4,5.

384. Preparation of Actinium Metal, Joseph Stites, Murrell Salutsky, Bob Stone, Journal of the American Chemical Society, 77, 1955, page 237-240.

385. MLM-821, Health Physics Monthly Information Report, 2/28/53, page 5.

386. Fractionation of Barium-Radium Mixtures as Chromates, Murrell Salutsky, Joseph Stites, A.W. Martin, November, 1953

387. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

388. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

389. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

390. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;60-64

391. Quarterly Health Physics Report, October through December 1956, 1/15/57, page 10.

392. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

393. Memo on 3/22/56, talks about microcurie quantities of Pa-231 being handled.

394. Doug Drapper, 10/93, Manager Radiological Assessment and Measurement

395. Paul Figgins, 11/93 & 2/94, Senior Research Specialist

396. Don Kelly, 3/94, Heat Source Project Manager, Production Support

397. No incident # - 5/19/60, Lucius Jones, Pu-238, R-149
Incident #372 - 6/2/60, Lucius Jones, Pu-238, R-148/149
No incident # - 1/16/63, Redding, Phillip, " R-149
Incident #044 - 4/19/65, Hendrickson, E.; " R-149

NOTE: Paul Figgins believes the Phillip Redding incident occurred in R-151.

398. Joe Garner, 1/94, Supervisor Health Physics

399. Don Kelly, 3/94, Heat Source Project Manager, Production Support

400. Don Rogers, 9/93, Senior Fellow

401. Dick Eppley, 10/93, Manager Isotopic Separation

402. Paul Figgins, 11/93, Senior Research Specialist

403. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

404. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

405. Doug Draper, 10/93, Manager RAM

406. MLM-ML-88-48-0003, Final Report: R-149 Laboratory Decommissioning Project, J.R. Geichman, R.R. Jaeger, V.E. Castleberry, 9/30/88, page 3

407. Paul Figgins, 11/93, Senior Research Specialist

408. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

409. Joe Garner, 4/94, Supervisor Health Physics

410. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

411. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

412. Calvin Love, 10/93, Senior Research Specialist

413. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

414. Paul Figgins, 2/94, Senior Research Specialist

415. MLM-MU-58-68-0001, Quarterly Health Physics Report, April through June 1958, 8/11/58, page 7.

416. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

417. Don Rogers, 9/93, Senior Fellow

418. Incident #083 - Hapner, G., 2/11/74, Pu-238, R-151

419. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

420. Joe Garner, 4/94, Supervisor Health Physics

421. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

422. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

423. MLM-736, Health Physics Information Report, 7/31/52, page 5

424. MLM-752, Health Physics Information Report, 8/31/52, page 4,5.

425. Joe Garner, 4/94, Supervisor Health Physics

426. Paul Figgins, 2/94, Senior Research Specialist

427. Ralph Watrous, 4/94, Chemist

428. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

429. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

430. MLM-870, Health Physics Monthly Information Report, 6/31/53, page 5.

431. MLM-895, Health Physics Monthly Information Report, 8/31/53, page 4.

432. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

433. Joe Garner, 4/94, Supervisor Health Physics

434. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

435. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

436. Reactor Fuels and materials Development - Plutonium Research, MLM-1156, 1162, 1171, 1199, 1244, 1262; L.J. Wittenberg and G.R. Grove, 1963 - 1965

437. Paul Figgins, 11/93 & 2/94, Senior Research Specialist

438. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

439. Don Rogers, 9/93, Senior Fellow

440. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

441. Paul Figgins, 11/93, Senior Research Specialist

442. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

443. Joe Garner, 4/94, Supervisor Health Physics

444. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

445. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

446. Reactor Fuels and materials Development - Plutonium Research, MLM-1156, 1162, 1171, 1199, 1244, 1262; L.J. Wittenberg and G.R. Grove, 1963 - 1965

447. Paul Figgins, 11/93 & 2/94, Senior Research Specialist

448. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

449. Don Rogers, 9/93, Senior Fellow

450. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

451. Don Kelly, 3/94, Project Manager, Production Support

452. Paul Figgins, 11/93, Senior Research Specialist

453. Dick Eppley, 10/93, Manager Isotopic Separation

454. MLM-ML-88-48-0003, Final Report: R-149 Laboratory Decommissioning Project, J.R. Geichman, R.R. Jaeger, V.E. Castleberry, 9/30/88, page 3

455. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 14, 52

456. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

457. Joe Garner, 4/94, Supervisor Health Physics

458. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

459. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

460. MLM-821, Health Physics Monthly Information Report, 2/28/53, page 4.

461. Joe Garner, 1/94, Supervisor Health Physics

462.462. Paul Figgins, 2/94, Senior Research Specialist

463. MLM-736, Health Physics Information Report, 8/31/52, page 4,5.

464. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

465. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

466. MLM-809, Health Physics Monthly Information Report, 1/31/53, page 5.

467. MLM-1028, Quarterly Health Physics Report - October through December 1954, 1/5/55, page 7.

468. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;3-6

469. Joe Garner, 4/94, Supervisor Health Physics

470. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

471. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

472. MLM-727, Health Physics Monthly Information Report, 6/1/52, page 4.

473. MLM-821, Health Physics Monthly Information Report, 2/28/53, page 4.

474. Joe Garner, 1/94, Supervisor Health Physics

475. Paul Figgins, 2/94, Senior Research Specialist

476. MLM-736, Health Physics Information Report, 8/31/52, page 4,5.

477. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

478. MLM-798, Health Physics Monthly Report, 12/31/52, page 5,6

479. MLM-798, Health Physics Monthly Report, 12/31/52, page 4

480. MLM-821, Health Physics Monthly Information Report, 2/28/53, page 4,5

481. MLM-621, MLM-MU-51-71-0037, Decontamination Of Process Waste Solutions Containing Fission Products By Adsorption And Coprecipitation Methods, C.S. Lowe, 11/13/51, page 9

482. Larry Bentz, 2/94, Analytical Chemist (Retired - 1974)

483. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;76-83

484. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

485. Larry Bentz, 2/94, Analytical Chemist (Retired - 1974)

486. Larry Bentz, 2/94, Analytical Chemist (Retired - 1974)

487. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

488. Wayne Amos, 2/94, Program Manager Heat Source RTG Programs

489. MLM-MU-58-70-0001, Quarterly Health Physics Report, July through September 1958, 10/23/58, page 9.

490. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

491. Paul Lamberger, 11/94, Specialist, Senior-1

492. MLM-621, MLM-MU-51-71-0037, Decontamination Of Process Waste Solutions Containing Fission Products By Adsorption And Coprecipitation Methods, C.S. Lowe, 11/13/51, page 9

493. Larry Bentz, 2/94, Analytical Chemist (Retired)

494. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;76-83

495. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

496. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;61

497. Lerroy Jones, 4/94, Director of Research and Development

498. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

499. Paul Figgins, 11/93, Senior Research Specialist

500. MLM-MU-58-70-0001, Quarterly Health Physics Report, July through September 1958, 10/23/58, page 9.

501. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

502. Joe Garner, 4/94, Supervisor Health Physics

503. Residue Adsorption-I, Separation of Strontium-90 and Yttrium-90, H.W. Kirby, August 1962, Journal of Inorganic Chemistry, 1963, Vol.25, page 483-499.

504. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

505. Don Rogers, 9/93, Senior Fellow

506. Paul Figgins, 11/93, Senior Research Specialist

507. Letters between Harold Kirby and R.P. Schuman of the Phillips Petroleum Company, Idaho Falls, Idaho, 1960-1965, Ionium Capsules Bur-49-65A.

508. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

509. Memo on 3/22/56 discusses the use of Pa-231 in R-167

510. Incident #105 - Henderson, J., 7/8/83, Cm-244, R-167

511. Lerroy Jones, 4/94, Director of Research and Development

512. Paul Figgins, 11/93, Senior Research Specialist

513. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

514. Richard Carlson, 10/93, Senior Research Chemist

515. Richard Eppley, 10/93, Manager Isotopic Separation

516. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

517. Don Rogers, 2/94, Senior Fellow

518. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

519. Joe Garner, 4/94, Supervisor Health Physics

520. Paul Figgins, 2/94, Senior Research Specialist

521. MLM-736, Health Physics Information Report, 7/31/52, page 4,5.

522. Ralph Watrous, 4/94, Chemist

523. Don Rogers, 2/94, Senior Fellow

524. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

525. Incident #177 - 6/27/51, Economides, M., Radium, R-171, 172

526. Don Rogers, 2/94, Senior Fellow

527. T.B. Rhinehammer, 4/94, Research Chemist

528. T.B. Rhinehammer, 4/94, Research Chemist

529. Richard Eppley, 10/93, Manager Isotopic Separation

530. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

531. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

532. Don Rogers, 2/94, Senior Fellow

533. Incident #095 - Pitre, E., 9/8/78, tritium, R-176

534. MD-10050, Technical Manual R-Building Health Physics Precautions, W.T. Cave, W.D. Pardieck, 10/28/75

535. Paul Figgins, 2/94, Senior Research Specialist

536. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

537. Phillip Rhude, 4/94, Supervisor Health Physics

538. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

539. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 14, 52

540. Don Hobrock, 10/93, Senior Fellow

541. Paul Figgins, 1/94, Senior Research Specialist

542. Joe Garner, 1/94, Supervisor Health Physics

543. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

544. MLM-ML-88-48-0003, Final Report: R-149 Laboratory Decommissioning Project, J.R. Geichman, R.R. Jaeger, V.E. Castleberry, 9/30/88, page 3

545. Incident #184 - Jordan, C., 1/31/89, Ac-227, R-Corr 5

546. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, Tom Flanagan, and Bob Myers.

547. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

548. Don Rogers, 9/93, Senior Fellow

549. Toby Elswick, 1/94, Manager Plutonium Operations / Tritium Production

550. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

551. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

552. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

553. Ernest Johnson, 10/93, Specialist, Heat Source Production

554. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

555. Ernest Johnson, 10/93, Specialist, Heat Source Production

556. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

557. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

558. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

559. Calvin Love, 10/93, Senior Research Specialist

560. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

561. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

562. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

563. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

564. Ernest Johnson, 10/93, Specialist, Heat Source Production

565. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

566. Ernest Johnson, 10/93, Specialist, Heat Source Production

567. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

568. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

569. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

570. Calvin Love, 10/93, Senior Research Specialist

571. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

572. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

573. Paul Figgins, 11/93, Senior Research Specialist

574. Ernest Johnson, 10/93, Specialist, Heat Source Production

575. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

576. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

577. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

578. Ernest Johnson, 10/93, Specialist, Heat Source Production

579. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

580. Ernest Johnson, 10/93, Specialist, Heat Source Production

581. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

582. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

583. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

584. Calvin Love, 10/93, Senior Research Specialist

585. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

586. Toby Elswick, 7/93, Manager Plutonium Operations / Tritium Production

587. Don Rogers, 9/93, Senior Fellow

588. Paul Lamberger, 10/93, Specialist, Senior-1

589. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

590. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

591. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 6-8

592. Paul Lamberger, 10/93, Specialist, Senior-1

593. Tom Flanagan, 9/93, Specialist ES&H

594. Don Hobrock, 10/93, Senior Fellow

595. Doug Draper, 10/93, Manager RAM

596. Consulting committee for this appendix consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Harold (Andy) Anderson, and Chuck Woods, 12/94.

597. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 69

598. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 69, 79

599. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 69, 80

600. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 72, 81

601. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 72, 82-83

602. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 72, 84-85

603. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 73, 86

604. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 73, 87-88

605. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 73, 89-90

606. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 74, 91

607. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 74, 92-93

608. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 75, 94

609. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 75, 95-96

610. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 76, 97

611. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

612. Pat Adams, 1/94, Manager Health Physics

613. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 229-235

614. Earl Johns, 2/94, Manager Tritium Recovery Operations

615. Dick Vallee, 3/94, Vice President EG&G Mound

616. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

617. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 187-200

618. Paul Lamberger, 10/93, Specialist, Senior-1

619. Pat Adams, 1/94, Manager Health Physics

620. Earl Johns, 2/94, Manager Tritium Isotopic Separation

621. Tom Flanagan, 1/94, Specialist ES&H

622. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

623. Harold Anderson, 12/93, Manager Stockpile Evaluation

624. Joe Garner, 1/94, Supervisor Health Physics

625. No incident # - memo, 6/7/61, Tritium, SW-8
No incident # - Ratleff, A., 5/26/72, " "
Incident #076 - Conover, J., 3/13/73, " "
#310 - Gibbs, G., 7/18/73, " "

626. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

627. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 138

628. Paul Lamberger, 10/93, Specialist, Senior-1

629. Terry Buxton, 12/93, Manager Nuclear Technology

630. Don Hobrock, 7/93, Senior Fellow

631. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

632. Dick Carlson, 1/94, Senior Research Specialist

633. MLM-621, MLM-MU-51-71-0037, Decontamination Of Process Waste Solutions Containing Fission Products By Adsorption And Coprecipitation Methods, C.S. Lowe, 11/13/51, page 9

634. Larry Bentz, 2/94, Analytical Chemist (Retired)

635. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, 2;76-83

636. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

637. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

638. MLM-809, Health Physics Monthly Information Report, 1/31/53, page 5.

639. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2; 50-54

640. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

641. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;50-58

642. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

643. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

644. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 8.

645. Memo on 1/1/56 discussing Pa-231 separation being set up in HH Building.

646. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

647. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 138

648. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

649. No incident # - Zink, John, 8/27/64, tritium, SW-13/1B

650. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 214-220

651. Calvin Love, 10/93, Senior Research Specialist

652. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

653. Incident #370, 8/28/85, Ray Steinmeyer, Tritium, SW-12, 13,

654. Paul Figgins, 8/93, Senior Research Specialist

655. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2; 48-50

656. MLM-700, Health Physics Monthly Information Report, 4/30/52, page 4.

657. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

658. Paul Figgins, 8/93, Senior Research Specialist

659. MLM-736, Health Physics Information Report, 7/31/52, page 6.

660. MLM-832, Health Physics Monthly Information Report, 3/31/53, page 5

661. MLM-870, Health Physics Monthly Information Report, 6/30/53, page 5.

662. MLM-Mu-59-62-0001, Quarterly Health Physics Report, October through December 1958, 2/2/59, page 4.

663. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 183

664. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 152, 153

665. Incident #617 - Blevins, B., 9/24/86, Tritium, SW-20

666. Paul Figgins, 8/93, Senior Research Specialist

667. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;68,69

668. Paul Figgins, 8/93, Senior Research Specialist

669. MLM-2151, "A Solvent Extraction Method For Recovery Of Thorium-229 From Aged Uranium-233, M.R. Hertz, W.S. Stringham, R.M. Watrous, 1/31/75.

670. M. Ray Hertz, 4/94, Senior Research Chemist

671. Richard Eppley, 10/93, Manager Isotopic Separation

672. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

673. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

674. Richard Eppley, 10/93, Manager Isotopic Separation

675. Paul Figgins, 11/93, Senior Research Specialist

676. MLM-2985, The Recovery Of Protactinium-231 and Thorium-230 From Cotter Concentrate: Pilot Plant Operation and Process Development, M.R. Hertz, P.E. Figgins, W.R. Deal, 2/10/83.

677. M. Ray Hertz, 4/94, Senior Research Chemist

678. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

679. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

680. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

681. Richard Eppley, 10/93, Manager Isotopic Separation

682. Paul Figgins, 11/93, Senior Research Specialist

683. M. Ray Hertz, 4/94, Senior Research Chemist

684. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

685. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

686. Richard Eppley, 10/93, Manager Isotopic Separation

687. Paul Figgins, 11/93, Senior Research Specialist

688. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

689. Incident #096 - 10/31/78, Deal, W., Ac-227, SW-132

690. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

691. Paul Figgins, 8/93, Senior Research Specialist

692. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

693. Richard Eppley, 10/93, Manager Isotopic Separation

694. Paul Figgins, 11/93, Senior Research Specialist

695. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

696. Paul Figgins, 8/93, Senior Research Specialist

697. M. Ray Hertz, 4/94, Senior Research Chemist

698. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

699. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

700. Richard Eppley, 10/93, Manager Isotopic Separation

701. Paul Figgins, 11/93, Senior Research Specialist

702. M. Ray Hertz, 4/94, Senior Research Chemist

703. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

704. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

705. Joe Garner, 1/94, Supervisor Health Physics

706. Tom Flanagan, 1/94, Specialist ES&H

707. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 214-220

708. Calvin Love, 10/93, Senior Research Specialist

709. Tom Flanagan, 1/94, Specialist ES&H

710. Richard Carlson, 10/93, Senior Research Specialist

711. Incident #196, 11/20/64, R. Goss, Tritium, SW-142
#370, 8/28/85, Ray Seeinmeyer, Tritium, SW-142

712. Incident #630 - Brown, J., 1/25/65, Mercury, SW-142

713. Dave Billing, 1/94, Manager SW Building

714. Earl Johns, 1/95, Supervisor of Tritium Systems Operations

715. Earl Johns, 1/95, Supervisor of Tritium Systems Operations

716. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 171-180

717. Tom Flanagan, 1/94, Specialist ES&H

718. Paul Lamberger, 1/95, Specialist, Senior-1

719. Tom Flanagan, 1/94, Specialist ES&H

720. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

721. Paul Lamberger, 10/93, Specialist, Senior-1

722. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

723. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 187-200

724. Paul Lamberger, 10/93, Specialist, Senior-1

725. Harold (Andy) Anderson, 12/93, Manager Materials Stockpile

726. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

727. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 138

728. Tom Flanagan, 1/94, Specialist ES&H

729. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

730. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 154, 181

731. Tom Flanagan, 1/94, Specialist ES&H

732. Pat Adams, 1/94, Manager Health Physics

733. Tom Flanagan, 1/94, Specialist ES&H

734. Incident #573 - Bolton, M., 8/11/61, Po-210, SW-202

735. Pat Adams, 1/94, Manager Health Physics

736. Tom Flanagan, 1/94, Specialist ES&H

737. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, page 229-235

738. Tom Flanagan, 1/94, Specialist ES&H

739. Pat Adams, 1/94, Manager Health Physics

740. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 154-164, 171

741. Tom Flanagan, 1/94, Specialist ES&H

742. Mike Deaton, 1/94, Function Testing Supervisor

743. Harold (Andy) Anderson, 12/93, Manager of Stockpile Evaluation

744. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

745. Tom Flanagan, 1/94, Specialist ES&H

746. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 154-164, 171

747. Tom Flanagan, 1/94, Specialist ES&H

748. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

749. Mike Deaton, 1/94, Function Testing Supervisor

750. Tom Flanagan, 1/94, Specialist ES&H

751. Joe Garner, 1/94, Supervisor Health Physics

752. M. Ray Hertz, 4/94, Senior Research Chemist

753. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

754. Harold (Andy) Anderson, 12/93, Manager Stockpile Evaluation

755. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

756. Terry Buxton, 12/93, Manager Nuclear Technology

757. Mike Deaton, 1/94, Function Testing Supervisor

758. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

759. Tom Flanagan, 1/94, Specialist ES&H

760. Joe Garner, 1/94, Supervisor Health Physics

761. Incident #075, 7/28/72, Stevenson, R., Tritium, SW-231

762. FSAR, SW/R Tritium Complex, T. Buxton, 2/92, pages 123-138

763. Tom Flanagan, 1/94, Specialist ES&H

764. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

765. Joe Garner, 1/94, Supervisor Health Physics

766. Terry McConville, 6/95, Science Fellow

767. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 9

768. A Summary Review of Mound Laboratory's experience in D&D of Radioactive Facilities, 1949 - 1973, J.M. Garner & W.P. Davis, Mound Laboratory, page 6.

769. Carl Kershner, 3/94, Senior Fellow

770. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

771. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

772. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

773. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

774. Paul Lamberger, 10/93, Specialist, Senior-1

775. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

776. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

777. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

778. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

779. SAR, T Building, 12/93, page 102, 138-150

780. SAR, T Building, 12/93, page 140

781. Jack Melke, 2/94, Senior Development Engineer

782. SAR, T Building, 12/93, page 68, 73

783. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

784. Paul Lamberger, 4/94, Senior Research Specialist

785. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

786. Jack Melke, 2/94, Senior Development Engineer

787. FSAR, T Building, 12/93, page 218-220

788. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

789. MLM-940, Health Physics Monthly Information Report, 1/31/54, page 4.

790. MLM-933, Health Physics Monthly Information Report, 12/31/53, page 4.

791. Jack Melke, 2/94, Senior Development Engineer

792. SAR, T Building, 12/93, page 60, 61, 73

793. Al Nunn, 4/94, Chemist

794. SAR, T Building, 12/93, page 135, 228

795. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

796. Jack Melke, 2/94, Senior Development Engineer

797. SAR, T Building, 12/93, page 60, 61, 73

798. Al Nunn, 4/94, ...

799. SAR, T Building, 12/93, page 67, 73

800. Jack Melke, 2/94, Senior Development Engineer

801. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

802. Clyde Gallaher, 8/93, T Building Manager

803. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

804. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

805. SAR, T Building, 12/93, page 102, 103, 232-240

806. Paul Lamberger, 4/94, Senior Research Specialist

807. Clyde Gallaher, 3/94, Manager of T Building

808. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

809. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

810. Drawing, T Building Service Floor, 2/68

811. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

812. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

813. SAR, T Building, 12/93, page 47-49, 73

814. Terry Buxton, 12/93, Manager Nuclear Technology

815. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

816. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

817. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

818. Drawing, T Building Service Floor, 2/68

819. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

820. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

821. SAR, T Building, 12/93, page 47-49, 73

822. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

823. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

824. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

825. Drawing, T Building Service Floor, 2/68

826. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

827. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

828. SAR, T Building, 12/93, page 47-49, 73

829. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

830. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

831. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

832. Drawing, T Building Service Floor, 2/68

833. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

834. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

835. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

836. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

837. Drawing, T Building Service Floor, 2/68

838. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

839. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

840. FSAR, T Building, 12/93, page 36, 45, 181, 220-222

841. Jack Melke, 2/94, Senior Development Engineer

842. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

843. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

844. Jack Melke, 2/94, Senior Development Engineer

845. FSAR, T Building, 12/93, page 218-220

846. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

847. Jack Melke, 2/94, Senior Development Engineer

848. Clyde Gallaher, 3/94, Manager T Building

849. SAR, T Building, 12/93, page 139, 170-171, 223-227

850. Quarterly Health Physics Report - April through June 1955, page 4.

851. Jack Melke, 2/94, Senior Development Engineer

852. Clyde Gallaher, 3/94, Manager T Building

853. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

854. SAR, T Building, 12/93, page 201-217

855. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

856. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

857. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

858. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 6

859. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

860. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

861. CERCLA, Vol 7, Waste Management, Weston Inc., page 2;7-9

862. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

863. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C: Lange, 7/12/93, page 8

864. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

865. CERCLA, Vol 7, Waste Management, Weston Inc., page 2;7-9

866. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

867. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

868. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

869. Ken Foster, 3/94, Senior Research Specialist

870. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 11

871. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

872. Carl Kershner, 3/94, Senior Fellow

873. Earl Johns, 2/95, Supervisor Tritium Recovery Operations

874. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

875. Incident #061 - 8/28/68, Delong, J., Po-210, T-57

876. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;37

877. Jack Melke, 2/94, Senior Development Engineer

878. SAR, T Building, 12/93, page 139, 171-178

879. Paul Lamberger, 4/94, Senior Research Specialist

880. Jack Melke, 2/94, Senior Development Engineer

881. Charles Wiedenheft, 3/94, Supervisor Mass Spec/Thermal Analysis

882. SAR, T Building, 12/93, page 139, 170-171, 223-227

883. Ken Foster, 3/94, Senior Research Specialist

884. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

885. Carl Kershner, 3/94, Senior Fellow

886. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 11

887. Earl Johns, 2/95, Supervisor Tritium Recovery Operations

888. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

889. Don Hobrock, 10/93, Senior Fellow

890. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

891. Jack Melke, 2/94, Senior Development Engineer

892. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

893. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

894. SAR, T Building, 12/93, page 183-186

895. M. Ray Hertz, 4/94, Senior Research Chemist

896. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

897. Ernest Johnson, 10/93, Specialist, Heat Source Production

898. Don Kelly, 10/93, Heat Source Program Manager

899. Carl Kershner, 3/94, Senior Fellow

900. Don Hobrock, 10/93, Senior Fellow

901. Jack Melke, 2/94, Senior Development Engineer

902. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;37

903. SAR, T Building, 12/93, page 139, 165-170

904. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

905. Charlie Lindsey, 10/93, Supervisor Mechanical Testing

906. Charlie Sienkiewicz, 10/93, Engineering Specialist

907. Paul Lamberger, 10/93, Specialist, Senior-1

908. SAR, T Building, 12/93, page 139, 154-165

909. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

910. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

911. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

912. Drawing, T Building Service Floor, 2/68

913. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

914. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

915. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

916. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

917. Paul Lamberger, 11/93, Specialist, Senior-1

918. Charlie Lindsey, 10/93, Supervisor Mechanical Testing

919. Charlie Sienkiewicz, 10/93, Engineering Specialist

920. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

921. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

922. Drawing, T Building Service Floor, 2/68

923. MLM-1594(LD), Polonium-210 Program, 1/22/69, C. Richard Grove, page 6 with corresponding drawing of T Building service floor (2/68)

924. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

925. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

926. SAR, T Building, 12/93, page 64,76

927. Jack Melke, 2/94, Senior Development Engineer

928. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

929. M. Ray Hertz, 4/94, Senior Research Chemist

930. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

931. Carl Kershner, 3/94, Senior Fellow

932. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

933. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

934. SAR, T Building, 12/93, page 77,79

935. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

936. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

937. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

938. SAR, T Building, 12/93, page 137, 230-232

939. Paul Lamberger, 11/93, Specialist, Senior-1

940. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

941. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

942. Clyde Gallaher, 8/93, T Building Manager

943. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

944. SAR, T Building, 12/93, page 77

945. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

946. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

947. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 11

948. Paul Lamberger, 11/93, Specialist, Senior-1

949. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

950. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

951. Incident #126, Coleman, H., 9/28/64, Po-210, T-237

952. SAR, T Building, 12/93, page 36, 45, 181

953. Clyde Gallaher, 3/94, Manager of T Building

954. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

955. Incident #522 - Carmack, J., 10/17/86, Pu-238, T-238

956. SAR, T Building, 12/93, page 36, 45, 181

957. Clyde Gallaher, 3/94, Manager of T Building

958. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

959. Incident #522 - Carmack, J., 10/17/86, Pu-238, T-238

960. Incident #562 - Bond, B., 10/20/60, Po-210, T-242

961. M. Ray Hertz, 4/94, Senior Research Chemist

962. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

963. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

964. SAR, T Building, 12/93, page 102

965. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

966. Carl Kershner, 3/94, Senior Fellow

967. Joseph Grasso, 3/94, Project Manager SNAP-29 Program

968. SAR, T Building, 12/93, page 77

969. Clyde Gallaher, 3/94, Manager T Building

970. Carl Kershner, 3/94, Senior Fellow

971. Joseph Grasso, 3/94, Project Manager SNAP-29 Program

972. Earl Johns, 7/93, Supervisor Tritium Recovery Operations

973. Paul Lamberger, 10,93, Senior Research Specialist

974. MLM-MU-58-68-0001, Quarterly Health Physics Report, April through June 1958, 8/11/58, page 5.

975. Carl Kershner, 3/94, Senior Fellow

976. Joseph Grasso, 3/94, Project Manager SNAP-29 Program

977. Carl Kershner, 3/94, Senior Fellow

978. Joseph Grasso, 3/94, Project Manager SNAP-29 Program

979. Earl Johns, 7/93, Supervisor Tritium Recovery Operations

980. Paul Lamberger, 10,93, Senior Research Specialist

981. Bob Phillips, 5/94, Research Chemist

982. Incident #002, 11/17/54, W. Craft, Polonium, T-251

983. Incident on 5/26/60, E. Stoeckel, F. Neff, Po-210, T-254

984. Carl Kershner, 3/94, Senior Fellow

985. Joseph Grasso, 3/94, Project Manager SNAP-29 Program

986. Jack Melke, 2/94, Senior Development Engineer

987. Harold (Andy) Anderson, 12/93, Manager Stockpile Evaluation

988. SAR, T Building, 12/93, page 58, 59

989. Carl Kershner, 7/93, Senior Fellow

990. Donald Kelly, 10/93, Heat Source Program Manager

991. Incident #060, Brown, D., 8/22/68, Alpha (Po-210), T-260 Box 10

992. Carl Kershner, 3/94, Senior Fellow

993. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 12, 13

994. Polonium-210 Production, presentation at the SYMPOSIUM ON ISOTOPIC POWER FUELS at Oak Ridge National Laboratory on June 26, 1963, report by F.M. Huddleson, R.K.Harris, and M.R. Hertz, July 9, 1963

995. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

996. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

997. Incident Memo Reports, 2/28/50 & 9/19/50.

998. Incident #512, Leslie, R; 8/9/66, polonium, T-266

999. Incident #124, 10/30/64, Carl Kershner, polonium, T-267, GB #5

1000. Carl Kershner, 3/94, Senior Fellow

1001. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 9

1002. Carl Kershner, 7/93, Senior Fellow

1003. Don Hobrock, 10/93, Senior Fellow

1004. Jack Melke, 2/94, Senior Development Engineer

1005. SAR, T Building, 12/93, page 187, 194-200

1006. Paul Lamberger, 11/94, Senior Research Specialist

1007. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1008. Carl Kershner, 3/94, Senior Fellow

1009. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 12, 13

1010. Polonium-210 Production, presentation at the SYMPOSIUM ON ISOTOPIC POWER FUELS at Oak Ridge National Laboratory on June 26, 1963, report by F.M. Huddleson, R.K.Harris, and M.R. Hertz, July 9, 1963

1011. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

1012. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1013. Incident Memo Reports, 2/28/50 & 9/19/50.

1014. Incident #612 - Love, C., 10/12/67, Po-210, T-270

1015. Carl Kershner, 3/94, Senior Fellow

1016. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 11

1017. Carl Kershner, 3/94, Senior Fellow

1018. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1019. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;37

1020. Jack Melke, 2/94, Senior Development Engineer

1021. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1022. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 6

1023. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

1024. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

1025. Paul Lamberger, 4/94, Senior Research Specialist

1026. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1027. Carl Kershner, 3/94, Senior Fellow

1028. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 18

1029. William Bond, 3/94, Supervisor Neutron Source Program

1030. MLM-???, Quarterly Health Physics Report - April through June 1955, page 4.

1031. Incident #003, 11/27/56, Birden, J., polonium, T-277,279
Incident #003, 11/27/56, E. Winterland, polonium, T-277, 279
Incident #017, 11/11/60, Bullen, C., Po-210, T-279

1032. M. Ray Hertz, 4/94, Senior Research Chemist

1033. Carl Kershner, 3/94, Senior Fellow

1034. MLM-1594(LD), Polonium-210 Program, 1/22/69, G. Richard Grove, page 5, 19, 21

1035. Don Kelly, 3/94, Heat Source Project Manager, Production Support

1036. Carl Kershner, 3/94, Senior Fellow

1037. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1038. Jack Melke, 2/94, Senior Development Engineer

1039. Harold (Andy) Anderson, 12/93, Manager Stockpile Evaluation

1040. SAR, T Building, 12/93, page 58, 59

1041. Carl Kershner, 3/94, Senior Fellow

1042. Paul Lamberger, 4/94, Senior Research Specialist

1043. Carl Kershner, 3/94, Senior Fellow

1044. Paul Lamberger, 4/94, Senior Research Specialist

1045. SAR, T Building, 12/93, page 102, 103, 137, 228-230

1046. Carl Kershner, 3/94, Senior Fellow

1047. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

1048. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1049. Joseph Grasso, 3/94, Project Manager for SNAP-29

1050. Incident #018 - Copsey, B., 12/16/60, Po-210, T-310A

1051. SAR, T Building, 12/93, page 51, 79

1052. Charles Wiedenheft, 3/94, Supervisor Mass Spec/Thermal Analysis

1053. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

1054. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1055. SAR, T Building, 12/93, page 77,79

1056. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

1057. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1058. Carl Kershner, 3/94, Senior Fellow

1059. Earl Johns, 3/94, Supervisor Tritium Recovery Operations

1060. Incident #111, 11/1/67, Lucius Jones, Po-210, T-311

1061. SAR, T Building, 12/93, page 77,79

1062. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

1063. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1064. SAR, T Building, 12/93, page 51, 79

1065. Charles Wiedenheft, 3/94, Supervisor Mass Spec/Thermal Analysis

1066. Ken Foster, 3/94, Senior Research Specialist (Retired/88)

1067. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1068. Mark McClelland, 7/93, Radiation Technician

1069. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1070. Incident #022, Bullen, C., 10/20/61, Po-210, T-Corr. 20

1071. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;3-8

1072. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

1073. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

1074. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;15, 16

1075. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;15, 16

1076. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

1077. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;8,9

1078. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

1079. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

1080. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1081. CERCLA, Vol 3, Site Scoping Report, Radiological Site Survey, 3/93, page 3;6

1082. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;3-9, 15

1083. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1084. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

1085. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;51

1086. Larry Klinger, 2/95, Specialist, Industrial Waste

1087. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1088. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 5.

1089. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;26-30, 4;9-15

1090. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1091. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;73

1092. Larry Klinger, 2/95, Specialist, Industrial Waste

1093. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1094. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;8,9

1095. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

1096. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

1097. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1098. CERCLA, Vol 3, Site Scoping Report, Radiological Site Survey, 3/93, page 3;6

1099. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;3-9, 15

1100. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1101. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

1102. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;51

1103. Larry Klinger, 2/95, Specialist, Industrial Waste

1104. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1105. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 5.

1106. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;26-30, 4;9-15

1107. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1108. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;73

1109. Larry Klinger, 2/95, Specialist, Industrial Waste

1110. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1111. Pat Adams, 2/95, Manager Health Physics

1112. Pat Adams, 2/95, Manager Health Physics

1113. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;26-30, 4;9-15

1114. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1115. Fred Traino, 2/95, Manager of WD Building

1116. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;8,9

1117. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

1118. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

1119. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1120. CERCLA, Vol 3, Site Scoping Report, Radiological Site Survey, 3/93, page 3;6

1121. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;3-9, 15

1122. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1123. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

1124. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;51

1125. Larry Klinger, 2/95, Specialist, Industrial Waste

1126. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1127. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 5.

1128. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;26-30, 4;9-15

1129. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1130. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;73

1131. Larry Klinger, 2/95, Specialist, Industrial Waste

1132. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1133. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;8,9

1134. Polonium 210 Production, 7/9/63, F. M. Huddleston, R.K. Harris, and M.R. Hertz, 10 pages of process description and 6 pages of flow charts.

1135. MLM-1158, Radioactive Impurities in the polonium process at Mound Laboratories, R. C. Lange, 7/12/93, page 8

1136. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1137. CERCLA, Vol 3, Site Scoping Report, Radiological Site Survey, 3/93, page 3;6

1138. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;3-9, 15

1139. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

1140. Quarterly Health Physics Report, April through June 1955, 6/20/55, page 9.

1141. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;51

1142. Larry Klinger, 2/95, Specialist, Industrial Waste

1143. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1144. Quarterly Health Physics Report, January through March 1956, 4/24/56, page 5.

1145. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;26-30, 4;9-15

1146. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1147. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;73

1148. Larry Klinger, 2/95, Specialist, Industrial Waste

1149. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

1150. Larry Klinger, 10/93, Chemist in WD / Specialist in waste management

1151. Larry Klinger, 2/95, Specialist, Industrial Waste

1152. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1153. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;9

1154. Toby Elswick, 10/93, Manager Plutonium Operations / Tritium Production

1155. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1156. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;15, 16

1157. Gary Silver, 10/93, Fellow

1158. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1159. Incident #325 - Roberts, R., 8/1/77, Pu-238, WDA-112

1160. Gary Silver, 10/93, Fellow

1161. Barbara Alexander, 10/93, Chemist WD / WDA

1162. Gary Silver, 10/93, Fellow

1163. Pat Adams, 2/95, Manager of Health Physics

1164. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1165. Barbara Alexander, 2/95, Engineering Specialist

1166. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 1/95

1167. Barbara Alexander, 2/95, Engineering Specialist

1168. Larry Klinger, 2/95, Specialist, Industrial Waste

1169. Larry Klinger, 2/95, Specialist, Industrial Waste

1170. Barbara Alexander, 2/95, Engineering Specialist

1171. Gary Silver, 10/93, Fellow

1172. Larry Klinger, 2/95, Specialist, Industrial Waste

1173. Larry Klinger, 2/95, Specialist, Industrial Waste

1174. Barbra Alexander, 2/95, Engineering Specialist

1175. Incident #090 - Lawhun, P., 11/12/75, Pu-238, WDA-Penthouse

1176. No incident # - Report, 5/26/72, Pu-238, Tanks

1177. CERCLA, Vol. 7, Waste Management, Weston Inc., 7/92, 4;8

1178. MLM-883, Health Physics Monthly Information Report, 7/31/53, page 4.

1179. MLM-832, Health Physics Monthly Information Report, 3/31/53, page 4.

1180. MLM-854, Health Physics Monthly Information Report, 5/31/53, page 4.

1181. MLM-883, Health Physics Monthly Information Report, 7/31/53, page 4.

TABLE OF CONTENTS FOR SECTION 2
SUPPORTING BUILDINGS

1. BACKGROUND INFORMATION 1

2. WAREHOUSE #9 1

3. WAREHOUSE #13 2

4. WAREHOUSE #15 3

5. BUILDING #21 3

6. BUILDING #34 4

7. BUILDING #50 5

8. BUILDING #59 (CFX) 5

9. BUILDING #68 6

10. B-BUILDING 6
    - 10.1 Room B-146 7

11. E-BUILDING 7
    - 11.1 Room E-105 7
    - 11.2 Room E-107 7
    - 11.3 Room E-113 8
    - 11.4 Room E-141, 142, 144, 155 8
    - 11.5 Rooms E-174, 175, 177, 185, 194 8

12. H-BUILDING 9

13. I BUILDING 10

14. M BUILDING 10

15. P BUILDING 10

16. R&R BUILDING 11

17. SD BUILDING 12

18. BUILDINGS WHERE RADIONUCLIDE UPTAKE IS UNLIKELY 13

19. ENDNOTES AND REFERENCES 14

SUPPORTING BUILDINGS

1. BACKGROUND INFORMATION

All dates represent the duration of actual usage of radioisotopes in their respective projects. It is clearly understood that residual amounts of all radioisotopes referred to in each room may still be found in floors, walls, and ceilings and should be considered, up to the present, in every case for D&D work. The statement, sometimes made, that there are no radionuclides of concern refers only to there being no radionuclides used during the period specified and does NOT refer to residual radionuclides which MAY BE present as fixed radiation. Any buried waste lines would also be contaminated.

All radionuclides are ranked according to the degree of concern for uptake and internal dosimetry considerations for each room. Rooms referenced to Appendix B for additional information usually will not have a ranking in this manual since the ranking is done in that appendix, where all radionuclides are listed.

2. 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 off-site shipment. Radioisotopes of concern and their compounds are:[1]

ruthenium-106	cesium-137	antimony-125
tellurium-121,127	zirconium-93,95	niobium-94
strontium-90	rare earths (especially cerium)	
yttrium-88,90,91	plutonium-238,239	

Note: All radionuclides were of equal concern.[2]

3. WAREHOUSE #13

(1953) This warehouse was used for the storage and then shipping of several drums of sludge from the Purex/Bismuth Phosphate decontamination program. The settling and mixing tanks were also taken there. Radioisotopes of concern and their compounds are: [3]

ruthenium-106	cesium-137	antimony-125
tellurium-121,127	zirconium-93,95	niobium-94
strontium-90	plutonium-238,239	
yttrium-88,90,91	rare earths (especially cerium)	

Note: All radionuclides were of equal concern.[4]

This warehouse was also used for temporary storage for drums of low level contamination from the radium-226/actinium-227 decontamination operations. Radioisotopes of concern and their compounds are: [5 6]

radium-226	radium carbonate
actinium-227	radium nitrate
radium bromide	actinium oxalate
actinium fluoride	potassium-40
barium nitrate	radon and daughters
thorium-228	thorium-229
thorium-230	

Note: Actinium-227 is the major radionuclide of concern with both radium-226 and thorium-228 being a close second. The polonium-208, 209, 210 are all a distant third.[7]

4. WAREHOUSE #15

(1955 - 1961) This warehouse stored 1,650 tons of the thorium-232 refinery program (Monex) sludge. It was highly corrosive and continually leaked through the barrels causing much contamination. Over 34 isotopes were identified from the feedstock of this program with most being nonradioactive. Radioisotopes of concern and their compounds are: [8]

thorium-232,228	radium-228,224
uranium-238	thorium-232 daughters (especially thallium-208)

Note: Thorium-228,232 and radium-224 are all equal as the major radionuclides of concern. Uranium-238 is a secondary concern. However, when considering the quantity of radionuclides, and not activity, 99% of the mass of radionuclides are thorium-232.[9]

5. BUILDING #21

This building was constructed in 1964 for bulk storage of the thorium ores and sludge from the old Monex project, a thorium-232 refinery program. Originally designed like a silo with no doors or windows, the oxalate sludge was stored in one side and hydroxide sludge in the other. Up to 1973 at least 117 55-gallon leaky drums still remained outside of the building. Contamination of the surrounding grounds occurred from the fugitive dust resulting from the dumping of this sludge into this "silo." From October of 1974 to July of 1975 this sludge was repackaged in 55-gallon drums and shipped off site. Radionuclide contents of the sludge were primarily thorium isotopes, rare earth isotopes, uranium, and others. [10]

In 1975 1,251 55-gallon drums of Cotter Concentrate was stored in Building 21 until 1987 when they were shipped off site. This concentrate contained significant quantities of the following which are radionuclides of concern:[11]

thorium-230,232	uranium-234,235,238
actinium-227	protactinium-231
radium-223,224,226	actinium nitrate
actinium oxide	

5.1 Thorium-230 was the major radionuclide of concern with over 95% of the activity. [12]

5.2 Fourteen elements besides those isotopes listed above are also contained in the Cotter Concentrate as listed on page 2-71 of CERCLA, VOL. 7, July 1992. There is no indication that these fourteen additional elements are radioactive.

5.3 **The surrounding grounds** also served as storage for Pu-238 waste packages in 1967. There was a 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 of sludge through the roof, and the repackaging into drums. [1314]

5.3.1 A surface sample of 34,000 Pci/g was taken at about 80 feet from Building #21.

5.3.2 A surface sample of 54.3 Pci/g of thorium was taken 150 ft from Building #21.

5.3.3 In general it was found that all surface samples were much higher around Building #21 than further down the hill.

6. BUILDING #34

This building has a dual purpose: Serving as a drop test area for waste packages and simulation of pyrophoric metal training for the fire fighters.[15]

The empty 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 fire fighting practice to simulate pyrophoric situations. Radioisotopes of concern include:

uranium-238 oxide

7. BUILDING #50

Building 50 is designated as the assembly and testing building for the RTG (Radioisotopic Thermoelectric Generators).

In Building 50, the RTG is 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 with high 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.[16] [17]

8. BUILDING #59 (CFX)

This building contains a sub-critical assembly which has the capability to produce some fission products. However, all fission products were sealed inside aluminum containers so the probability of contamination is remote. The water surrounding the containers inside the assembly is constantly monitored and no contamination has been observed.[18] [19]

Californium-252 and enriched uranium were used for irradiation. These radioisotopes were encapsulated in metal cladding so no concern for internal dosimetry.[20] Some intentional irradiation is done with the major contamination being Fe-55,59 and Co-60.[21] [22] Radionuclides or concern are:

californium-252	uranium-234,235,238
iron-55,59	cobalt-60

Note: Historically the major radionuclides of concern were californium-252 and uranium-235 equally. In the future when tearing down the facility radionuclides of concern will be uranium-235 and iron-59 in the form of rust.[23]

This building has not been operational since 1990 and is not expected to ever operate again. [24]

9. BUILDING #68

This building functions as a decontamination and decommissioning staging area and handles the radionuclide waste from R Building.[25 26 27]

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:

plutonium-238 oxide plutonium-239 oxide

10. B-BUILDING

From ~1950 to ~1955 this building was used for biological research of the effects of polonium-210, actinium-227, and other alpha emitters on animals. These results were used to estimate the effects of radionuclides used at Mound on humans. All biological testing was discontinued in about 1955 when detonator manufacturing began. Biological research was discontinued by 1955. [28 29 30]

A Biological Research Quarterly from June of 1954 discusses some mice and rat experiments which were conducted over a two year period with polonium-210. In another experiment rats were given an actinium-227 solution which also contained thorium-227, radium-223, radon-219, polonium-215, and bismuth-211. [31]

Another report by D.S. Anthony and K.A. Bush discusses experimental results of single acute and multiple exposures of polonium-210 to rats with higher dosages of polonium than in the previous report. [32]

Studies with plutonium was also done with a special emphasis on Pu-238.

Other reports discuss experimental work using radium-226 and actinium-227.[33 34]

10.1 Room B-146

One of the lab rooms where early research was done.

Radioisotopes of concern and their compounds are:

polonium-210	actinium-227
plutonium-238	thorium-227
radium-223,226	radon-219
polonium-215	bismuth-211

10.1.1 Polonium-210 was the major radionuclide of concern with actinium-227 being secondary.[35]

10.1.2 Incident - (Pu-238, 7/5/78)[36]

10.1.3 B-Building was decontaminated by July of 1955. [37]

11. E-BUILDING

This building provides analytical services such as environmental labs. Functions include low level counting of soil and water samples, including fish and vegetation. [38]

11.1 Room E-105

(1949 - PRESENT) This room provides analytical services such as low level environmental counting.

11.2 Room E-107

(1949 - PRESENT) This room provides analytical services such as low level environmental counting. Low level plutonium-238 standards were produced in this room. They also leak checked welded containers containing tritium.[39] [40]

11.2.1 Operations have been drastically curtailed since 1990.

11.2.2 The fumehoods are contaminated.[41]

11.2.3 Incident - (plutonium, 9/30/88)[42]

11.3 Room E-113

(1952) This is a room where chemistry test tubes, pipettes, etc. were stored.

11.3.1 **Health Physics Monthly Information Report** reported alpha contamination from preparing slide mounts in R-Building and then placing the pipettes in clean test tubes and storing them in E-113. Somehow the rack holding the test tubes was contaminated which led to alpha contamination of E-113.[43]

11.4 Room E-141, 142, 144, 155

(1981 - 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 the lead-210 being encapsulated. These are all stored in E-141 but are also used in rooms E-142, 144, 155 which are also environmental labs. Radionuclides of concern are:[44]

plutonium-238,239	thorium-229,230
tritium	uranium-232,234,236,238
lead-210	

11.5 Rooms E-174, 175, 177, 185, 194

These rooms have been used for cold storage and were therefore not thought to contain any radionuclides. However, recent surveying has turned up items in these rooms which were contaminated with alpha, beta, and gamma radiation. The following specific results were found.[45]

11.5.1 Room 174 - alpha from an unknown source

11.5.2 Room 175 - beta and gamma from an unknown source

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

11.5.4 Room 185 - (~1985 - PRESENT) alpha and beta on metallurgical sample contaminated with U-235, a second sample with suspected contamination from Th-232.

11.5.5 Room 194 - alpha from possible plutonium, beta and gamma from possible U-235 and or U-238

An overview of operations in E Building include the following radionuclides of concern: [46] [47]

nitrate and chloride solutions of:

plutonium-238,239,242	uranium-232,234,235,236,238
thorium-229,230	polonium-210
tritium	lead-210

Note: Plutonium-238 was the major radionuclide of concern with polonium-210 being second and tritium third.[48]

12. H-BUILDING

Although this building performs many innocuous tasks such as credit union and change rooms, there are some activities which have the potential of radionuclide uptakes. [49]

The laundry had a "hot laundry" capability where clothes exposed to radionuclides were dealt with, which is the primary reason the building was built.

Bioassay labs and other environmental labs are housed in H Building and have the potential for low levels of exposure.

Most radionuclides are tracer nitrate and chloride solutions of Pu-238, Pu-239, Pu-242, U-232, U-236, and Th-229. Tritium and Po-210 may also be included. [50]

It has also been suggested that radium-226, thorium-228, and actinium-227 also be included in the list. [51]

Radionuclides and related compounds of concern are:

plutonium-238,239,242
thorium-228,229
radium-226
tritium
uranium-232,236
actinium-227
polonium-210

Note: Plutonium-238 was the major radionuclide of concern with polonium-210 being second and actinium-227 third.[52]

13. I BUILDING

I Building refers to "Isolation Building."

13.1 Low level counting of bioassay (urine and fecal) samples, and environmental counting such as soil, vegetation, etc., were done. There is little possibility of uptakes to be concerned with. [53]

13.2 (~1955 - PRESENT) This area is used for Non-Destructive Testing (NDT) and the assembly of explosive devices. No radionuclides are used. [54]

14. M BUILDING

Room M-20 had a Livermore drybox.[55]

Machining of uranium-238 was also done in this building.

15. P BUILDING

"P" for Powerhouse Building - In 12/12/50 there was an incident where a pipe broke spraying the body with 213°F steam. There was soft beta associated with this incident.[56]

Note: Very dilute tritium was the only radionuclide of concern.[57]

16. R & R BUILDING

This was a small building located between the SM and the PP Buildings. It was used for the sorting of plutonium solid waste, some of which could be reprocessed.[58 59]

Special concern was given to the old drums which had begun to leak. The material in these drums was sorted and repacked to alleviate any leaking problems.

The compound forms of this plutonium and lung solubility classes are as follows.

16.1 Plutonium oxide - PuO_2 - Class Y This could also take the form of a plutonium oxide hydrate - $PuO_2.XH_2O$

16.2 Plutonium hydroxide - $Pu(OH)_4$ - Class Y

16.3 Plutonium nitrate - $Pu(NO_3)_4$ - Class W This could also take the form of plutonium nitrate pentahydrate - $Pu(NO_3)_4.5H_2O$

16.4 Incident - (Pu-238, 2/27/74, several others)[60]

16.5 Plutonium-238 was the major radionuclide of concern with plutonium-239 being secondary.[61]

R & R Building no longer exists. It has been D&D'd.

17. SD BUILDING

(1947 - 1970) This was an old sanitation building which could have had some contaminated sludge from broken lines/pipes. Contamination would have been minor in concentration but radionuclides from the polonium processing could have been found there. Radionuclides of concern and related compounds are:[62]

iron-55,59	silicon-31
cobalt-60	lead-209
tin-121	zinc-65
chromium-55	vanadium-52
gallium-70,72	cesium-137
strontium-90	selenium-75
bismuth-210	silver-112
antimony-124	tellurium-121-->134?
mercury-203	polonium-208,209,210
silver polonide	tellurium polonide
polonium chloride	polonium nitrate
plutonium-238,239	

Note: Polonium-210 was the major radionuclide of concern with plutonium-238 second and zinc-65 being third.[63]

18. BUILDINGS WHERE RADIONUCLIDE UPTAKE IS UNLIKELY

No Radionuclide uptake for the following buildings is likely. Radionuclides may have been present in the past or may even be present now but are sealed in such a way that an uptake would be unlikely.

1. Building 19
2. Building 23
3. Building 30
4. Building 31
5. Building 41
6. Building 45
7. Building 51
8. Building 57

19. ENDNOTES AND REFERENCES

Note: The dates given here represent the date the person was contacted, and not when he was employed.

1. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;85

2. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

3. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;85

4. Paul Figgins, Senior Research Specialist, Consultant on ranking, 1/95

5. MLM-752, Health Physics Information Report, 8/31/52, page 4.

6. MLM-883, Health Physics Monthly Information Report, 7/31/53, page 5.

7. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

8. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;50-58

9. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

10. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;50-58

11. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 2;69-73

12. Paul Figgins, Senior Research Specialist, Consultant on ranking, 2/95

13. CERCLA, Vol 3, Site Scoping Report, 12/92, page 5;1-6

14. Paul Figgins, 11/93, Senior Research Specialist

15. Walter Wallace, 7/93, Senior Health Physicist

16. Walter Wallace, 7/93, Senior Health Physicist

17. Ernest Johnson, 10/93, Specialist, Heat Source Production

18. IRT-0033-001, Neutron Radiography Facility Safety Analysis Report, Kay Crosbie and Jack Young, 4/29/76

19. Analysis of Residual Radioactivity in CFX Core, A. Shapiro and J. Bartels, 5/92

20. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

21. Paul Figgins, 11/93, Senior Research Specialist

22. Paul Lamberger, 11/93, Specialist, Senior-1

23. Harold (Andy) Anderson, Manager Stockpile Evaluation, and Paul Lamberger, Specialist, Senior-1, Consultants on probable ranking, 2/95

24. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

25. Walter Wallace, 7/93, Senior Health Physicist

26. MLM-ML-88-48-0003, Final Report: R-149 Laboratory Decommissioning Project, J.R. Geichman, R.R. Jaeger, V.E. Castleberry, 9/30/88, page 3

27. Final Report, R-Building Decontamination & Decommissioning Project, September, 1993, R.L. Sohn, W.P. Davis, page 22

28. Paul Lamberger, 11/93, Specialist, Senior-1

29. Paul Lamberger, 10/93, Specialist, Senior-1

30. Doug Draper, 11/93, Manager of RAM

31. MLM-989, Biological Research Quarterly Progress Report through June 17, 1954, D.S. Anthony

32. J-77, "Experimental Data Useful in Establishing Maximum Permissible Single and Multiple Exposures to Polonium", D.S. Anthony, K.A. Bush, and entire staff of biological division, Mound, Miamisburg, Ohio, no date given.

33. Reports written by Stringam and Murphy in possession of Joe Garner, 1/94, Supervisor Health Physics

34. MLM-736, Health Physics Information Report, 7/31/52, page 6.

35. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

36. Incident #525 - Jarvis, J., 7/5/78, Pu-238, B-146

37. Quarterly Health Physics Report - April through June 1955, page 4.

38. Walter Wallace, 7/93, Senior Health Physicist

39. Paul Lamberger, 10/93, Specialist, Senior-1

40. Walter Wallace, 1/94, Specialist Health Physics

41. Phil Ryan, 7/95, Helth Physics Supervisor

42. Incident #492 - Mcatee, V., 9/30/88, plutonium, E-107

43. MLM-764, Health Physics Monthly Information Report, 9/30/52, page 5

44. Lowell (Hoppy) Hopkins, 7/95, Senior Chemist

45. Occurrence report: OH-MB-EGGM-EGGMAT04-1995-0004, 4/27/95, also latest 10 day Update 5/20/95

46. Paul Figgins, 11/93, Senior Research Specialist

47. Paul Lamberger, 11/93, Specialist, Senior-1

48. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

49. Walter Wallace, 7/93, Senior Health Physicist

50. Paul Figgins, 11/93, Senior Research Specialist

51. Joe Garner, 1/94, Supervisor Health Physics

52. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

53. Joe Garner, 1/94, Supervisor Health Physics

54. Jeff Mathews, 2/94, Manager of I Building

55. Incident, 5/24/55, Charles Wells, LiOH, M-20

56. Incident, Heinlein, Herman, 12/12/50, soft beta, P Building

57. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

58. Walter Wallace, 7/93, Senior Health Physicist

59. CERCLA, Vol 7, Waste Management, Weston Inc., 7/92, page 4;12

60. Incident #084 - 2/27/74, Gephart, P., Pu, R&R

61. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

62. The review committee for this document consisting of: Paul Lamberger, Jim O'Connell, Emil Mershad, Ray Ratay, Harold (Andy) Anderson, and Bob Myers.

63. Harold (Andy) Anderson, Manager Stockpile Evaluation, Consultants on probable ranking, 2/95

INFORMATION ON APPENDIX B

Appendix B is classified and is located in Document Control. It is a supplement to Section 1 and presents additional classified information for the buildings discussed above in Section 1. Information on the following rooms can be found in Appendix B:

R Building:	108	111	112	120
	127	129	130	133
	137	145	149	152
	160	161	167	171
	172			
SM Building:	3	10		
SW Building:	8	9	13	19
	22	142	150	152
	208	210	219	238
	240			
T-Building:	1W	2W	4E	36
	36A	48	49	50
	234	247	248	249
	250	251	252	253
	254	255	256	257
	258	259	260	266
	267	268	269	270
	271	277	279	
WD Building:	1	101		
WDA Building:	110			

APPENDIX A

This appendix will list most of the major daughter nuclides of the radionuclides listed in the main document. Only where branching occurs, and a very small fraction of the parent radionuclides is involved, will the daughters NOT be listed. Associated with the daughter radionuclides will be their nuclear half-life (not biological), and the result of decaying 1.0 curie of the parent radionuclide over a 50-year period. If the daughters are included in more than one branching scenario, then the activity of all occurrences will be summed together.

The parents are listed alphabetically with the daughters listed somewhat in the order they occur in the decay chain. The only exception to the ordered listing is where summing occurs with more than one appearance of a daughter radionuclide.

NUCLIDE	HALF-LIFE	CURIES
Actinium-225	1.00e+1 da	0.0
Fr-221	4.80e-0 min	0.0
At-217	3.23e-2 sec	0.0
Bi-213	4.57e+1 min	0.0
Pb-209	3.25e-0 hr	0.0
Po-213	4.20e-6 sec	0.0
Actinium-227	2.18e+1 yr	2.036e-1
Ra-223	1.14e+1 da	2.043e-1
Rn-219	3.96e-0 sec	2.043e-1
Po-215	7.78e-4 sec	2.043e-1
Pb-211	3.61e+1 min	2.043e-1
Bi-211	2.13e-0 min	2.043e-1
Tl-207	4.77e-0 min	2.038e-1
Th-227	1.87e+1 da	2.012e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Aluminum-26	7.20e+5 yr	9.999e-1
Antimony-124	6.02e+1 da	4.769e-92
Astatine-217	3.23e-2 sec	0.0
Bi-213	4.57e+1 min	0.0
Pb-209	3.25e-0 hr	0.0
Po-213	4.20e-6 sec	0.0
Calcium-45	1.63e+2 da	1.624e-34
Cesium-137	3.02e+1 yr	3.170e-1
Ba-137m	2.55e-0 min	2.999e-1
Cobalt-60	5.27e-0 yr	1.395e-3
Curium-244	1.81e+1 yr	1.475e-1
Pu-240	6.54e+3 yr	2.354e-3
U-236	3.42e+6 yr	1.556e-8
Th-232	1.41e+10 yr	1.456e-17
Ra-228	5.75e-0 yr	9.685e-18
Ac-228	6.13e-0 hr	9.684e-18
Th-228	1.91e-0 yr	8.223e-18
Ra-224	3.62e-0 da	8.215e-18
Rn-220	5.56e+1 sec	8.215e-18
Po-216	1.46e-1 sec	8.215e-18
Pb-212	1.06e+1 hr	8.215e-18

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Bi-212	6.06e+1 min	8.215e-18
Tl-208	3.05e-0 min	2.951e-18
Po-212	2.98e-7 sec	5.263e-18
Gallium-72	1.41e+1 hr	0.0
Hydrogen-3	1.23e+1 yr	5.947e-2
Iron-55	2.70e-0 yr	2.663e-6
Iron-59	4.46e+1 da	6.594e-124
Krypton-85	1.07e+1 yr	3.944e-2
Lead-209	3.25e-0 hr	0.0
Mercury-203	4.66e+1 da	1.063e-118
Neptunium-237	2.14e+6 yr	9.999e-1
Pa-233	2.70e+1 da	9.999e-1
U-233	1.59e+5 yr	2.172e-4
Th-229	7.34e+3 yr	5.109e-7
Ra-225	1.48e+1 da	5.097e-7
Ac-225	1.00e+1 da	5.089e-7

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Fr-221	4.80e-0 min	5.089e-7
At-217	3.23e-2 sec	5.089e-7
Bi-213	4.57e+1 min	5.089e-7
Pb-209	3.25e-0 hr	5.088e-7
Po-213	4.20e-6 sec	4.979e-7
Niobium-94	2.03e+4 yr	9.983e-1
Plutonium-236	2.85e-0 yr	5.256e-6
U-232	7.20e+1 yr	2.548e-2
Th-228	1.91e-0 yr	2.617e-2
Ra-224	3.62e-0 da	2.618e-2
Rn-220	5.56e+1 sec	2.618e-2
Po-216	1.46e-1 sec	2.618e-2
Pb-212	1.06e+1 hr	2.618e-2
Bi-212	6.06e+1 min	2.618e-2
Tl-208	3.05e-0 min	9.405e-3
Po-212	2.98e-7 sec	1.677e-2
Plutonium-238	8.78e+1 yr	6.737e-1
U-234	2.44e+5 yr	1.171e-4
Th-230	7.70e+4 yr	2.808e-8
Ra-226	1.60e+3 yr	2.081e-10
Rn-222	3.82e-0 da	2.079e-10
Po-218	3.05e-0 min	2.079e-10
Pb-214	2.68e+1 min	2.079e-10
Bi-214	1.99e+1 min	2.079e-10
Po-214	6.37e-5 sec	2.078e-10
Pb-210	2.23e+1 yr	6.202e-11

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Bi-210	5.01e-0 da	6.193e-11
Po-210	1.38e+2 da	5.952e-11
Plutonium-239	2.41e+4 yr	9.986e-1
U-235	7.04e+4 yr	4.921e-8
Th-231	2.55e+1 hr	4.920e-8
Pa-231	3.28e+4 yr	2.602e-11
Ac-227	2.18e+1 yr	9.686e-12
Ra-223	1.14e+1 da	9.625e-12
Rn-219	3.96e-0 sec	9.625e-12
Po-215	7.78e-4 sec	9.625e-12
Pb-211	3.61e+1 min	9.625e-12
Bi-211	2.13e-0 min	9.625e-12
Tl-207	4.77e-0 min	9.599e-12
Th-227	1.87e+1 da	9.515e-12
Plutonium-240	6.54e+3 yr	9.947e-1
U-236	3.42e+6 yr	1.101e-5
Th-232	1.41e+10 yr	1.250e-14
Ra-228	5.75e-0 yr	9.037e-15
Ac-228	6.13e-0 hr	9.037e-15
Th-228	1.91e-0 yr	7.962e-15
Ra-224	3.62e-0 da	7.956e-15
Rn-220	5.56e+1 sec	7.956e-15
Po-216	1.46e-1 sec	7.956e-15
Pb-212	1.06e+1 hr	7.955e-15
Bi-212	6.06e+1 min	7.955e-15
Tl-208	3.05e-0 min	2.858e-15
Po-212	2.98e-7 sec	5.097e-15

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Plutonium-241	1.44e+1 yr	9.011e-2
Am-241	4.32e+2 yr	2.870e-2
Np-237	2.14e+6 yr	3.254e-7
Pa-233	2.70e+1 da	3.244e-7
U-233	1.59e+5 yr	2.761e-11
Th-229	7.34e+3 yr	3.583e-14
Ra-225	1.48e+1 da	3.568e-14
Ac-225	1.00e+1 da	3.558e-14
Fr-221	4.80e-0 min	3.558e-14
At-217	3.23e-2 sec	3.558e-14
Bi-213	4.57e+1 min	3.558e-14
Pb-209	3.25e-0 hr	3.557e-14
Po-213	4.20e-6 sec	3.481e-14
Plutonium-242	3.76e+5 yr	9.999e-1
U-238	4.47e+9 yr	7.756e-9
Th-234	2.41e+1 da	7.742e-9
Pa-234m	1.17e-0 min	7.742e-9
Pa-234	6.70e-0 hr	1.239e-11
U-234	2.44e+5 yr	5.476e-13
Th-230	7.70e+4 yr	8.415e-17
Ra-226	1.60e+3 yr	3.538e-10
Rn-222	3.82e-0 da	5.466e-18
Po-218	3.05e-0 min	6.469e-18
Pb-214	2.68e+1 min	9.404e-18
Bi-214	1.99e+1 min	9.857e-18
Po-214	6.37e-5 sec	7.859e-18
Pb-210	2.23e+1 yr	1.009e-17
Bi-210	5.01e-0 da	1.122e-17
Po-210	1.38e+2 da	1.170e-17

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Polonium-209	1.02e+2 yr	7.119e-1
Pb-205	1.51e+7 yr	1.941e-6
Polonium-210	1.38e+2 da	1.868e-4
Potassium-40	1.28e+9 yr	1.000e+0
Promethium-146	2.02e+3 da	1.899e-3
Promethium-147	2.62e+0 yr	1.831e-6
Sm-147	6.90e+9 yr	3.802e-10

Promethium-148, 148m, 149 all have such short half-lives that essentially no measurable activity remains after 50 years. This is also true for the daughters.

Protactinium-231	3.28e+4 yr	9.989e-1
Ac-227	2.18e+1 yr	7.959e-1
Ra-223	1.14e+1 da	7.951e-1
Rn-219	3.96e-0 sec	7.951e-1
Po-215	7.78e-4 sec	7.951e-1
Pb-211	3.61e+1 min	7.951e-1
Bi-211	2.13e-0 min	7.951e-1
Tl-207	4.77e-0 min	7.930e-1
Th-227	1.87e+1 da	7.844e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Radium-223	1.14e+1 da	0.0
Rn-219	3.96e-0 sec	0.0
Po-215	7.78e-4 sec	0.0
Pb-211	3.61e+1 min	0.0
Bi-211	2.13e-0 min	0.0
Tl-207	4.77e-0 min	0.0
Radium-224	3.62e-0 da	0.0
Rn-220	5.56e+1 sec	0.0
Po-216	1.46e-1 sec	0.0
Pb-212	1.06e+1 hr	0.0
Bi-212	6.06e+1 min	0.0
Tl-208	3.05e-0 min	0.0
Po-212	2.98e-7 sec	0.0
Radium-225	1.48e+1 da	0.0
Ac-225	1.00e+1 da	0.0
Fr-221	4.80e-0 min	0.0
At-217	3.23e-2 sec	0.0
Bi-213	4.57e+1 min	0.0
Pb-209	3.25e-0 hr	0.0
Po-213	4.20e-6 sec	0.0
Radium-226	1.60e+3 yr	9.786e-1
Rn-222	3.82e-0 da	9.786e-1
Po-218	3.05e-0 min	9.786e-1
Pb-214	2.68e+1 min	9.783e-1
Bi-214	1.99e+1 min	9.783e-1
Po-214	6.37e-5 sec	9.781e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Pb-210	2.23e+1 yr	7.782e-1
Bi-210	5.01e-0 da	7.781e-1
Po-210	1.38e+2 da	7.746e-1
Radium-228	5.75e-0 yr	2.412e-3
Ac-228	6.13e-0 hr	2.412e-3
Th-228	1.91e-0 yr	3.615e-3
Ra-224	3.62e-0 da	3.621e-3
Rn-220	5.56e+1 sec	3.621e-3
Po-216	1.46e-1 sec	3.621e-3
Pb-212	1.06e+1 hr	3.621e-3
Bi-212	6.06e+1 min	3.621e-3
Tl-208	3.05e-0 min	1.301e-3
Po-212	2.98e-7 sec	2.321e-3
Rhodium-106	2.99e+1 sec	0.0
Selenium-75	1.20e+2 da	1.267e-46
Silicon-31	1.57e+2 min	0.0
Strontium-90	2.86e+1 yr	2.977e-1
Y-90	6.41e+1 hr	2.977e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES

Tellurium-121, 125, 127, 131, 132, 133, 134 all have such short half-lives that essentially no measurable activity remains after 50 years. This is also true for the daughters.

Tellurium-123	1.00e+13 yr	1.000e-0
Tellurium-129	6.96e+1 min	0.000e-0
I-129	1.57e+7 yr	8.429e-12
Thorium-228	1.91e-0 yr	1.358e-8
Ra-224	3.62e-0 da	1.365e-8
Rn-220	5.56e+1 sec	1.365e-8
Po-216	1.46e-1 sec	1.365e-8
Pb-212	1.06e+1 hr	1.365e-8
Bi-212	6.06e+1 min	1.365e-8
Tl-208	3.05e-0 min	4.907e-9
Po-212	2.98e-7 sec	8.750e-9
Thorium-229	7.34e+3 yr	9.953e-1
Ra-225	1.48e+1 da	9.953e-1
Ac-225	1.00e+1 da	9.953e-1
Fr-221	4.80e-0 min	9.953e-1
At-217	3.23e-2 sec	9.953e-1
Bi-213	4.57e+1 min	9.953e-1
Pb-209	3.25e-0 hr	2.150e-2
Po-213	4.20e-6 sec	9.738e-1
Pb-209	3.25e-0 hr	9.738e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Thorium-230	7.70e+4 yr	9.996e-1
Ra-226	1.60e+3 yr	2.142e-2
Rn-222	3.82e-0 da	2.142e-2
Po-218	3.05e-0 min	2.142e-2
Pb-214	2.68e+1 min	2.141e-2
Bi-214	1.99e+1 min	2.141e-2
Po-214	6.37e-5 sec	2.141e-2
Pb-210	2.23e+1 yr	1.058e-2
Bi-210	5.01e-0 da	1.058e-2
Po-210	1.38e+2 da	1.039e-2
Thorium-232	1.41e+10 yr	1.000e-0
Ra-228	5.75e-0 yr	9.976e-1
Ac-228	6.13e-0 hr	9.976e-1
Th-228	1.91e-0 yr	9.964e-1
Ra-224	3.62e-0 da	9.964e-1
Rn-220	5.56e+1 sec	9.964e-1
Po-216	1.46e-1 sec	9.964e-1
Pb-212	1.06e+1 hr	9.964e-1
Bi-212	6.06e+1 min	9.964e-1
Tl-208	3.05e-0 min	3.580e-1
Po-212	2.98e-7 sec	6.383e-1
Uranium-232	7.20e+1 yr	6.180e-1
Th-228	1.91e-0 yr	6.348e-1
Ra-224	3.62e-0 da	6.349e-1
Rn-220	5.56e+1 sec	6.349e-1
Po-216	1.46e-1 sec	6.349e-1
Pb-212	1.06e+1 hr	6.349e-1
Bi-212	6.06e+1 min	6.349e-1

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Tl-208	3.05e-0 min	2.281e-1
Po-212	2.98e-7 sec	4.068e-1
Uranium-233	1.59e+5 yr	9.998e-1
Th-229	7.34e+3 yr	4.710e-3
Ra-225	1.48e+1 da	4.705e-3
Ac-225	1.00e+1 da	4.701e-3
Fr-221	4.80e-0 min	4.701e-3
At-217	3.23e-2 sec	4.701e-3
Bi-213	4.57e+1 min	4.701e-3
Pb-209	3.25e-0 hr	4.701e-3
Po-213	4.20e-6 sec	4.599e-3
Uranium-234	2.44e+5 yr	9.999e-1
Th-230	7.70e+4 yr	4.500e-4
Ra-226	1.60e+3 yr	4.839e-6
Rn-222	3.82e-0 da	4.836e-6
Po-218	3.05e-0 min	4.836e-6
Pb-214	2.68e+1 min	4.835e-6
Bi-214	1.99e+1 min	4.835e-6
Po-214	6.37e-5 sec	4.834e-6
Pb-210	2.23e+1 yr	1.774e-6
Bi-210	5.01e-0 da	1.772e-6
Po-210	1.38e+2 da	1.721e-6
Uranium-235	7.04e+8 yr	1.000e-0
Th-231	2.55e+1 hr	1.000e-0
Pa-231	3.28e+4 yr	1.057e-3
Ac-227	2.18e+1 yr	5.283e-4

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES
Ra-223	1.14e+1 da	5.263e-4
Rn-219	3.96e-0 sec	5.193e-4
Po-215	7.78e-4 sec	5.263e-4
Pb-211	3.61e+1 min	5.263e-4
Bi-211	2.13e-0 min	5.263e-4
Tl-207	4.77e-0 min	5.249e-4
Th-227	1.87e+1 da	5.198e-4
Uranium-238	4.47e+9 yr	1.000e-0
Th-234	2.41e+1 da	1.000e-0
Pa-234m	1.17e-0 min	1.000e-0
Pa-234	6.70e-0 hr	1.600e-3
U-234	2.44e+5 yr	1.415e-4
Th-230	7.70e+4 yr	3.177e-8
Ra-226	1.60e+3 yr	2.277e-10
Rn-222	3.82e-0 da	2.275e-10
Po-218	3.05e-0 min	2.275e-10
Pb-214	2.68e+1 min	2.275e-10
Bi-214	1.99e+1 min	2.275e-10
Po-214	6.37e-5 sec	2.274e-10
Pb-210	2.23e+1 yr	6.671e-11
Bi-210	5.01e-0 da	6.660e-11
Po-210	1.38e+2 da	6.395e-11
Vanadium-52	3.75e-0 min	0.0

APPENDIX A, continued

NUCLIDE	HALF-LIFE	CURIES

Xenon-122, 125, 127, 129, 131, 133, 135, 137, 138 all have such short half-lives that no essentially no measurable activity remains after 50 years. This is also true for the daughters.

Xenon-123	2.14e-0 hr	0.0
I-123	1.31e+1 hr	0.0
Te-123	1.00e+13 yr	2.441e-17

Yttrium-88, 90, 90m, 91, 91m all have such short half-lives that no essentially no measurable activity remains after 50 years. This is also true for the daughters.

Zinc-65	2.44e+2 da	3.206e-23
Zirconium-93	1.53e+6 yr	9.999e-1
Nb-93m	1.46e+1 yr	9.069e-1
Zirconium-95	6.40e+1 da	1.341e-86
Nb-95	3.51e+1 da	2.965e-86