

***Historical Background Report
for Rocky Flats Plant Waste
Shipped to the INEEL and
Buried in the SDA from
1954 through 1971***

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**Idaho
Completion
Project**

May 2004

Bechtel BWXT Idaho, LLC

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May 2004

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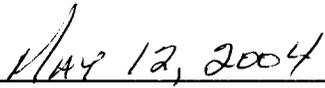
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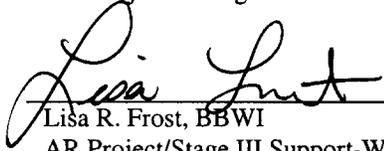
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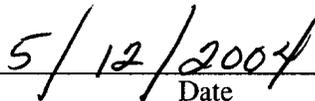
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EXECUTIVE SUMMARY

The purpose of this background report is to provide the acceptable knowledge information for pre-1970 Rocky Flats waste as required by the Waste Isolation Pilot Plant (WIPP) hazardous waste facility permit and the WIPP Waste Acceptance Criteria. The document will be used to support the characterization and disposition of waste generated by the Rocky Flats Environmental Technology Site, which was known as the Rocky Flats Plant (RFP) during the 1953 through 1970 timeframe, and disposed at the Idaho National Engineering and Environmental Laboratory (INEEL) Subsurface Disposal Area. This document and its supporting documentation are intended to provide a consistent, defensible, and auditable record of acceptable knowledge for the waste.

Preliminary hazardous waste determination and radioisotopic content evaluation were made for the RFP wastes based on the information in this report as taken from the acceptable knowledge documents reviewed. Also provided are summarizations of the WasteOScope data for each of the generators identified and as disposed of in the Subsurface Disposal Area pits and trenches.

The use of acceptable knowledge to make hazardous waste determinations by waste generators and treatment, storage, and disposal facilities was authorized by the Resource Conservation and Recovery Act (RCRA) and New Mexico Hazardous Waste Management Regulations. Knowledge of the materials and processes that generated a waste was used for baseline characterization of transuranic (TRU) wastes presented in this document. Acceptable knowledge includes information relating to plant history, process operations, and waste management, in addition to waste-specific data generated prior to the effective date of the RCRA regulations. Acceptable knowledge, as an alternative to sampling and analysis, can be used to meet all or part of the waste characterization requirements under RCRA.

The wastes addressed by this document include containers of TRU and non-TRU low level radioactively contaminated wastes shipped from RFP to INEEL from 1954 through 1970. The wastes consist of a wide variety of matrices generated during plutonium pits production; depleted uranium component fabrication; enriched uranium processing; support operations including recovery, treatment, maintenance, laboratory, machining of non-nuclear weapon components, and research and development; and special order work. The inventory also contains wastes generated by nonroutine events including renovations, spills, fires, and decommissioning. The wastes are also contaminated with chemical and other hazardous materials used in the various RFP processes and may be commingled with non-defense related wastes in the disposal area.

In addition to published documents describing the inventory and historical operations, acceptable knowledge documentation was collected from numerous other sources including the RFP library, historical document archives, operator historical records, and interviews with cognizant personnel. This includes references to initial and confirmatory acceptable knowledge data that were generated during the 3,100 m³ Project. Those data were collected for waste generated at the RFP from November 1970 through 1989 and were for waste in containers that were characterized and sent for disposal at the WIPP facility, or stored in the INEEL accessible storage inventory. However, the continuity of processes and similarities of source material made much of that data sufficiently relevant to be included in this report.

Over 500 sources of information were obtained and reviewed. The information presented is traceable to the source by the alpha-numeric references in the text of this document. The references are divided into published documents, unpublished data, and correspondence, which correspond to the "P," "U," and "C" references. An additional class of document, the Discrepancy Resolution, was generated specifically to provide a record of the resolution of apparent discrepancies among multiple documents that were reviewed and included as part of the acceptable knowledge record. These documents correspond to the "D" references.

Once acceptable knowledge information was identified and obtained, the documentation was summarized; the summaries documented using an established procedure; and, both the summaries and documents were incorporated into a database and source document library. Additional acceptable knowledge documents and corroborating data will be accumulated in the future, and will be incorporated in future revisions or supplements to this report.

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ACRONYMS AND ABBREVIATIONS

74A	Building 74 ponds; A = catch pond for run off; B = process waste pond; C = B output
AEC	Atomic Energy Commission
ANL-W	Argonne National Laboratory-West
AK	acceptable knowledge
²⁴¹ Am	americium-241
BBWI	Bechtel BWXT Idaho, LLC
Be	beryllium
Bldg.	building
CBFO	Carlsbad Field Office
CC	cemented firebrick
Ci/g	curies per gram
CPC	Coors Porcelain Company
CPR	cellulosics, plastic, and rubber
CWS	Chemical Warfare Service
D-38	Tuballoy, a depleted uranium form with less of the fissionable U-235 isotope than the approximate 0.7 percent by weight found in natural uranium and rich in the ²³⁸ U isotope
DCHP	dicesium hexachloroplutunate
DOE	Department of Energy
DOR	direct oxide reduction
DOT	Department of Transportation
DOW	DOW Chemical Company
DU	depleted uranium
EDL	economic discard limit
EU	enriched uranium
F	graphite
ft ²	square foot

G	percolation still bottoms (from uranium processes)
g/ft ³	gram per cubic foot
g/g	gram per gram
HEPA	high-efficiency particulate air (filter)
HEU	highly enriched uranium (RF-C021)
hr	hour
HWN	hazardous waste number
IAD	Immediate Action Directive
ICC	Interstate Commerce Commission
IDC	item description code
IDR	initial drum retrieval
in.	inch(s)
INEL	Idaho National Engineering Laboratory
INEEL	Idaho National Engineering and Environmental Laboratory
LGW	line generated waste (RF-C045)
LLD	lead lined drum (high gamma)
LLW	low-level waste
m	meter
MLLW	mixed low-level waste
mr	millirem
MSE	molten salt extraction
MTD	empty drum [used on the empty contaminated lathe coolant (oil) drums; RF-C027]
MTC	empty container (RF-C045)
MUD	Impure materials contaminated with HEU ground to a fine powder for nitric acid leaching. The nitric acid solution was filtered and the solids collected from the process were called MUD
MUF	material unaccounted for

NDA	non-destructive assay
NOL	normal operating loss
NOS	not otherwise specified
nret	non-retrievable
NRTS	National Reactor Testing Station
OASIS	Organic and Sludge Immobilization System
ORNL	Oak Ridge National Laboratory
OT	possibly depleted uranium oxide (RF-C021)
OY	Oralloy, a form of highly enriched uranium (RF-C021)
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene (perchloroethylene)
Pu	plutonium
PVC	polyvinyl chloride
R&D	research and development
RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
RFP	Rocky Flats Plant
RO	roaster oxide (RF-C045)
RWMC	Radioactive Waste Material Complex
SDA	Subsurface Disposal Area
SNM	special nuclear material
SS	special source
SSNM	strategic special nuclear material
SVOC	semivolatile organic compound
T	tuballoy (a form of depleted uranium; RF-C021, RF-P085)
TOSCO	The Oil Shale Corporation

TRU	transuranic
VOC	volatile organic compound
WAC	waste acceptance criteria
WILD	Waste Information and Location Database
WIPP	Waste Isolation Pilot Plant
WP	waste paper
ZPPR	Zero Power Physics Reactor

Historical Background Report for Rocky Flats Plant Waste Shipped to the INEEL and Buried in the SDA from 1954 through 1971

1. INTRODUCTION

The purpose of this background report is to provide the acceptable knowledge (AK) information required by the Waste Isolation Pilot Plant (WIPP) hazardous waste facility permit and the WIPP Waste Acceptance Criteria to support the characterization and disposition of waste generated by the Rocky Flats Environmental Technology Site (RFETS) from 1954–1970, which was known as the Rocky Flats Plant (RFP) during that timeframe, and disposed at the Idaho National Engineering and Environmental Laboratory (INEEL) Subsurface Disposal Area (SDA), located at the Radioactive Waste Management Complex (RWMC).

Several names have been used in the AK source documentation to designate the RFP and the Idaho burial grounds sites, including Rocky, Rocky Flats Site, Rocky Flats Environmental Technology Site, and RFP; and Arco, the Idaho desert, the Idaho site, the Idaho burial grounds, the National Reactor Testing Station (NRTS), the Idaho National Engineering Laboratory (INEL), and the INEEL, respectively. From this point on in this report, the RFP and the Idaho site will be identified by the RFP and INEEL acronyms.

This document was organized to provide the reader a comprehensive presentation of the transuranic (TRU) waste inventory for the period of coverage, including descriptions of the historical plant operations that generated and managed the wastes to specific information about the composition of each waste. Brief descriptions of each section are as follows:

- Section 1: An RFP facility overview and mission description.
- Section 2: The defense waste determination rationale.
- Section 3: A general description of the TRU Waste Management Program for the relevant period, including categorization schemes, packaging, characterization and inspections, waste criteria, and limitations. INEEL disposal requirements, the method used to tabulate the different wastes shipped to the INEEL from RFP, and an explanation of the rationale and delineation of the wastes into seven waste types are also presented.
- Section 4: 19 subsections with descriptions of operations and processes for 17 RFP buildings from which the wastes were generated, other sources or wastes, and the wastes from off-site generations trans-shipped by RFP to INEEL. Each subsection includes a discussion of historical operations and waste characteristics (such as physical forms and waste matrices, and chemical and radioisotopic contaminants potentially present in the wastes).
- Section 5: A summary of the as-disposed waste types and disposal volumes is presented along with a discussion of potential implications of known or suspected chemical constituents for hazardous waste classification.
- Section 6: Discussion of the distribution of radioisotopes in the wastes, especially with respect to estimated mass fractions values for weapons grade plutonium, highly enriched uranium (HEU), and depleted uranium.

Also included in this report are the following supporting appendices:

- Appendix A: A discussion of WasteOScope processes used throughout this report, including limitations, assumptions, and summary data tables.
- Appendix B: The discrepancy resolution that was written to resolve the disparities in waste designations used in the AK documents reviewed.
- Appendix C: A list of the AK source documents reviewed and/or referenced.

2. ROCKY FLATS PLANT FACILITY OVERVIEW

The U. S. Atomic Energy Commission (AEC) announced its decision on March 23, 1951, to build the RFP. The plant was built to increase the quantity and quality of the nation’s nuclear arsenal and played an important role in the U.S. nuclear weapons complex from that time until 1990 (RF-P085). The plant was intended from the beginning to be a manufacturing facility. The primary activities at the RFP involved the manufacture of nuclear weapons components; specifically, primaries (commonly called triggers; RF-U115). Rocky Flats also had a role in the retirement of weapons, dismantling the components it originally produced to retrieve and recycle materials. Table 2-1 is a timeline of pertinent events that took place at RFP from 1951 through 1970.

In the early years, similar weapons components were manufactured at Rocky Flats, Hanford, Oak Ridge National Laboratory (ORNL), and Los Alamos. In the early 1960s, the government converted to the “single mission” concept, when the Department of Energy (DOE) facilities became specialized providers of key weapons components and services. Rocky Flats became the primary facility for production of ‘pits’ or primaries and Rocky Flats’ enriched uranium work was relocated to the Oak Ridge Reservation in between 1964 and 1966 (RF-P084, RF-P085, RF-115).

Research and development (R&D) was always part of the activities at the RFP. However, the focus of the work was not in the area of weapons design or development, but directed toward other areas, including metallurgy of plutonium and uranium; recovery and purification of those materials; and improving the manufacturing operation, processes, and assembly techniques (RF-P085).

During the course of manufacturing metal products and recovering plutonium, uranium, and americium, radioactively contaminated wastes were generated that are contaminated with fissionable and non-fissionable materials; associated lubricating and cleaning compounds; and other materials such as rags, slags, sludges, clothing, tools, and paints. Starting in 1954 and continuing until 1970, the majority of these wastes were shipped to INEEL for disposal in the SDA. (RF-P085)

Table 2-1. Timeline of pertinent events at the RFP site from 1951–1970 (RF-P084, RF-P085, RF-U115).

Date	Event
3/23/51	AEC announced decision to build Rocky Flats Plant.
July 1951	Groundbreaking for first permanent building (Bldg. 991, D-Plant) at the RFP site.
Later in 1951	Construction began on Buildings 771 (C-Plant), 444 (A-Plant), and 881 (B-Plant).
1952	First operations – building start-ups and process equipment testing began.
1952	Building 774 built to treat radioactive aqueous waste.
1952	Building 881 was constructed to house HEU component manufacturing, and in 1954 housed all HEU operations (casting to forming, machining, assembly, recovery, and purification).
1953	First production products (primaries and plutonium buttons) completed.
1954	RFP was fully operational. National Reactor Testing Station (NRTS) in Idaho approved to receive waste from RFP.
April 22, 1954	First shipment of wastes from RFP to Idaho (RF-C077).
April 1954 through September 1958	Debris, oils, and concreted dry material wastes considered plutonium-contaminated were accumulated in the ‘Mound Area’ on the RFP site (RF-C084; see Figure 2-1).

Table 2-1. (continued).

Date	Event
1955	First major facility expansion. Included increasing capability for producing larger plutonium buttons.
1956/1957	Buildings 447, 776, 777, 883, and the Building 991 tunnels (997, 998, and 999) were constructed. Additions were made to Buildings 444, 881, and 771 (annexes and laboratory spaces).
1957	Building 774 in service to collect plutonium-contaminated organic liquids from machining operations.
1957	Change in concept resulting in a shift in relative amounts of uranium and plutonium used in trigger production; more plutonium and beryllium components; less uranium. See first 1958 entry below.
1957	Americium recovery and purification began for shipment to the Isotope Pool at ORNL. Most of the waste from the americium recovery line was waste packaged in lead-lined containers.
September 11 and 12, 1957	Plutonium casting residue fire occurred in the development laboratory in Building 771. Processes were moved to Building 776 and combustible Chemical Warfare Service (CWS) filters were replaced with comparable filters with asbestos media.
1958	Full-scale beryllium (Be) production operations began in Building 444. Additional processing of depleted uranium (DU) components began as required by the change in concept in Building 883.
1958	Plutonium fabrication operations moved from Building 771 to Building 776 (Recovery operations remained in Building 771).
September 1958	Contaminated waste drums were moved from the Mound Area at RFP to the 903 open storage area (RF-C084).
July 1959	All unburied drums (from the Mound Area) were moved to the 903 area (RF-C084).
1960	Solvent extraction (tributylphosphate and dodecane) was replaced by anion exchange in the plutonium recovery process line in Building 771.
Early 1960s	The government converted to a "single mission" approach, where various DOE facilities became specialized providers of key weapons components and services. RFP became the primary facility for production of 'pits' or triggers.
1963	Rocky Flats' enriched uranium work and enriched uranium recovery operations were relocated to ORNL.
1963	A continuous rotary fluorinator, a continuous precipitator, and a continuous calcinatory were installed in Building 771.
June 21, 1963	Discontinuance by the AEC of the NRTS as an interim burial site for off-site radioactive waste with the exception of RFP waste (RF-C072).
1964	Plutonium recovery capability and capacity expanded in Building 771.
April 8, 1964	Future waste shipments from RFP to NRTS will be unclassified. No classified D-38 oxides, classified shapes, or other materials will be included in future packages (RF-C105).
1964-1966	Stainless steel component work began in Building 881.
1965	Treatment of aqueous liquids by evaporation and storage of contaminated organic liquid wastes began in Building 774.
1967	A second major plant expansion – included construction of Building 559.

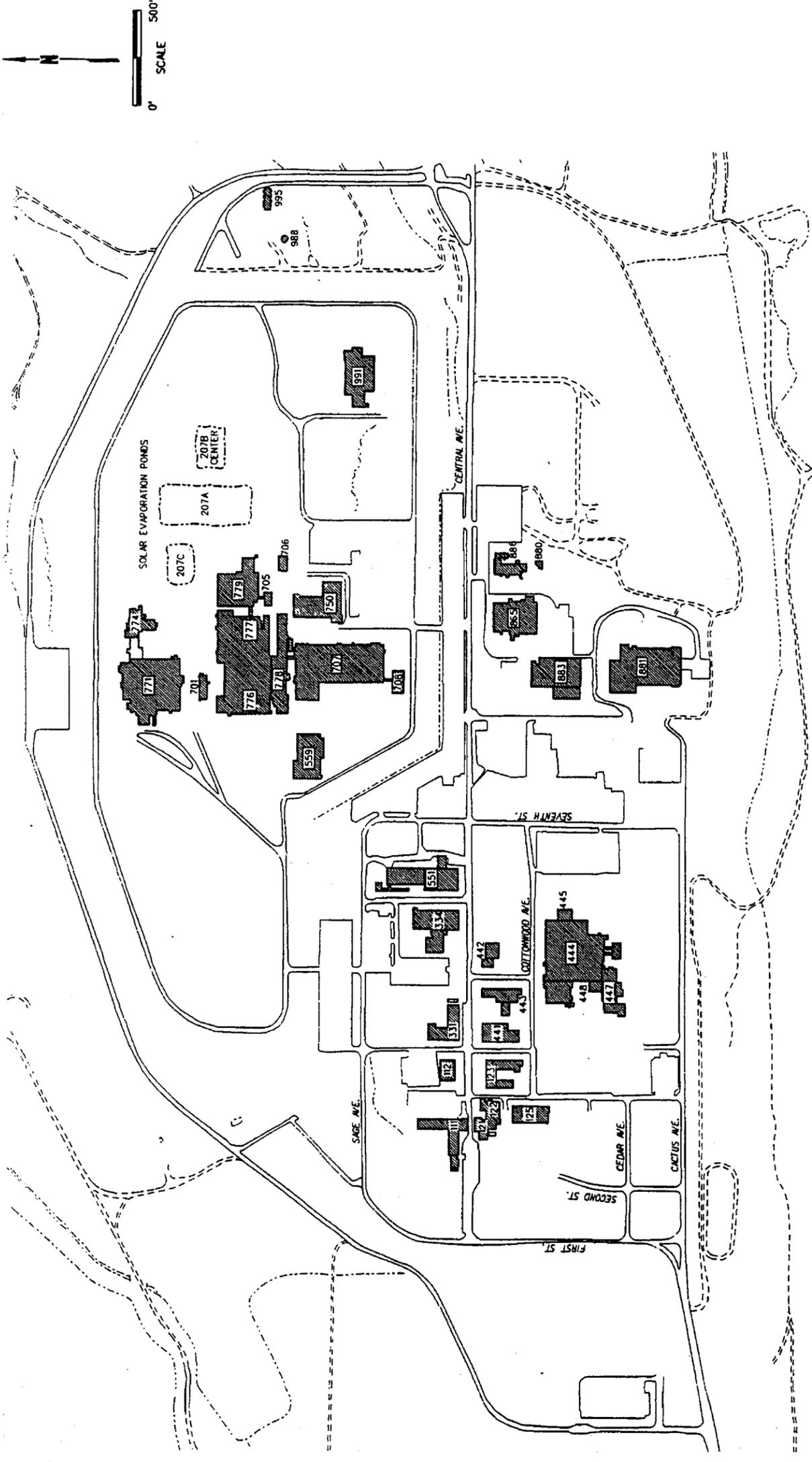
Table 2-1. (continued).

Date	Event
1967	Molten salt extraction (MSE) process implemented in Building 776. MSE became the feed source for the americium purification process.
1968-1969	Neptunium used in studies and in fabrication of foil in Building 779. Neptunium oxide purified for ORNL (Building 771; RF-P090).
1969	Several operations relocated to other buildings due to the major fire in Buildings 776 and 777. Fabrication capability lost until Building 707 came on line.
~ October 1970	Burial of plutonium-contaminated wastes at the INEEL was discontinued. IAD 0511-21 (1970) requirement initiated that plutonium-contaminated wastes were to be segregated from other wastes, and if buried, to be buried in readily retrievable containers (RF-U161). However, uranium-contaminated waste continued to be accepted for burial into 1971.

2.1 Location and Description

The RFP is located in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver. The 6,550-acre DOE-owned and contractor-operated facility was part of the nationwide nuclear weapons production complex. Construction of the first permanent buildings for the plant began in 1951. By 1954, approximately 700,000 ft² of building space had been completed. Originally, the plant was separated into four areas of operations. These areas were known as the A, B, C, and D Plants, and were established according to the four primary types of work which took place at Rocky Flats. The A-Plant included Building 444 operations, which involved almost exclusively the fabrication of DU components, graphite molds, and tools used in machining operations. The B-Plant is now known as Building 881, where enriched uranium was recovered and used in the manufacture of components. C-Plant is now Building 771, which housed plutonium operations, and D-Plant (Building 991) was the center of final product assembly operations. Each of the four plants was operationally independent and separate from the others during the early years of operations. As the plant operations expanded, as much as 1.6 million ft² of space was occupied by manufacturing, chemical processing, plutonium recovery, and waste treatment operations. Plutonium operations were located primarily in the 384-acre high-security area (Protected Area; RF-P085).

A map of the Rocky Flats site as it was in 1970 is provided as Figure 2-1 (RF-P085). The waste generators, including RFP buildings and structures that were identified on RFP shipping records and recorded in the Bechtel BWXT Idaho, LLC (BBWI) database, originally named WasteOScope (RF-U169), are listed in Table 2-2. The database was developed from an extensive review of the shipping records for RFP wastes shipped during the 1954 to 1971 timeframe. The shipping records referred to include the AEC Form 740s and the trailer load lists. WasteOScope refers to the data downloaded on February 10, 2004. Since that time, the database was renamed the Waste Information and Location database, and is currently under review and validation. For this report, the name "WasteOScope" will be retained because the supporting data on compact disc carries that title. Also provided in the table are approximate dates of construction and brief descriptions for those buildings. Several of the waste generator numbers shown in the Building/Generator column and used in shipping records do not identify the source building or generator. It is assumed that these numbers were assigned to designate waste type or other conditions not as yet identified. It was determined that the number 741, 742, 743, 744, and 745 designate the '74 series' sludge wastes from the liquid waste treatment in Building 774, and that the '87 series' (870, 871, and 872), as well as the 892 designation, identify oil wastes.



Key to buildings:

No.	Description
111	Administration
112	Cafeteria
121	Plant Protection
122	Medical
123	Health Physics
125	Standards Laboratory
331	Garage & Fire Station
334	General Shop, Maintenance
441	Production Support
442	Filter Test Laboratory
443	Heating Plant
444	Depleted Uranium & Beryllium Operations
445	Carbon Storage
447	Manufacturing
448	Shipping, Receiving, Storage
551/553	General Warehouse
559	Plutonium Analytical Lab
701	Pilot Plant Development
705	Coatings Laboratory
706	Library
707	Manufacturing
708	Compressor Building
750	Production Engineering Facility
771	Plutonium Recovery
774	Waste Treatment Plant
776	Manufacturing
777	Assembly
778	Service Building
779	Plutonium Development
865	Material & Process; R&D Metallurgical Facility
880	Storage
881	Stainless Steel Manufacturing
883	Rolling and Forming
886	Nuclear Criticality Safety
988	Tertiary Treatment Pump House
991	Production Warehouse and Final Assembly Bldg. (Originally D- Plant)
995	Sewage Treatment Facility

Figure 2-1: Rocky Flats Facility as it appeared in 1970. Map developed from maps and information in ChemRisk document, Reconstruction of Historical Rocky Flats Operations, and Identification of Release Points.

Figure 2-1. Map of the Rocky Flats site as it was in 1970.

Table 2-2. RFP waste generators; including buildings and structures that were identified as having generated wastes sent to the INEEL from 1954 through 1970 (RF-P084, RF-P085, RF-U169).

Date Constructed	Building/ Generator	Building Description/Processes
1953	122 & 122S	Medical facility/treatment or decontamination of personnel
1953 or earlier	123	Health Physics Laboratory/radioactive contamination measurements.
1957	207A	Solar evaporation pond
1960	207B & C	Solar evaporation ponds
1952	218	Acid storage tanks area
1953 or earlier	331	Garage and Fire Station/Vehicle maintenance. Portion of the building was used as R&D Laboratory (RF-P065, RF-U115)
1953 or earlier	441	Production Support Laboratory/Uranium recycle, R&D, and general chemical analyses.
1953	444	Originally the A-Plant; depleted uranium and beryllium metallurgy/beryllium machining, production plating, assembly welding, brazing, etching, and coating, foundry, graphite mold production and cleaning, crucible cleaning, DU machining, and tool fabrication.
1957	445	Carbon storage and location of A-Plant exhaust filter plenum.
1956	447	Manufacturing building/electron beam welding, electrochemical milling operations, heat treatment operations, Vacuum Arc Melt Furnace, chip roaster.
1953 or earlier	551	General Warehouse/Receipt and storage of supplies including chemicals, and housed an area for mock-up testing & training.
	553	Annex to Building 551, Warehouse. Used as a generator ID in shipping records and WasteOScope.
1968	559	Plutonium Analytical Lab/spectrochemical, chemical, and mass spectrometric analysis.
1965	701	Waste Treatment Research and Development Facility/design, build, and evaluate development of processes.
1966	705	Coatings Laboratory/laboratories and offices/vapor deposition operations, metallography.
1967	707	Built to support production of the Part V weapons design not included in Building 776/777. Acquired plutonium foundry, casting, and machining functions from Building 776/777 as a result of the 1969 fire, but did not start operations until May 1970.
N/A	741*	Used as a generator ID in shipping records and WasteOScope. One of the 74 series sludges: First Stage Sludge.
N/A	742*	Used as a generator ID in shipping records and WasteOScope. One of the 74 series sludges: Second Stage Sludge.
N/A	743*	Used as a generator ID in shipping records and WasteOScope. One of the 74 series sludges: 743 Grease Plant Sludge.
N/A	744*	Used as a generator ID in shipping records and WasteOScope. One of the 74 series sludges: Solidified waste/Cemented liquid wastes – Bottle Process.
N/A	745*	Used as a generator ID in shipping records and WasteOScope. One of the 74 series sludges: Evaporator Salts.

Table 2-2. (continued).

Date Constructed	Building/ Generator	Building Description/Processes
N/A	746*	Used as a generator ID in shipping records and WasteOScope. Used for empty contaminated drums and associated debris.
1953	771	Originally the C-Plant; Plutonium Recovery Operations/Plutonium recovery, distillation of carbon tetrachloride, incinerator (fissile material recovery), ion exchange, caustic scrubber, americium recovery, and purification.
1953	774	Process Waste Treatment Facility/nuclear waste packaging facility, decontamination, caustic precipitation; converted to storage in 1981.
1957	776/777	Assembly and Manufacturing Buildings/Plutonium machining. Plutonium components manufacturing including casting and fabrication; housed plutonium foundry, machining, storage, assembly, and certification.
1965	779	Plutonium Research and Development Building/Research chemistry and metallurgy of plutonium to improve manufacturing and recovery processes.
N/A	870*	Used as a generator ID in shipping records and WasteOScope for oil waste. Generated from Building 883 processes.
N/A	871*	Used as a generator ID in shipping records and WasteOScope for oil waste.
N/A	872*	Used as a generator ID in shipping records and WasteOScope for oil waste.
1953	881	Originally the B-Plant; Enriched Uranium Recovery & Manufacturing (1952–66); Stainless steel manufacturing (1966-1984; RF-P084). Also laboratories, maintenance shops, and plant support/U-235 processing.
1957	883	Beryllium and Uranium Machining Facility/rolling and forming HEU and DU, Be rolling, Be machining.
1965	886	Nuclear Safety Facility/nine tanks with uranyl nitrate in nitric acid and four empty utility tanks/safety experiments for equipment design.
1966	889	Uranium Contaminated Equipment Decontamination Building (used as a drum prefix for housekeeping waste–combustible/debris). Used as a generator ID in 1954 through 1970 shipping records and WasteOScope for drums of debris and some inorganic sludge waste.
N/A	892*	Used as a generator ID in shipping records and WasteOScope for drums of debris.
1953 or earlier	991	Originally the D-Plant, Final Assembly Building; later became Production Warehouse and Final Assembly Building.

* Additional numbers used in shipping records (load lists) and in WasteOScope in the generator column to identify specific wastes as described above.

2.2 Rocky Flats Plant Mission Description

The Rocky Flats site had two primary missions during the period of operations from 1952 through 1990: (1) the manufacture and assembly of nuclear weapons components, and (2) the processing of retired weapons and other materials for plutonium, americium, and uranium recovery. In general, the plant's primary missions changed little from 1952 until 1990, when plutonium operations were suspended (RF-P085).

The primary nuclear weapon component manufactured and assembled at the RFP site were triggers, also known as 'pits.' The triggers are the first-stage fission bombs used to initiate the second-stage fusion reaction in hydrogen bombs. With the exception of periodic refinements, only three trigger configurations were manufactured at the plant. The first two trigger designs were solid units manufactured primarily of uranium, similar to the devices used during World War II. In 1957, the trigger design was changed to sealed hollow spheres, which were manufactured with much less uranium and more plutonium. This design change resulted in lighter, smaller, and more powerful weapons (RF-P085). In the early 1960s, when DOE implemented the single mission concept to reduce redundant operations between DOE facilities, Rocky Flats became the primary manufacturer for nuclear weapons primaries.

The general design of the primary did not change dramatically after 1958, although the relative amounts of metals, dimensions, and other features of the components were modified over the years. The construction materials included plutonium, uranium, beryllium, aluminum, and stainless steel. Other metals such as cadmium, vanadium, silver, and gold were also used in some of the components. The plant also supported weapons development programs responsible for fabricating, testing, and assembling parts with new geometries or metal compositions. Because of the plant's metal manufacturing capabilities, Rocky Flats often fabricated other weapons parts, including components made of stainless steel and beryllium. Beryllium was used throughout the history of the RFP but was not used in full-scale production operations until 1958. Prior to 1957, beryllium use was minor and consisted of use in the R&D of weapons components. In 1957, full production of beryllium components began and consisted of machining and beryllium forms inspection. A wrought beryllium process was developed at RFP in the mid-1960s, and was used in the recycle of beryllium metal scrap into cast beryllium forms. Beryllium components were handled and assembled into configurations in Buildings 707, 776, and 777. Disassembly of stockpile returned pits was performed in Building 777. These activities generated trace amounts of beryllium in some of the waste shipped to INEEL. Mixtures of beryllium and plutonium were processed in Building 771 (RF-P085).

Recovery operations, a continuous component of operations at RFP, were conducted to recover and purify fissionable or economically viable materials from wastes generated during the manufacturing processes. Plutonium, uranium, and americium metals were recovered from retired warheads, manufacturing residues, and waste materials. Recovery operations were conducted in Building 771. The uranium recovery process was similar to the 1950's plutonium recovery process involving similar chemistry, including solvent extraction. Americium recovery and purification operations were needed to deal with the americium encountered in the handling of plutonium due to the reduction of effectiveness of the plutonium operations and the increase in personnel exposure stemming from in-growth of americium-241 (^{241}Am) from plutonium-241 (^{241}Pu) decay. RFP provided purified americium-241 oxide to ORNL (RF-P085).

Other activities at the RFP facility that were not directly related to the main mission were described as "devoted to studying, research, and development," "special order," and "cash sales" (RF-C244). Examples of the R&D areas pursued at the RFP facility include:

- R&D in plutonium science to identify its properties, limitations, and interactions with other materials

- R&D to develop production techniques and tooling requirements for the beryllium work
- R&D development of casting and coating techniques for uranium production.

“Special order” projects for other facilities in the weapons complex were conducted at the RFP, such as studies using tracer isotopes (i.e., neptunium, curium) added to weapons components to measure performance; and the Zero Power Physics Reactor (ZPPR) project in which special fuel elements were manufactured for testing in the Argonne National Laboratory-West (ANL-W) reactor (RF-C244).

2.3 Defense Determination for Rocky Flats Plant Waste

Defense waste is defined by the DOE Carlsbad Field Office (CBFO^a) as nuclear waste derived from the manufacture of nuclear weapons and operation of naval reactors. “Contact-Handled Transuranic Waste Acceptance Criteria (WAC) for the Waste Isolation Pilot Plant” (DOE/WIPP-02-3122) defines defense waste as originating from specific defense activities, as specified in Section 10101 (3) of the Nuclear Waste Policy Act of 1982. The term “atomic energy activity” means any activity of the Secretary (of DOE) performed in whole or in part in carrying out any of the following functions: (RF-P090)

- Naval reactors development
- Weapons activities, including defense inertial confinement fusion
- Verification and control technology
- Defense nuclear materials production
- Defense nuclear waste and materials byproduct management
- Defense nuclear materials security and safeguards and security.

Virtually all of the waste generated at Rocky Flats that was shipped to the INEEL was generated through defense program weapons activities. This includes wastes generated during the 1954 through 1970 timeframe based on the fact that the RFP mission and waste generating process did not change significantly over time. Based on a review of data, there is no historical record or evidence of spent nuclear fuel or high-level waste ever having been handled at Rocky Flats. Four activities conducted at RFP in the 1954 through 1970 timeframe were categorized in the 1997 CAO memorandum to J. Roberson (RF-C244) as non-defense related:

1. Manufacture of fuel elements for the ZPPR. Fuel elements were manufactured in Building 444 for installation in the Argonne National Laboratory-West reactor. Described in more detail in Section 4.5.
2. Development of technology for Project Plowshare, which was the effort to develop technology for using nuclear explosives for peaceful application. It was reported that RFP was involved in the project from 1959 through 1974, and that the work was conducted in Building 707, however, this building was not constructed until 1967. Liquid wastes generated from component development and residue processing were solidified in building 774.

a. Formerly known as the Carlsbad Area Office (CAO).

3. Purification of americium-241 for resale. Americium purification processing was conducted in building 771 from 1957 through 1986. Wastes generated from this process were not segregated from other RFP wastes and may be included in wastes from Buildings 771, 774, and 559.
4. Generation of filter and glovebox gloves waste from non-defense related activities. It was reported that filters and glovebox gloves contaminated during non-defense related activities were not changed or replaced specifically for defense related processes. Therefore, they were commingled with and indistinguishable from defense related wastes.

Wastes from all four activities, conducted concurrently with defense related activities, were not segregated from weapons waste; therefore, the wastes were commingled and are WIPP eligible (RF-C244). Based on the guidance described above, defense wastes are identified as those wastes generated during work involving only defense activities or during work in which defense and non-defense wastes were inadvertently mixed in the past and from which the non-defense portion cannot be segregated. Accordingly, TRU waste generated at RFP can be classified as defense-generated TRU waste and is therefore eligible for disposal at the WIPP (RF-C244).

3. RFP TRU WASTE MANAGEMENT PROGRAM INFORMATION

3.1 Summary of 1954-1970 Volumes Disposed at the INEEL

The waste shipments from the RFP to the INEEL for burial commenced in April 1954 and continued into late 1989 (RF-U115). From 1952 through November 1970, approximately 65,100 m³ of TRU contaminated waste were buried in pits and trenches at the RWMC, as depicted in Figure 3-1. The TRU contaminated wastes were generated from RFP as well as from other AEC activities conducted at the INEEL and non-INEEL generators (RF-U029). Burial of plutonium-contaminated waste from RFP was discontinued in late 1970 (RF-U115) in response to the March 20, 1970, Immediate Action Directive (IAD) No. 0511-21 that required plutonium-contaminated wastes be segregated from other wastes, and if buried, to be buried in readily retrievable containers (RF-U161). Plutonium-contaminated wastes received at the INEEL beginning in November 1970 were retrievably stored at the RWMC. RFP uranium-contaminated wastes continued to be sent to INEEL for burial through 1972 (RF-U169).

In addition to the TRU contaminated wastes buried in the SDA, approximately 14,150 m³ of beta-gamma contaminated waste were intermixed with the buried TRU waste. These wastes were generated from non-RFP, INEEL, and other off-INEEL site generators. Examples of the beta-gamma radionuclides are: cobalt-60, cesium-137, strontium-90, iodine-131, yttrium-91, iron-59, cerium-144, and zinc-65 (RF-U029).

Historical information taken from published and unpublished documents, and from correspondence and interviews of cognizant individuals, is summarized in this report to be used in the determination of how wastes from the RFP and buried at the INEEL may be disinterred and repackaged into certifiable waste streams for disposal at the WIPP located in Carlsbad, New Mexico. Only those wastes shipped to the INEEL by RFP during 1954 through 1970 and buried in the SDA are addressed in this report.

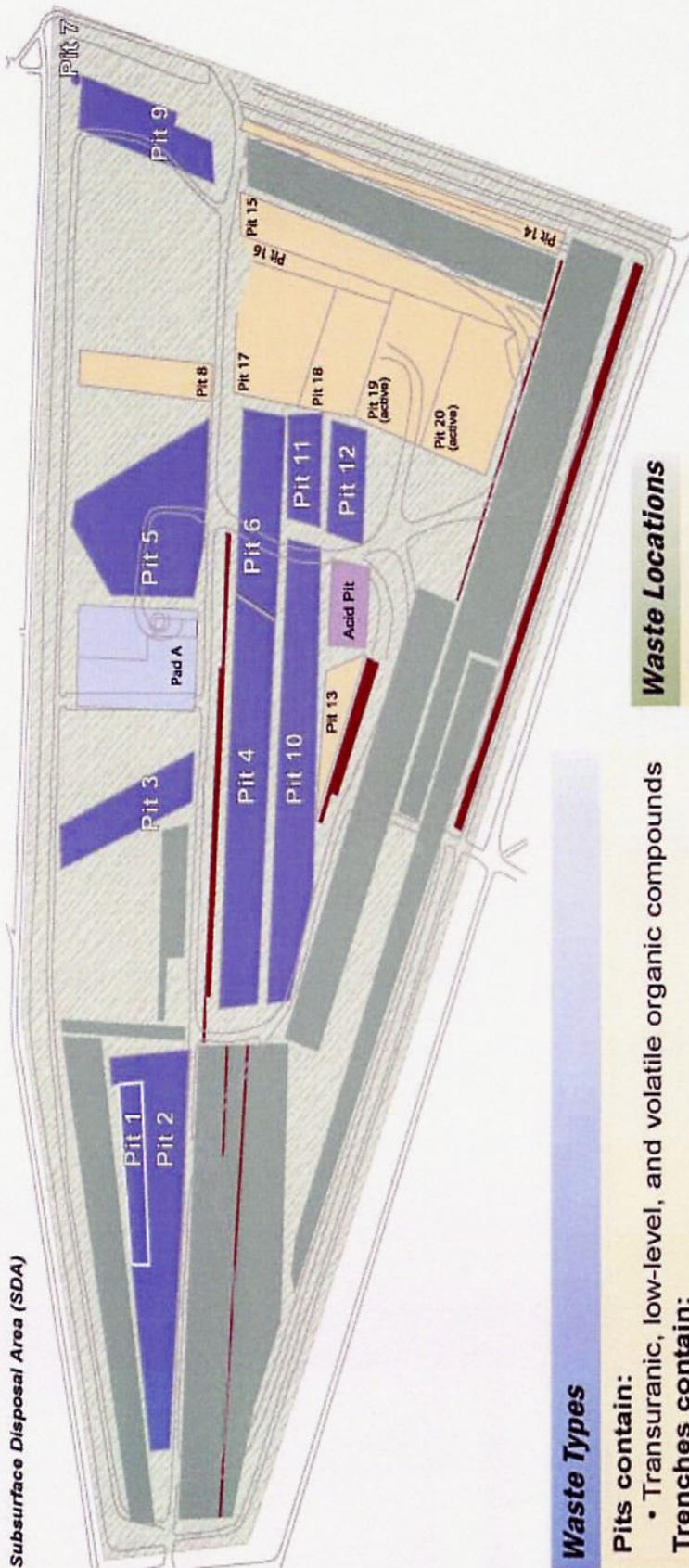
Wastes shipped to the INEEL from the RFP included waste from other generators, and are included in this report. These radioactive wastes received at the INEEL from RFP during 1960–1969, identified as being generated from other offsite generators, came from defense-related activities and operations funded or supported by the AEC. These offsite generators were universities, private industry, and defense agencies (RF-U029) and are described in detail in Section 4.12.

As part of the compilation of the RFP information for this report, the information taken from shipping records, which included AEC Form 740s and the trailer load lists, were used to estimate the number of containers and volume of each waste type for each generator and burial site. The data was taken from a data download dated February 10, 2004, called WasteOScope (RF-U169). The data was used along with the information compiled from AK documents in the development of this background report that will be used as the baseline for characterization of the wastes to be retrieved from INEEL RWMC burial sites. The estimated waste volumes for each generator and RWMC burial site as determined from WasteOScope are presented in Appendix A. How the waste types were identified and the assumptions made to delineate waste type volumes for this report are described in detail in Section 5. WasteOScope, renamed Waste Information and Location Database (WILD), is currently under review and validation, and the estimated number of containers and volumes are subject to change. The WasteOScope name will be retained for this report because the compact disc with the supporting data carries that title.

Disposal Types and Locations



Subsurface Disposal Area (SDA)



Waste Locations

- TRU Pits
- Non-TRU Pits
- Trenches
- Soil Vaults
- Pad A
- Acid Pit

Waste Types

- Pits contain:**
- Transuranic, low-level, and volatile organic compounds
- Trenches contain:**
- Transuranic, and low-level wastes
- Soil vaults contain:**
- Remote-handled, low-level wastes
- Pad A contains:**
- Nitrate salts, uranium, and low-level wastes
- The Acid Pit contains:**
- Partially grouted, low-level contaminated soil

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Figure 3-1. Pits and trenches at the INEEL Radioactive Waste Management Complex.

3.2 Rocky Flats Plant Waste Management Practices

Radionuclide contaminated waste materials were generated during the fabrication, assembly, and processing of nuclear weapons components in the DOE weapons production complex. Waste materials generated at the RFP and shipped to the INEEL from 1954 through 1970 are suspect radioactively-contaminated waste, including wastes containing RCRA regulated materials. This also includes wastes that are currently regulated as low level waste (LLW), mixed low level waste (MLLW), TRU, and mixed TRU.

Waste management practices during the 1950s and early 1960s were often based on the program or processes specific to related-building within which the wastes were generated. Documentation of formalized waste management practices was not found in the historical record. An early (circa 1953) tentative procedure (RF-U112) for the handling of contaminated solid and liquid wastes provided some insight into the early handling. Initially, the responsibility for treatment and handling of all contaminated waste was the purview of the C-Plant (Building 771). Specifically, they were to manage the transportation of the waste materials from the various areas to Building 774 for final packaging of the solid wastes for shipment, and the processing of all contaminated liquid wastes to acceptable concentration or activity levels. The descriptions of the RFP waste management practices for this time frame were supported by the process descriptions and other details included in reports or other documents. Historically, the RFP waste quality program progressed from very little control over the quality of the waste shipped off-site in the 1950s to a fully instituted waste management program in the 1970s (RF-U115).

In 1952, three types of liquid and three types of solid wastes were identified. Liquid wastes were identified as sanitary, storm water run off, and process liquids (RF-C085). Solid wastes were categorized as solidified liquids, combustible, and non-combustible wastes. Sanitary liquid waste was not radiologically contaminated, and was treated at the sewage treatment plant in Building 995. Effluent from the treatment facility was released to the environment or into the municipal sewer for further treatment if necessary. Dried sludge from Building 995 treatment was land disposed of on-site and in some cases off-site for use as fertilizer. Storm water run-off was also free of any contamination and was either surface drained to the soil or drained directly to a nearby water course (RF-C085).

Process wastes included actual liquid wastes from plutonium, uranium, beryllium, and other operations as described in the building sub-section presented in Section 4.0. These wastes included cooling water, laundry, and manufacturing or recovery liquids. All had the potential of being contaminated with radionuclides. Also included were some chemically contaminated liquid wastes. All wastes with the potential to contain radionuclide or chemical constituents were transferred to Building 774 for treatment prior to storage, disposal, or release (RF-C085). After treatment, effluents from the Building 774 treatment process were sampled to determine the appropriate disposition; liquids with radionuclide concentration greater than that allowed by AEC (the actual allowed level was not specified) were solidified, low-level radionuclide, or chemical-contaminated liquids were sent to Building 995 for further treatment by dilution with sanitary sewage and release to Walnut Creek, or free release. The RFP policy at that time was that no liquid waste was to be released until the level of radioactivity and chemical content were reduced by processing to within acceptable limits (RF-C085). The solidified liquid process wastes were packaged in 55-gal drums and stored on site until a disposal site was found (RF-U115).

In January 1953, a waste disposal organization, the Waste Disposal Unit, was established as part of the Analytical Laboratory organization to supervise the ultimate disposal of processed liquids and solid wastes, and to gather and correlate disposal data. Later, the group's title was changed to the Waste Disposal Co-Ordination Group to reflect its function more closely. The group did not have any facilities under its jurisdiction. Their responsibilities included the chemical, radiological, and physical state of the

plant collection ponds and tanks, contaminated waste storage and disposal, waste data collection and coordination of waste projects, and authorization of the release of compliant waste waters from the plant. Waste treatment and packaging were carried out by operating personnel, and shipping was handled by the traffic group (RF-U115).

In January 1965, the group was transferred from the Analytical Laboratory organization to the Health Physics Group. In September 1970, the group title was changed to Health Physics Waste Disposal. With the upgrading of radiological waste to a product level and the establishment of rigid waste acceptance criteria in the early 1970s, a Waste Operations Group was organized which included the original Waste Disposal Co-Ordination Group (RF-U115). The plant operating groups packaged the solid radioactive waste in compliance with standard practices issued by the Waste Operations Group. Waste inspectors were provided to ensure compliance. The storing and loading of radiological waste for off-site shipment were managed by Waste Operations (RF-U115).

At the startup of the RFP in the 1950s, the waste policy in place at RFP was to declare the loss of special nuclear material (SNM) via a normal operating loss (NOL) concept. Under this policy, waste generators were responsible for assigning an SNM value to the waste generated. Management of the waste, including processing, was based on the SNM activity levels. Waste processing, to varying degrees, was always part of waste management activities because of the emphasis on recovering fissionable materials from manufacturing residues at the plant. Because the RFP wastes included materials such as plutonium and enriched uranium that were extraordinarily costly to procure and sensitive in terms of national security, it was economically imperative to recover these materials from wastes prior to their disposal. The primary objectives of recovery operations were to process the waste material until it could be safely and economically discarded.

Economic discard limits (EDLs) were established to provide concentrations of SNM present in waste, below which it was not economically feasible to attempt recovery. EDLs were calculated based on the value of the material, the labor required to recover the material, and the efficiency of the recovery process. Limits were determined for plutonium, HEU, and other accountable isotopes such as neptunium-237, uranium-233, and for americium-241, which was deemed valuable by the AEC. The dates of recovery operations of the accountable or valuable isotopes can be tied to the establishment of EDLs. However, recovery of the isotopes and establishment of EDLs occurred before sophisticated recovery processes and assay methods were established. Americium recovery was initiated in 1957, although its recovery was deemed important due to its value beginning in 1952. Plutonium recovery was initiated in 1953, with uranium recovery initiated in 1954. Wastes with activity for the particular isotope below the EDL was disposed of as radioactive waste (RF-P085, RF-U115). EDLs changed over time depending on the fluctuation of isotope value, waste materials, and process efficiencies. The concentration of the accountable isotope or EDL was calculated using the following formula (RF-U115):

$$D = (L)(T_s)/(C-F)(E) \text{ or } D = (L)(T_l)/(C-F)(E)$$

Where:

D = Economic Discard Limit

T_s = time to process one kg of residue solid

T_l = time to process one kg of residue solid per liter of liquid residue

C = DOE value for a kg of metal

F = Cost to produce one kg of metal

E = Process efficiency

The resulting EDLs were expressed in isotope gram per residual solid gram or isotope gram per liquid residue liter. The EDLs changed with process improvements and with changing costs of the SNM metals used; however the changes were generally small over time. Consequently, the majority of waste shipped to INEEL was based on EDLs.

Determination of the radioactive materials activity in wastes depended on the waste form. For liquid waste, radiochemical analysis was performed by the appropriate support analytical laboratory. An estimating method was initially used for solid waste. These methods proved to be inadequate as the material unaccounted for (MUF) at RFP grew to an unacceptable level. A need for improved methods for assaying plutonium in the waste was identified in 1964 (RF-U115).

From 1952 to 1953, low level contaminated wastes containing nitrates and radioactive materials (i.e., laundry wastewater) were discharged directly into North Walnut Creek. Decontaminated process wastewater, and sewage treatment plant effluent were released into South Walnut Creek. From 1953 to 1957, low-level contaminated liquid wastes were discharged into an onsite pond for eventual discharge into the creek. After 1957, laundry wastewater was released into South Walnut Creek and low-level contaminated liquids were rerouted to the process waste treatment facility. In 1954, an effort to eliminate free liquids in waste drums and to provide for the absorption of any liquids that may develop during transport was initiated in response to the discovery of liquid leakage from seven drums in a shipment to Idaho. Drums of sludge that contained or were suspected of containing liquids were to be wrapped in plastic and placed in cartons before shipping, and absorbent material was to be supplied for the floor of the trailer (RF-U115). Shipping practices are described in more detail in Section 3.2.3.

RFP waste processing practices varied over time. As the understanding of radiation improved, knowledge in the area of waste technology progressed, and tighter regulatory requirements were enacted (RF-P085). An R&D effort was launched in the middle 1960s to develop gamma-neutron counting systems applicable to drummed solid wastes to improve the methods used to determine radionuclide activity. The first production drum counter was installed in Building 771 in 1969 (RF-U115).

Beginning in 1970, liquid radioactive wastes were treated in one of two processes (RF-P085, RF-U126):

1. Chemical precipitation and sand filtration of wastes classified as “high rad – low nitrate.” The process effluent was analyzed and, if deemed suitable, discharged to the drainage ditch upstream of the onsite sewage treatment plant.
2. Evaporation of wastes classified as “high rad – high nitrate.” Sludge produced (Buildings 444, 776, and 881) from this liquid was drummed for off-site burial at the INEEL.

Uranium contaminated sludge (from Buildings 771, 774, and 779) was either buried in an on-site landfill or, if it exceeded established radioactivity limits, drummed and shipped to the INEEL (RF-U126). Other radioactive solid wastes were determined to be within the allowable limits for disposal on-site (RF-P085).

3.2.1 Categorization Schemes Used by RFP during 1954-1970

Waste categorization schemes used at RFP during 1954 to 1970 varied according to the programs that generated wastes during that timeframe, and in some instances were specific to the buildings the

waste came from. In general, RFP fabrication operations generated both liquid and solid contaminated wastes. Liquid wastes were categorized as (1) aqueous based solutions or (2) organic based solutions and treated in Building 774. There were five categories of solid waste established mainly to describe plutonium-contaminated solid wastes, but were also used to describe HEU, DU, and beryllium-contaminated solid wastes. The five waste categories were defined as follows (RF-U115):

- Line generated wastes (LGWs) were generated by glovebox operations. These wastes were usually highly contaminated with plutonium and required evaluation to determine the disposition status. Evaluation of the isotopic content of wastes was based on the current method used at the time of generation. If determined to contain accountable isotopes above the EDL, the wastes were designated as recoverable residues. Plutonium-contaminated waste was sent to Building 776 for surface contamination removal and packaged. The majority of line-generated waste was composed of items used in operating and maintaining the line (RF-U115, RF-P085).
- Sludge wastes were primarily generated from Building 774 liquid waste treatment operations. They were identified as “74 series sludges” and identified by the generator numbers 741, 742, 743, 744, and 745 in the shipping records and WasteOScope. These indicate types of sludge generated and not the generator building. Each type of sludge is described in detail in Section 4.10. However, occasionally other sludges were apparently generated outside of Building 774 and were assigned the appropriate building generator numbers such as 881 and 444. These were identified as Waste Type IV in the shipping records. It is assumed that these sludges were generated by accumulation within processing equipment in the building identified (RF-U115).
- Filter waste referred mainly to ventilation filters used to remove airborne contamination. Large filters (2 × 2 × 1 ft) were used in the building exhaust plenum systems while small filters (12 × 12 × 8 in.) were employed as intake and exhaust filters on glovebox systems. These filters were evaluated to determine throw-away status. If above the discard limit, the filter medium was removed and processed for SNM recovery. However, assay of processing filters did not occur until the 1960s (RF-U115).
- Maintenance operations wastes consisted of contaminated equipment and ancillary electrical and piping apparatus. These materials were generated by repair and replacement activities, such as obsolete equipment removal, new equipment installation, safety systems upgrade, area strip outs, and preventive maintenance requirements. A significant quantity of this waste was packaged into crates for shipment to INEEL. Glovebox maintenance required the erection of contamination control tents, which upon job completion, were packaged as waste. These activities have remained fairly constant over the active life of the plant (RF-U115).
- Non-line generated wastes were generated in plutonium process areas, but not within glovebox lines. Other sources were the uranium processing buildings. A significant amount of these wastes were generated by housekeeping activities, and consisted of rags, paper, wipes, surgical gloves, cotton gloves, plastic bags, contaminated clothing, wood, tape, other combustible materials, and other small routinely used items. These wastes had, at best, trace amounts of plutonium contamination. Over the years, housekeeping wastes have remained fairly constant with variations in quantity associated with production and R&D levels. The rising waste disposal costs stimulated a waste reduction effort for housekeeping wastes. The only notable change was an increase of polyethylene-based plastics and a reduction of polyvinyl chloride (PVC) plastics (RF-U115).

The methods used to determine isotopic content of wastes evolved over time. Initially an estimating approach was used to determine radionuclide content in solid wastes based on a “by difference” approach (i.e., difference between radioactivity at the start and the end of the process) coupled with operating

experience or knowledge. During the 1950s and early 1960s, chemical assay and radionuclide analysis, along with swipes and contact dose rate data, were used to determine radioisotopic content (RF-U115).

Buildings 444 and 447 used their own waste identification scheme for segregation purposes. The letter waste codes used were sometimes included on the shipping records and are presented in Table 3.1 (RF-U115).

Table 3.1. Buildings 444 and 447 waste identification codes (RF-U115).

Identification Code	Description	Shipping or Waste Type
A	Filter paper	II
B	Coolant still bottoms	IV
C	Metal, firebrick	V
D	Paper, rags, wood	I
E	*Waste oil	—
F	Graphite	V
G	*Perclene still bottoms	—
K	Process waste filter	IV
M	Cyanide cement	V
N	Miscellaneous solids	V
	CWS or HEPA filters	III

*Were to be processed on RFP site and not shipped.

Another categorization scheme used at RFP to identify waste types from 1954 through 1970 was the use of Roman numeral designations (i.e., I, II, III, IV, and V; RF-U115). One scheme did not replace the other; they were used concurrently. Waste containers shipped to INEEL were categorized by waste type to identify the physical form of the waste. The definitions for the Roman numeral designators, which were relatively consistent for the RFP generators, are as follows:

- Type I: Combustibles (i.e., paper, rags, and wood), also defined as housekeeping wastes in some documents.
- Type II: Filter paper, including fiber/fibrous pads (containing asbestos) and non-HEPA filters.
- Type III: Filters and filter media, defined as including CWS and HEPA filters from glove boxes and building ventilation systems. “CWS filters” refers to the brand Chemical Warfare Service filters that were utilized in building ventilation systems.
- Type IV: Inorganic sludges. Refer mainly to the series of sludges produced by the Liquid Waste Treatment Plant (Building 774).
- Type V: Non-combustibles, such as glass, scrap metal, firebrick, spent equipment, wire, electric motors, piping, sheet metal, glove box material, and tantalum molds.
- Type VI: Contaminated organics (55-gal oil drums).

The waste designators included in the two categorization schemes described here, as well as other types of designations, are shown on load lists and in AK source documents, and are included in WasteOScope. A discrepancy resolution was written to address the multiple identifiers/designators used over this timeframe, and is presented in Appendix B.

In addition to identifying waste by type, waste containers generated by RFP were assigned container numbers that identified building generators by a prefix number followed by a serial number. From 1954 through 1969, the container/drum numbers were usually assigned by the building/generator and coordinated by the Waste Coordination Group. Before 1970, these prefixes were used to identify building/generators, and in some cases, identify specific waste types as illustrated in Table 3-2. Wastes were identified from the trailer load lists associated with the shipping records using this table for entries into WasteOScope. It is assumed that some drum markings (e.g., drum barcodes and identification numbers taped or glued to the containers) will not be discernable when the drums are retrieved. In some cases, only the drum prefixes and not the individual container identification numbers were recorded on the shipping records. Container identification numbers are not included in WasteOScope (RF-U115).

Table 3-2. Crosswalk of waste container prefix and building numbers used before 1970 (RF-U115).

Prefix Number	Building Number	Building Mission or Waste Description
Plutonium Waste Pre-1970		
122	122	Medical Treatment
123	123	Health Physics Laboratory
59	559	Plutonium Analytical Laboratory
71	771	Plutonium Recovery & Recycle
71(596)	771, 776, 777	1969 Fire Waste
741	774	First Stage Sludge
742	774	Second Stage Sludge
743	774	Grease Plant (Organic) Sludge
744	774	Cemented Liquid Waste
745	774	Evaporator Salts
746	774	Empty Contaminated Drums
76	776	Plutonium Manufacturing
77	777	Plutonium Component Assembly
78	778	Plutonium Laundry
79	779	R&D Laboratories
79A	779A	R&D Laboratories
81	881	HEU & Plutonium Waste
91	991	Plutonium & HEU Component Assembly
95	995	Sewage Treatment Plant
HEU Waste Pre-1970		
22	122	Medical Treatment
23	123	Health Physics Laboratory
81	881	HEU Fabrication, Chemical Recycle
83	883	HEU Forming
86	886	HEU Criticality Exposure Assembly

Table 3.2. (continued)

Prefix Number	Building Number	Building Mission or Waste Description
89	889	HEU Decontamination Facility
91	991	HEU Component Assembly
DU Waste Pre-1970		
31	331	Temporary Development Facility
41	441	DU Analytical Laboratory
44	444	DU Fabrication
47	447	Roaster Oxide
83	883	DU Forming
Beryllium Waste Pre-1970		
41	441	Beryllium Analyses
44	444	Beryllium Fabrication
47	447	Beryllium Fabrication
71	771	Beryllium Component Destruction
741	774	Beryllium in First Stage Sludge
742	774	Beryllium in Second Stage Sludge
745	774	Beryllium in Evaporator Salts
76	776	Beryllium Components Handled
77	777	Beryllium Components Handled
79A	779A	Beryllium Components Processed
83	883	Beryllium Forming
Transuranic Waste		
59	559	Plutonium Analysis
07	707	Plutonium Fabrication
71	771	Plutonium Recovery and Recycle
71 (596)	771	1969 Fire Waste
741	774	First Stage Sludge
742	774	Second Stage Sludge
743	774	Grease Plant (Organic) Sludge
744	774	Cemented Liquid Waste
745	774	Evaporator Salts
746	774	Empty Contaminated Drums
76	776	Plutonium Manufacturing
77	777	Plutonium Component Assembly
78	778	Plutonium Laundry
79	779	R&D Laboratories
79A	779A	R&D Laboratories
81	881	HEU and Plutonium Waste
95	995	Sewage Treatment Plant

Table 3.2. (continued)

Prefix Number	Building Number	Building Mission or Waste Description
Non-Transuranic Waste		
23	123	Health Physics Laboratory
31	331	Temporary Development Facility
44	444	DU Fabrication
47	447	Roaster Oxide
865	865	R&D Development Facility
81	881	HEU Cleanup and Decommissioning
83	883	DU Forming
86	886	HEU Criticality Exposure
89	889	HEU Decontamination Facility

3.2.2 Description of RFP Waste Criteria and Restrictions or Limitations

Specific information regarding restrictions or limitations was not found for the RFP site; however, it may be assumed that INEEL requirements (as described in Section 3.2.5) for accepting waste from other generators were used for shipment to Idaho.

In June 1957, the Rocky Flats AEC Office granted permission to the DOW Chemical Company (RFP) to accept wastes generated by local off-site institutions and government agencies (e.g., universities, private industry, and defense agencies; RF-C066). From May 1960 to August 1963, the INEEL was designated as an interim National Disposal Site for commercial radioactive waste burial. In June 1963, use of the INEEL as an interim burial site for off-site radioactive wastes other than from RFP was to be discontinued. However, because there were no commercial radioactive waste burial facilities with AEC approval for storing or burying radioactive waste containing classified material or material of a sensitive nature, AEC and contractor generated classified waste continued to be received and buried at INEEL for a period of time through 1964 (RF-C072, RF-C078).

Acceptance criteria at RFP, as well as at the INEEL, from 1957 through 1964 were based on instructions from the AEC regarding wastes to be sent and received. This is illustrated by several letters from the AEC or from DOW with information regarding acceptance, and in some cases, specific packaging requirements. In a June 6, 1961 memorandum, Dow Chemical Company (RFP) informed the Coors Porcelain Company that they would accept the liquid wastes as planned, but that the classified low level solid wastes would have to be shipped directly to the Hanford site. At that time the liquid wastes from Coors was disposed of on the RFP site (C006). The most specific criteria found in the AK documentation was in regard to classified materials that were sent to INEEL toward the end of the time period. In 1964, there was no explicit classification guidance for RFP wastes; however, DOW did acknowledge the following waste classification 'conditions' (RF-C105):

- Shapes of weapons parts, including prototypes, were classified without regard to the materials. Fixtures and gages which revealed parts, shapes, and dimensions were also classified.
- Isotopic plutonium composition for the most part was unclassified as well as the presence of gallium in plutonium, provided it was not associated with a specific weapon or component. At the time of this letter, it was assumed that plutonium containing gallium or with an isotopic composition of less than 7.7% Pu-240 was unclassified.
- Uranium enriched in U-235 was unclassified.

- Depleted uranium waste with isotopic composition ranges of 0.10% to 0.29%, 0.30% to 0.39%, and 0.41% to 0.7% was classified.
- Additionally, the AEC General Counsel considered all information on plutonium or uranium to be classified by the terms of the Atomic Energy Act of 1954, except under certain conditions (i.e., was the subject of a specific topic in a classification guide; RF-C105).

A 1964 letter sent from Coors to DOW Chemical Company listed low level solid wastes sent to RFP to be trans-shipped to Idaho, including some drums with classified additives. This letter included information regarding the shipment of aqueous waste sent to RFP for disposal on site (RF-C066). In April 1964, a memorandum from RFP to INEEL stated that all future waste shipments to INEEL from RFP would be unclassified, and that no classified D-38 oxides, classified shapes, or other classified materials would be included in packages sent to Idaho (RF-C105).

3.2.3 Waste Packaging Procedures at RFP

RFP radioactive waste packaging for shipment to the INEEL evolved from using any available and suitable container in the 1950s to standardized quality-controlled and performance tested containers in about 1969. The upgrades and improvements instituted over time were driven by AEC directives, Department of Transportation (DOT) and Interstate Commerce Commission (ICC) regulations, and INEEL receiving criteria that changed in response to increased waste generation and shipping and disposal concerns (RF-U115).

RFP wastes shipped to the INEEL from 1954 through 1970 were packaged in the following types of containers (RF-C047, RF-C015):

- Drums: 55-, 40-, and 30-gal
- Crates or wooden boxes; categorized as standard (84 × 48 × 48 in), greater than standard (e.g., 96 × 48 × 48 in., 84 × 48 × 52 in., and 84 × 48 × 50 in.), and less than standard (no size[s] given)
- Cartons: included original vendor (filter) shipping cartons (24 × 24 × 14 in., 24 × 24 × 16 in., 24 × 24 × 18 in., 24 × 24 × 28 in., and 28 × 28 × 16 in.), and corrugated paper boxes or cartons containing 55-gal drums.

Initially, there were no requirements regarding the types of containers that could be used for packaging wastes for disposal. The majority of waste containers shipped to INEEL from RFP were 55-gal drums. The next most common drum size was 30-gal. Wooden boxes or crates were used for waste items too large or too heavy for drum packaging beginning in December 1954. Originally, the box dimensions were tailored to fit the waste items being shipped. Prior to 1962, boxes were fabricated in several sizes as shown above, including some larger than the 96 × 48 in. size. Corrugated paper boxes (cartons) were used to package low specific activity (LSA) filters and surface contaminated drums (RF-C154, RF-C-261, RF-U052, RF-U115).

Small quantities of 40- and 45-gal drums, and a very limited number of 20-gal drums, were shipped from 1958 through 1961. Occasionally, drums of a different capacity received at RFP from off-site generators were trans-shipped to INEEL. The original source of drums used for waste packaging was a mixture of vendor product drums and newly purchased drums. Second-hand 55- and 30-gal drums, purchased in Denver, were used for waste packaging until 1967 (RF-C154, RF-U052, RF-U115). Other waste containers shipped to the INEEL during the late 1950s were several tanks, a few small metal boxes,

two cylinders, and cardboard cartons (occasionally used for special items; RF-C154, RF-U052, RF-U115).

In 1953, radionuclide contaminated wastes packaged in 30 gal drums were kept in interim storage at RFP awaiting determination of a permanent waste disposal site by the AEC (RF-C132). On March 29, 1954, DOW Chemical Company (RFP) was given authorization to make an experimental truck shipment of waste to the INEEL. The test shipment was completed on April 22, 1954. A total of 343 30-gal drums were shipped (RF-C068, RF-C083, RF-C086, RF-U115).

In 1957, the Waste Disposal Co-ordination Group provided specific procedures to be used for packaging wastes (RF-C124). The procedures identified the types of drums to be used and included the following requirements:

- Appropriate closure rings and drum heads (i.e., matched to the drum) use to obtain the tightest possible fit, and use of rubber sealing gaskets to prevent leakage.
- Waste identification by painting waste information such as building drum identification number (e.g., 774:drum number), gross weight, and codes (as follows) for waste types on the containers:
 - I Combustible
 - II Filters (paper)
 - III CWS Filters
 - IV Sludges and muds
 - V Non-combustible
 - VI Contaminated Organics (55-gal oil drums).
- Specified gross weight for each drum type used.
- Specific marking of drums containing Mud wastes (Waste Type IV) was to be a 4-in. square of red paint on the top and side of the containers, or the application of red pressure sensitive tape to the drum (RF-C124).
- Specific marking of drums of contaminated organics (Waste Type VI) was to be either painting the drum yellow or the application of three broken bands of yellow pressure sensitive tape around the drum (RF-C124).

The purchase of new drums for packaging sludge wastes in Building 774 began in April 1958, necessitated by increased waste production as new processes came on line. In the early 1960s, the increase in plutonium production and the concurrent increase in waste generation necessitated the purchase of new drums for all building generators (RF-C154, RF-U052, RF-U115).

Beginning in 1962, wooden box dimensions became standardized, and boxes were fabricated out of 3/4-in. plywood with 1 × 3-in. battens (bottom battens were 2 × 4 in. and made of fir). Cement coated nails on 2 1/4-in. centers driven from the inside out were used, and the joints and battens were glued (RF-C015, RF-C057, RF-C154, RF-U115).

In 1966, some RFP facilities such as Building 774, Liquid Waste Treatment, began using Department of Transportation (DOT) Specification 17C drums to take advantage of the additional allowable gross weight limit of 880 lb for 17C drums (RF-U115). To facilitate loading into trailers and/or railcars, box size was standardized to 48 × 48 × 84 in. (RF-C015, RF-C057, RF-U115.)

In early 1967, two shipping categories were established for wastes to be shipped to the INEEL. The categories were based on the type of container and associated DOT material limitations and packaging requirements as described below:

- **Category A**

- **Container** – Used 55-gal metal drums, open-head, 18-gauge (.0478) with bolt type locking ring and 3/8-in. diameter bolt. Required that the drums were cleaned inside but not reconditioned or leak tested (RF-U115).
- **Material Limits** – Package gross weight limited to 480 lb. Plutonium content was limited to 1 g (RF-U115).
- **Packaging** – Required an 8-mil polyethylene bag as a drum liner. Soft, bulky items were placed directly into this liner. Heavy items or items with sharp edges were wrapped in 8-mil fiberboard sleeves and individually sealed in 8-mil polyethylene before being placed into a bag-liner. The bag-liner was then sealed and the drum lid fixed with a lock ring and bolt (RF-U115).

- **Category B**

- **Container** – ICC-6C or -17C (or equivalent) 55-gal open-head metal drum (RF-U115).
- **Material Limits** – Package gross weight was limited to 880 lb. Plutonium content not to exceed 200 g/drum (RF-U115).
- **Packaging** – Same as Category A above.

RFP shipping containers were upgraded later in 1967 to meet new DOT radioactive materials regulations. The new regulation required ICC specification drums, such as the 17H and 17C, for packaging line-generated waste. However, spent HEPA and CWS filters continued to be shipped to the INEEL in the original filter vendor cartons. This practice ended in April 1970 when corrugated paper boxes were no longer allowed to be shipped for burial at INEEL. The filters were then packaged for shipment in wooden boxes. In general, during the 1954 to 1970 timeframe, AEC sites found that compliance with DOT packaging requirements generally satisfied INEEL burial ground requirements. Large bulky items such as metal scrap, light fixtures, tool machines, lumber, piping, hoods, air ducts, etc., externally contaminated with plutonium and/or uranium that could not be accommodated in drums were placed into wood crates (RF-P017, RF-C154, RF-U115, RF-U161).

Beginning in November 1967, all line-generated wastes were required to be packaged in the new, ICC-specification drums. The switchover from used drums to new DOT specification 17C 55-gal drums for all waste types appears to have begun in late 1967 into 1968. However, 17H 30-gal drums continued to be used (RF-C015).

A special permit (No. 5948) was issued by DOT effective April 8, 1969, authorizing the DOW Chemical Company of Golden, Colorado to ship fissile and large quantities of radioactive waste materials, not otherwise specified (N.O.S.) in accordance with the provisions of AEC approval, from RFP

to INEEL. This permit expired March 31, 1971. The wastes, with the contents packaged as described below, were authorized for shipment only in specially modified ATMX Series 600 rail cars. The authorized packaging was to meet the requirements for shipment as Fissile Class I, and included crates and 30- and 55-gal drums containing waste that could be intermixed in any manner within the rail car (RF-P019).

In 1968, the limitation placed on the crates for shipment in the ATMX rail cars was 14 ft 10 in. × 8 ft × 8 ft. In 1969, the allowable dimensions were increased to 22 × 8 × 8 ft to accommodate large pieces of equipment. After the Building 776/777 fire in 1969, the number of larger wooden crates shipped from RFP to INEEL increased to facilitate disposal of large fire damaged equipment (RF-U115).

Outer containers were often marked to specify contents or special conditions as follows:

- Red or blue markings on the drum label or noted on the load lists indicated plutonium content. Blue indicated less than 15 grams of plutonium; red indicated 15 grams or more plutonium (RF-U115).

Inner packaging of contaminated radioactive waste evolved alongside the changes in containerization. Inner packaging changed from a simple liner system using polyethylene bag liners to a maximum containment configuration of inner bags and rigid drum liners in the early 1970s. Packaging was governed by the waste type to be shipped, the packaging and shipping regulations, and the receiver site's disposal criteria in effect at the time.

The radionuclide-contaminated wastes that were stored beginning in 1953, awaiting the determination by AEC of a permanent waste disposal site, were packed in concrete for shielding purposes. The wastes were packed between 10-in. layers of concrete in the bottom and top of the drums (RF-C132). In April 1954, a total of 343 30-gal drums were shipped to the INEEL in an experimental truck shipment. An undetermined number of the drums in this initial shipment contained liquid. When the shipment arrived at the INEEL, seven of the drums were found to be leaking 'an alkaline' liquid. It was determined by surveys and smears taken of the drums and trailer that the liquids were not radioactive, and it was assumed that the liquids came from Building 74 (774) sludge drums (RF-C068, RF-C083, RF-C086, RF-U115).

Although the AEC Idaho operations office did anticipate a certain residual amount of liquid in sludge wastes, they wanted to avoid disposal of liquids in the burial grounds (INEEL). After receipt of the initial 1954 shipment with the leaking drums, it was decided that in the future, prior to shipment, liquids were to be amalgamated into a solid, or if liquid seepage was probable, absorbent material(s) would be provided by either packaging the containers in fiberpack drums with plastic liners, or placing absorbent paper on the floor of the shipping trailer (RF-C068, RF-C083, RF-C086, RF-U115).

Beginning in March 1955, contaminated air filters (i.e., CWS) were placed in polyethylene bags and packaged in the original shipping (vendor) cartons of the replacement filters (RF-C154, RF-U052, RF-U115).

In 1957, the directions from the Waste Disposal Co-ordination Group included the following inner waste packaging requirements:

- Use of polyethylene bag liners for muds, sludges, and other similar wastes
- Closure of the bag liners by gathering the open end together and binding with 2-in. masking tape.

Beginning January 1, 1967, line-generated wastes (LGW) were shipped to the INEEL as recorded in WasteOScope (RF-U169). LGW is defined as wastes generated by glovebox operations and were usually highly contaminated with plutonium, requiring plutonium assay to determine disposition status. The majority of LGW was composed of items used in operating and maintaining the glovebox line (RF-U115, RF-P085). LGW was bagged out of the glovebox in a polyethylene bag and sealed. The sealed bag was placed into a polyethylene-bag lined (5- or 8-mil) 17H or 17C drum. The drum bag (liner) was taped closed, and the drum lid was secured to the drum body by a 12-gauge bolted ring closure system. Items capable of puncturing the liner were taped and/or placed in 8-mil fiberboard sleeves with polyethylene wrapping. Powdery or small solid items were sealed within paint cans, plastic bottles, or other similar containers and bagged from the glovebox line. Lead liners were selectively used for wastes coming off the americium recovery line to ensure external radiation control requirements were met (RF-U115).

Beginning in 1967, non-line generated wastes, defined as wastes generated in plutonium process areas but not within glovebox lines, and from the uranium processing buildings generated predominantly by housekeeping activities, consisted of combustible materials and other small items. These wastes had trace amounts of plutonium contamination at most and were placed directly into polyethylene bag-lined (5- or 8-mil) drums or wooden crates. The liner was taped closed and/or closed by heat sealing. Any sharp or cutting edges were taped prior to bagging to prevent punctures (RF-U115).

Wooden crates used to transport large bulky items (e.g., metal scrap, light fixtures, tool machines, lumber, piping, hoods, and air ducts) externally contaminated with plutonium and/or uranium were lined with 8-mil polyethylene sheeting. Heavy items were secured to the crate skids with bolts. When full, the liner was taped and/or heat-sealed and the lid was nailed to the crate body. The closed crate was banded with 1.25-in. wide steel straps in at least four positions (RF-U115).

Each drum or crate authorized by the April 8, 1969 special permit (No. 5948) described previously, was lined with 5- or 8-mil polyethylene, respectively, and was allowed to contain large quantities of normal form plutonium-239, -240, -241, and/or americium-241, or mixtures of the foregoing in the form of radioactive wastes. The radioactive contents of each package were required to be in a form that was not readily dispersible, as further described below (RF-C035, RF-P019):

- **Drums** – not more than 100 g (for drums less than 55-gal size) or 200 g (for 55-gal or larger size) of fissile material per drum with maximum thermal decay energy of 2 watts per drum contents and not more than 200 lb of graphite per drum. The contents consisted of either process or line-generated wastes described as follows:
 - **Process Wastes** – greases or sludges hardened with “oil dry” or cement. Americium and plutonium present in grease as fine solids of metal or oxides, or dissolved in organic matter with an average concentration of $5 \text{ E-}10 \text{ g}$ of isotope/g of grease or $1.62 \text{ E-}9 \text{ Ci Am/g}$ of grease and $2 \text{ E-}6 \text{ Ci Pu/g}$ of grease. In sludges, americium and plutonium exist as the hydroxide at an average concentration of $1.07 \text{ E-}5 \text{ g Am/g}$ of sludge or $3.48 \text{ E-}5 \text{ Ci Am/g}$ sludge and $4.71 \text{ E-}5 \text{ g Pu/g}$ of sludge or $3.53 \text{ E-}5 \text{ Ci/g}$ (RF-C035, RF-P019).
 - **Line Generated Wastes** – included graphite molds, filter sludge, insulation, glass, washables, combustibles, metals, and miscellaneous residues with plutonium discard limits ranging from $7 \text{ E-}3 \text{ g Pu/g}$ of waste to $3 \text{ E-}4 \text{ g Pu/g}$ of waste (RF-C035, RF-P019).
- **Crates** – contents were similar to line-generated wastes described above, except that the size or bulkiness of the items precluded the use of drums. This included such items as pipe, lumber,

equipment, hoods, lathes, etc. The fissile material content of each crate was not to exceed 5 g/ft³ of waste (RF-C035, RF-P019).

In response to the March 20, 1970, IAD No. 0511-21, plutonium-contaminated wastes were required to be segregated from other wastes, and if these wastes were to be buried, they were to be buried in readily retrievable containers. Compliance with DOT requirements did not necessarily meet the intent of the IAD, and packaging and disposal requirements for the plutonium-contaminated wastes were revised to provide compliance with the new requirements (RF-U161). Plutonium-contaminated wastes shipped to the INEEL after October 1970 were not buried in the SDA, but were stored above ground in the retrievable storage areas constructed at the INEEL.

3.2.4 Characterization and/or Inspections Performed at RFP Prior to Shipment

During 1954 through 1970, contaminated liquid solutions transferred to Building 774 were analyzed by radiochemical analysis prior to transfer and treatment. The radiochemical content in solid waste was determined using an estimating method based on process knowledge. The SNM and DU content was then used to assign a normal operating loss (NOL) value calculated by the Nuclear Materials Management group and to determine the appropriate treatment and/or disposition (RF-U115).

The method used to determine radioisotopic content in solid waste proved to be inadequate as the material unaccounted for (MUF) at RFP grew to an unacceptable level. A need for improved methods for assaying plutonium in solid waste was identified in 1964, and an R&D effort was launched to develop gamma-neutron counting systems applicable to drummed solid wastes to improve the methods used to determine radionuclide activity. The first production drum counter was installed in Building 771 in 1969 (RF-U115).

In late 1969, installation of drum counters for waste SNM assays required identification of a more definitive matrix for the wastes to apply matrix density correction factors. Consequently, the waste types used previously to describe shipped waste were replaced in the 1970s by item description codes (IDCs) for specific materials such as graphite, firebrick, Raschig rings, sand, slag, and crucibles (RF-U115). At the same time as the change to the use of IDCs for waste identification, burial of waste at INEEL was stopped in favor of retrievable storage per new regulations (RF-P017, RF-U161).

3.3 Requirements for Disposal at the INEEL

In 1953, waste disposal requirements were determined by the AEC (RF-C132).

Several waste disposal options were identified. However, only the burial grounds identified in Idaho were determined to be feasible for disposal of the wastes in a safe manner (RF-C132). Development of the INEEL sub-disposal area (SDA) began in 1952 on a 5.3-ha (13-acre) tract of the original 40.5-ha (100-acre) site that had been set-aside for waste management purposes (RF-P088).

In 1959, new waste disposal regulations became effective for the Idaho site, requiring that a Waste Disposal Request and Authorization form be completed for each waste shipment to be received by the INEEL prior to or with the shipment. This form was required to verify that all special source (SS) materials contained in the waste sent to the INEEL were deducted from the DOW (RFP) accountability records prior to shipping. This was to assure the Idaho Operations Office that no special source nuclear material (SSNM) accountability was transferred to Idaho for SS material content in the waste shipped by RFP (RF-C079).

As of October 1, 1962, Phillips Petroleum Company became responsible for INEEL Burial Ground operations' acceptance of solid radioactive waste for disposal. From that point forward, appropriate forms

and approvals were required before waste of a pyrophoric or toxic nature, security concern, source material, material involving liquids, or materials with a radiation field greater than 500 mr/hour at 1 meter from the container or transporting vehicle was accepted at the site. Other special conditions such as waste packages exceeding a weight of 10 tons or large dimensions ($> 10 \times 10 \times 20$ ft), required special arrangements and acceptance (RF-C071).

From 1960 to 1963, the INEEL was designated by the AEC as an interim national disposal site for burial of commercial radioactive wastes. The burial ground was designed for burial in trenches and pits that were excavated periodically as required for waste disposal. Trenches were dug in a straight line about 5 ft wide and approximately 10 ft deep (i.e., down to the basalt). Trenches were dug in the high clay content areas. Wastes with high radioactivity were preferentially placed in trenches. Pits were dug in more sandy areas of the burial ground on the order of 30 ft \times 30 ft (900 ft²) dug down to the basalt. Pits were used for materials with relatively low radioactivity (RF-C078).

In 1954, RFP received authorization from AEC-Idaho and Phillips Petroleum Company (RFP AEC site contractor) to ship radioactive waste to Idaho. The authorization included contaminated classified waste. The normal operating practice during that time was to include classified waste containers with other waste containers in the same trailer load (RF-U115). In 1964, classified wastes were no longer accepted at the INEEL burial grounds (RF-C006) and from that time on, were directly shipped from RFP to the classified burial ground in Hanford, Washington.

In 1969, wastes routinely packaged in steel drums, wooden or cardboard (pasteboard) boxes, or plastic bags, were placed in pits or trenches. When the pit or trench was determined to be 'full,' they were covered with about 3 ft of soil. Most of the waste volume to be disposed of was composed of nonradioactive materials (e.g., broken equipment, paper, filters, glass, and scrap metals; RF-U063).

In 1969, the AEC listed the following three types of radioactive contamination that was associated with solid waste accepted for burial at the INEEL:

1. Activation products (INEEL waste), from neutron bombardment.
2. Fission products (INEEL waste), from fissioning of nuclear reactor fuel.
3. Fissionable fuel material (e.g., Pu-239), primarily from RFP.

Virtually all of the first two types of contaminated waste buried at the INEEL were generated from operations conducted on the INEEL. The majority of the third type of contaminated material was received from off-site generators, predominately RFP (RF-U063).

In the early years at the INEEL, it was expected that the waste sent for burial would be materials contaminated with radionuclides with relatively short half-lives and small quantities of plutonium. In 1969, it was realized that wastes were being sent to the INEEL with increasing quantities of plutonium, and better storage methods of plutonium-contaminated wastes were needed. In response to the issuance of the IAD, burial of plutonium-contaminated waste at the INEEL was discontinued in late 1970, and asphalt pads for above-ground interim storage were constructed at the RWMC and placed in operation to store plutonium-contaminated waste (RF-U161).

DOW Chemical Company (RFP) was given a Special Permit (#5948) on April 8, 1969, that authorized DOW (RFP) to ship fissile and large quantities of radioactive materials, per AEC approval. This allowed large shipments of normal form radioactive materials, NOS, containing fissile material that did not conform to the then current DOT regulations. This permit authorized waste packaging in DOE

Spec 17C or 17H or equivalent steel drums or wooden crates (DOT 19A or 19B) lined with 5- or 8-mil polyethylene respectively, and authorized shipment in AMTX 600 series railcars (RF-P019).

Waste received at the INEEL during the 1954 through 1970 timeframe and buried in pits and trenches located in the SDA at the RWMC are suspect radioactively contaminated wastes including wastes containing RCRA regulated materials. This includes wastes that are currently regulated as LLW, MLLW, TRU, and mixed TRU.

3.4 Assignment of Waste Type Designations for RFP Wastes Buried at the INEEL

In an effort to facilitate the review of available AK documentation, the waste inventory was subdivided into waste types consisting of materials with similar physical and chemical properties and waste sources, which, to a large extent, defined the nature of the contaminant source material and the processes that produced the waste. The rationale and the delineation of the waste into waste types is presented in this section. Also presented in this section is the method used to tabulate the containers and waste volumes for the waste types.

Information and inventories of the waste buried in the SDA have been compiled previously. Some of the previous compilations have been entered into databases. The most recent compilation of shipping records data is WasteOScope. The shipping records referred to include the AEC Form 740s from 1954 through 1971 and the associated trailer load lists. The container data used in this report was taken from a February 10, 2004 download from WasteOScope. Since that time, the database has been renamed to Waste Information and Location Database (WILD) and is currently under review and validation. As the data in WILD is updated and corrected based on the results of the validation effort, the estimated number of containers and volumes presented in this report are subject to change and will be revised when deemed appropriate. The WasteOScope name will be retained as a reference for the data presented in this report because the compact disc with the supporting data carries that title.

During collection and summarization of AK source documents for this report, discrepancies were identified for how wastes were categorized and the waste types identified for the different RFP generators and/or programs. These discrepancies were recorded and resolved for the record by a detailed discrepancy resolution (RF-D001), which has been included in this report as Appendix B. Based on this resolution, the RFP wastes were categorized under seven Roman numeral designations for this report.

Designations I through VI follow the convention used at RFP as described in Section 3.2.1. The addition of the VII waste designation is unique to this report to denote beryllium-contaminated wastes so that beryllium content could be more easily assessed. The specifics for all of the waste type designations and the rationale for the assignments are explained in greater detail in the following subsections. The correlation between WasteOScope entries and the final waste type designations is presented in the tables in Appendix A.

Other waste designations (e.g., letter, word, or acronyms previously described) used at RFP were identified in the discrepancy resolution and assigned to the seven Roman numeral designations based on physical form. The breakdown of the number of 'as-disposed of' waste containers and waste volume (ft³) are presented for each of the seven waste types for each pit and trench in Subsection 3-5 and for each generator in the Section 4 subsections for each building or generator identified in WasteOScope.

3.4.1 Waste Type Determination

3.4.1.1 Waste Type I. Waste Type I is used to identify combustible debris wastes such as paper, rags, and wood. In some AK source documents, individual containers of combustible wastes were also defined as housekeeping wastes (RF-C028) or identified by other types of designators (such as alpha characters D and W) on the shipping records and in WasteOScope (RF-U169). The following wastes are identified as Waste Type I (RF-C028, RF-C032, RF-C045, RF-C110, RF-C124, RF-C140, RF-U026, RF-U095, RF-U115):

- Combustibles: paper, rags, wood, plastics, cloth, etc. (Waste ID ‘D’ for building 444 debris, or ‘W’ for washed or wet combustibles)
- Personnel protective equipment (PPE), gloves, blankets (may contain asbestos or lead)
- Bioassay and medical wastes
- Benelex.

3.4.1.2 Waste Type II. Waste Type II consists of filter paper, including fiber/fibrous pads (containing asbestos), and non-HEPA filters. Filter paper waste was also identified with an alpha category, “A,” for filter paper generated from Building 444 (RF-U115). In the 1960s, machine coolants and other process liquids were filtered using filter paper, but the use of filter paper declined in the 1960s and, as a result, significantly reduced the volume of this type of waste (RF-C026, RF-C032, RF-C045, RF-C124, RF-C140, RF-D001, RF-U095, RF-U115, RF-U169).

3.4.1.3 Waste Type III. Waste Type III consists of filters and filter media, including CWS and HEPA filters removed from glove boxes and facility ventilation systems. The CWS filters were eventually replaced by HEPA filters (RF-C032, RF-C045, RF-C110, RF-C124, RF-U026, RF-U095, RF-U115).

In 1957, non-defense related operations were conducted in Buildings 559, 771, and 774 resulting in the generation of contaminated filter waste that was shipped to the INEEL and buried prior to 1971. Although these filters were generated from non-defense related activities, they cannot be segregated or distinguished from other Type III waste buried at the INEEL that was generated from defense related activities. These filter wastes are also eligible for disposal at WIPP. The majority of filter wastes were identified in the WasteOScope under Waste Type III, but process waste filters generated from Building 444 were also identified with an alpha category “K” (RF-U115, RF-U169).

Prior to the 1957 fire in Building 771, the booster and exhaust plenums in Building 771 all contained combustible CWS filters (i.e., Type III waste). After the 1957 fire, all combustible-type CWS filters in all buildings across RFP, except the old part of Building 881, were replaced with fire resistant glass filters, and ordinary paper prefilters installed ahead of CWS filters were replaced with fire-resistant paper or fire-resistant glass prefilters. Eventually, all filters were replaced with fire-resistant filters and HEPA filters (RF-P265, RF-U057). Therefore, all Type III CWS filters generated prior to 1957 are assumed to be combustible waste.

3.4.1.4 Waste Type V. Waste Type V consists of non-combustibles, such as glass, scrap metal, firebrick, spent equipment, graphite, wire, electric motors, piping, sheet metal, glove boxes, glove box material, tantalum molds, and roaster oxide. Five thousand three hundred and five (5,305) containers were identified in WasteOScope with the 746 generator code, but with the Type V designation. These are empty metal drums generated when contaminated oil waste stored on the 903 Pad were treated in the

Building 774 Grease Plant and repackaged. The drums were emptied of waste and cleaned until there was less than 3 g of plutonium remaining. Absorbent was added to the drums prior to packaging in individual cardboard cartons or wooden boxes (P047, U115). The empty drum waste physical matrix is metal and the Type V designation is appropriate. The following wastes are also identified as Waste Type V (RF-C028, RF-C032, RF-C045, RF-C110, RF-C124, RF-C140, RF-U095, RF-U115):

- Noncombustible debris; glass, scrap metal, brick, equipment, metal based objects, wire, electric motors, piping, sheet metal, graphite molds, DU, steel, aluminum, ion-exchange resins, glove boxes, and glove box parts (RF-C032, RF-C045, RF-C110, RF-C124, RF-C140, RF-U026, RF-U095, RF-U115).
- Cemented cyanide or cyanide cement from Building 444 (WasteOScope designations ‘M’, ‘CC’, and ‘CM’) were identified as a Type V waste, therefore it is assumed that this also consists of cyanide cement pieces produced (man-made) in Building 444 processes. The cyanide wastes were generated during production plating activities consisting of etching and plating Ware Reserve and special order parts (RF-C045, RF-P085, RF-U115).
- Concreted (cemented) raffinate (WasteOScope designation ‘CR’); majority of the raffinate (liquid waste) was sent to Building 774 for inclusion in first stage processing. The Type V cemented raffinate consists of small quantities of cemented raffinate packaged in small containers (RF-C045).
- Miscellaneous noncombustible solid wastes from Building 444 (WasteOScope designation ‘N’) and identified as a Type V.
- Slag heel (WasteOScope designation “SH”); slag heels were the solid material (dross) scraped or removed from crucibles or molds after plutonium button removal (RF-U115).
- Metal or cemented firebrick (WasteOScope designation ‘C’).
- Roaster oxide, identified in WasteOScope as RO, or mixed with organics as ‘L;’ this waste consists of DU sheet trimmings and other residues, e.g., DU metal or alloy pieces oxidized by calcining or roasting (RF-U115).
- Designations: ‘Empty,’ MTD, MTC, for empty drums containing residual organic sludge.

Recovery efforts from the 1957 fire in Building 771 and the 1969 fire in Building 776 generated a considerable amount of waste in the form of process equipment that was shipped to the INEEL. In addition, a large amount of equipment wastes were generated from decommissioning of the original plutonium fabrication line in Building 771 in 1958 through 1962. Process equipment and other large items shipped to the INEEL may contain lubricating oil. The items from the two fires and other recovery or clean-up operations are included in Table 3-3 (RF-P047).

3.4.1.5 Combined Waste Types I and V. In some instances, containers have been identified as a combination of Waste Types I and V for entries designated on the load lists and in WasteOScope as waste types F, FW, graphite, LGW (line-generated waste), or U233. Type V waste is defined as non-combustible debris. The description of container contents indicated both Type I (combustible debris) and Type V (non-combustible debris) waste are present in the containers. These waste type descriptors were also described in AK source documents as pertaining to both combustible and non-combustible wastes (RF-D001). The following wastes are identified from the WasteOScope as a combination of Waste Types I and V:

- Graphite, including HEU (Oralloy) graphite (graphite waste may include Type I and Type V debris wastes; RF-C032, RF-C045, RF-C110, RF-C124, RF-U115, RF-U095)
- 1969 Building 776 Fire waste (Waste ID of ‘FW;’ Boxes of fire waste may include Type I and Type V debris wastes)
- Graphite molds, crucibles, and combustibles (Building 881; identified as G, F, or Graphite — may contain Type I, Type V, or a combination of the two)
- Uranium contaminated debris (identified as U233; may contain Type I, Type V, or a combination of the two)
- Line generated waste (waste type as LGW) may contain Type I, Type V, or a combination of the two).

Table 3-3. Items from recovery or clean-up operations at Buildings 771 and 776.

Recovery Items	
<ul style="list-style-type: none"> • Lathes • Drill presses • Duct work, piping • Large tanks that may contain Raschig rings • Glass piping • Gloveboxes; whole and pieces from sizing • Furnaces • Freezers • Grit blaster • Counters and cabinets • Vacuum pumps • Mills, including gearbox, motors, and rollers • Shears • Neutron shields constructed of Benelex • All related tools, jigs, chucks, fixtures, electric motors and pumps, tool boxes, instruments, gauges, micrometers, jibs, and fixtures 	<ul style="list-style-type: none"> • Coolant pumps • Generators • Borers • Lapping machines, including vacuum pots and pump units • Fire extinguishers • 25-ton bridge crane, plus rails • Beams • Arc welders • Concrete with rebar, dirt, and asphalt • Building 771 roof, and ‘Transite’ (asbestos-cement) wall, and steel supports • 3 × 4 × 7 ft floor drill press • Saws and blades • Movie and still cameras • Power lift scaffolds • Forklift with batteries • Wood, sheetrock, and visqueen

3.4.1.6 Waste Type VII. Use of the Roman numeral designation VII to denote beryllium-contaminated waste is unique to this report. Beryllium-contaminated wastes were given this

designation to specifically identify waste containers so that beryllium content could be assessed. This is in response to requirements included in the Waste Isolation Pilot Plant (WIPP) contact-handled (CH) TRU waste acceptance criteria (WIPP CH-TRU WAC) that set plutonium-239 fissile gram equivalent limits specific to CH TRU wastes with beryllium content greater than 1% (DOE/WIP-02-3122, Revision 1, Dated March 1, 2004).

Note: *55-gal drums containing greater than 100 kilograms of beryllium are prohibited from storage and disposal at the WIPP.*

Waste Type VII consists of beryllium-contaminated debris wastes identified in WasteOScope as Be, Be(I), Be(II), Be(V), etc., and tabulated as one waste. Beryllium waste was often commingled with DU and other radioactive materials shipped to the INEEL. WasteOScope has a total of 2,592 containers with a gross volume of 20,484 ft³ of Type VII waste shipped to the INEEL from RFP. All of the Type VII waste containers were buried in the SDA pits. In 1973, RFP personnel assured an INEEL representative that the total quantity of beryllium shipped to the INEEL was very small (estimated less than 2 kg of beryllium; RF-C045, RF-U026, RF-U115, RF-P266).

Beryllium was a component of RFP wastes from plant start up, first from research and development of trigger components on a small scale, and later in full-scale production. Beryllium debris wastes were compiled under Waste Type VII from WasteOScope. The majority of the waste containers identified were generated from Building 444, with additional containers of Type VII waste also generated from Buildings 331, 441, 771, 881, 883, and from Building 774 under the 742 and 745 sludges. Beryllium-contaminated wastes were also generated by off-site generators, but in minor amounts. The volume of beryllium-contaminated wastes or waste beryllium or beryllium oxide shipped to the INEEL is unknown. However, it was estimated that during production, the casting process might have generated 3 to 7 kg/day of waste beryllium or beryllium oxide in the form of sculls (casting residues). In addition to sculls, impure or damaged castings that could not be salvaged were periodically included in the waste drums (RF-P047, RF-P085). This waste was identified on load lists and in WasteOScope as Be, and therefore tabulated for this report under Waste Type VII. It is assumed that this waste type for Building 444 includes discarded sculls, damaged forms, and in some cases, classified forms (RF-U115).

Further research into the time of waste generation and shipment to the INEEL could help determine which shipments were made before classified waste shipments to the INEEL ceased. If the containers were shipped during that time, it would strengthen the case that the waste was forms and not beryllium scrapings and crushed forms.

3.4.2 Homogeneous Solid Waste

RFP sludges are liquid wastes that were solidified or mixed with other material form sludge or a solid concreted form in either the Building 774 treatment facility, or in some cases, in the generator building in miniature processes similar to that used in the treatment facility (RF-C045). In 1953, it was reported that the final sludge waste was deposited in asphalt and/or polyethylene lined 30-gal drums. The sludge wastes are identified in WasteOScope under the generator codes 774, and the 74 series sludge codes 741, 742, 743, and 745, as well as for individual buildings as a Waste Type IV (RF-C132, RF-U169). Some of the sludge wastes are identified under other generator codes representing the generator buildings and are assumed to have been generated as sludges in the building identified and not necessarily treated in the Building 774 facility. The sludge wastes were packaged in several different drums sizes; 55- and 30-gal drums lined with polyethylene materials (bags) and some of the sludge waste placed directly into the drums. The sludges were typically contaminated with long-lived alpha emitting radionuclides and other radioisotopes and chemical constituents (RF-C032, RF-C045, RF-C124, RF-C132, RF-C140, RF-U026, RF-U095, RF-U115).

3.4.2.1 Waste Type IV. The Waste Type IV sludge wastes refer mainly to the series of sludges produced by the Liquid Waste Treatment Plant (Building 774). Type IV sludge waste includes the co-precipitation treatment sludge, solidified and MUD (i.e., solids from filtration of the resulting solution from nitric acid leaching of impure materials contaminated with HEU). The MUD was dried, assayed, packaged into drums, and shipped to the INEEL as Type IV sludge. Initially, nitric acid waste solutions were set up in concrete and sent to the INEEL as Type IV sludge. At some point, the shipment of solidified nitric acid was discontinued and only the solids were sent for burial (RF-C045, RF-U026, RF-U115).

Inorganic sludges were identified on load lists (shipping records) as Waste Type IV under separate generator codes that identify them as 74 series sludges. These generator codes designate the specific sludge, i.e., 741 for First Stage Sludge, 742 for Second Stage Sludge, 744 for Solidified off-specification aqueous liquids, and 745 for Evaporator Salts generated in Building 774. The sludges identified for this report as inorganic sludges and the processes associated with each type of sludge are described in more detail below (RF-C114, RF-U115):

- **741 Sludge:** The first stage sludge was generated during the first stage of a two-stage ferric hydroxide carrier precipitation process for removal of radioactive constituents. The pH of the acidic liquid waste was adjusted to 11 through the addition of sodium hydroxide. A precipitation agent (i.e., solution of ferric sulfate, calcium hydroxide, and a coagulating agent) was then added to the waste to remove the radioactive contaminants. The neutralized solution and precipitated slurry was filtered to separate liquid and solids. The solids contained the majority of the radioisotopes and were drummed as first stage sludge. Dry portland cement was interspersed with the first stage sludge during drum filling. Cement was also placed in the drum and liner bags before filling and on top after the liner was taped (RF-U288).
- **742 Sludge:** The first stage effluent was collected as feed for the second stage of the precipitation process, and the resulting solids from the second precipitation were drummed as second stage sludge. Both first and second stage sludges were loaded into 17C or 17H steel drums of at least 30-gal capacity. The majority of drums were 55-gal drums. A quantity of dry Portland cement was placed in the bottom of the drum. A polyethylene bag liner was positioned within the drum and additional dry Portland cement was interspersed with the filling sludge. After sealing the liner, additional dry Portland cement was placed on top. The filled drum was sealed, weighed, labeled, logged, and surveyed for surface contamination and external radiation levels (RF-P098, RF-P260, RF-P264, RF-U110). The 742 sludge containers may contain other miscellaneous waste items, such as electric motors, liquid chemical waste containers, radioactive sources, and other materials. Chemical wastes (generally liquids) contained in polyethylene or glass bottles were periodically disposed of in 742 series drums. This included small amounts of contaminated mercury in 0.5 liter bottles. Additionally, batteries were reported to have been disposed of in this fashion, and prior to 1969, at least two 25-lb packs of sodium or potassium cyanide pellets were distributed in the 742 sludge drums. Information concerning the volumes and specific types of chemical wastes dispositioned in this matter is not available (RF-P047).

Liquid waste from Buildings 441, 444, and 447 consisted of beryllium dissolved in a mixture of nitric and sulfuric acid from the beryllium processes. The spent acid with dissolved beryllium was transferred to Building 774 for processing into the second stage sludge for shipment to INEEL (RF-P260, RF-P264, RF-U110).

- **744 Sludge:** Other aqueous waste solutions processed in Building 774 that did not meet the feed specifications for first and second stage treatment were processed directly and identified as 744 sludge. These waste solutions contained constituents incompatible with the aqueous treatment

processes such as complexing agents, hazardous chemicals, and uncommon radioactive isotopes. These solutions were solidified directly with Portland cement. A maximum of 25-gal of waste solution was solidified per drum. Waste solutions received in small volumes (bottle containers) were often treated directly (RF-P047, RF-P108, RF-P260, RF-P264, RF-U115).

- **745 Sludge:** An evaporator process was established in Building 774 in 1967. Before that, liquid effluents were impounded in solar evaporation ponds. Concentrated salt liquids from this evaporator were packaged in 55-gal drums and shipped to INEEL as 745 sludge (RF-P098, RF-U115).

WasteOScope has a total of 40,881 containers with a gross volume of 298,188 ft³ of Type IV waste shipped to the INEEL from RFP. The breakdown of volume for the wastes, as buried in the SDA, is 260,893 ft³ in the pits and 37,295 ft³ buried in the trenches.

3.4.2.2 Waste Type VI. Waste Type VI consists of containers of oil and organic liquid wastes, as well as treated organic liquid wastes (RF-C124, RF-C234). The organic wastes include coolant still bottoms, perchloroethylene still bottoms generated in Building 444 (Building 444 designation G), contaminated waste oil, and organic sludge generated from Building 774 liquid waste treatment activities. These wastes were identified as 743 sludge. In 1957, contaminated organic wastes consisting of 55-gal oil drums were identified (RF-C124). For this report, all of the wastes identified as being organic wastes have been tabulated under this designation.

Contaminated organic liquid wastes were composed mainly of a variety of oils and solvents. The types of oils received for treatment were basically cutting, lubricating, hydraulic, and vacuum pump oils. The solvents were those used for degreasing and cleaning. Organic liquids were also used in the determination of density of machined parts. The largest contributor to the organic liquids waste inventory was spent lathe coolant diluted with carbon tetrachloride generated during plutonium machining operations (RF-C124, RF-P047, RF-P085, RF-U115, RF-P260, RF-P264).

The organic waste liquids sent to Building 774 were processed by mixing the waste liquids with Micro-Cel (E), a calcium silicate absorbent powder, to form a grease-like substance. Upon completion of the blending of the waste and absorbent, the grease-like mixture was discharged into shipping containers. Other organic liquids that were not processed were loaded directly into drums and, for a period of time, were stored at RFP until appropriate disposal was determined. Initially, some of these organic liquid drums were shipped to the INEEL (RF-C124, RF-C234).

The machining oils used to prevent airborne contamination and degreasing agents (trichloroethane, etc.) contaminated with beryllium were processed through Building 774, and became part of the 743 solidified waste. Beryllium that may have entered the waste treatment process from foundry, metallurgical, and casting operations would have added minor amounts of beryllium contamination with other sludges generated in Building 774.

3.4.3 Manipulation of the WasteOScope Data

The WasteOScope data were summarized by the waste types for this report for each pit and each trench and for each generator designation used (Appendix A). Included in Appendix A is a general discussion of discrepancies identified and assumptions that were made in their resolution during review of the data. Shipping records used to build the WasteOScope are listed in the AK source document inventory provided in Appendix C, compiled for this report.

The WasteOScope download was first copied from the CD into an Excel spreadsheet for manipulation to maintain the integrity of the original data. The copied data was first sorted by shipment identification number (Column 2). Then the entries in the container count column (G) and volume column (J) were evaluated for completeness. In some cases, there were blanks in the download in these two columns. For missing container count entries, the number of containers was determined by evaluating all of the entries for that shipment and accounting for all containers. For missing volume data, the volume was estimated based on the type and number of containers identified as described in Appendix A.

To determine the total number of containers and waste volumes for each waste type for each generator/building identified in WasteOScope, the copied data was sorted by generator and waste type. Then the data for each generator was saved in its own work sheet and the container counts and waste volumes were summed for each waste type. The total container counts and volumes for each of the waste types as recorded in WasteOScope for each RFP building or generator code were tabulated and are presented in Appendix Table A-2. The data for the off-site generators are presented in Appendix Table A-3. The data were then evaluated and grouped by the seven waste types (I, II, III, IV, V, VI and VII) as described above. The results are presented in the Section 4 subsections for each generator identified. The correlation of the waste types as recorded in WasteOScope and the Roman numeral waste type designations used in this report, are presented in Table 3-4.

The amended data was then resorted by disposal location (column 1) to be used to estimate the total number of containers and the waste volumes for each waste type for each pit or trench when disposed. The data for each location was saved in its own work sheet, and the container counts and waste volumes were summed. Waste Type IVs (Sludge Wastes) WasteOScope entries were then tabulated by their generator codes to separate those sludge wastes identified as specific types of sludge by the generator codes (i.e., 741, 742, 743, 744, and 745) and as empty drums (746) for each location. The data for the type IV sludge wastes designated 743 were subtracted from the Type IV inorganic sludge totals and added to the Type VI organic sludge totals. The data for the wastes identified as type IV in WasteOScope with a 746 generator code were subtracted from the Type IV sludge totals and added to the Type V non-combustible waste designation. The total container counts and volumes for each location are presented in Appendix Tables A-4 and A-5. The data were then evaluated and grouped by the waste types as described above and the compilation of the as-disposed waste types for each pit and trench is presented in Table 5-1.

Table 3-4. Correlation of the WasteOScope Waste Type designations and the Final Waste designations used for this report.

WasteOScope Waste ID	Roman Numeral Waste ID	WasteOScope Waste ID	Roman Numeral Waste ID
D	I	C	V
W	I	CC	V
I	I	CM	V
F	I or V	CR	V
FW	I or V	Empty	V
G (Gen. 771)	I or V	M	V
Graphite	I or V	N	V
LGW	I or V	RO	V
U233	I or V	SH	V

WasteOScope Waste ID	Roman Numeral Waste ID	WasteOScope Waste ID	Roman Numeral Waste ID
A	II	V	V
II	II	B	VI
K	III	G (Gen. 444)	VI
III	III	VI	VI
IV	IV	VII (Be)	VII (Be)

4. ROCKY FLATS PLANT WASTE GENERATION

Descriptions of the processes in each of the RFP buildings that generated wastes shipped to the INEEL for burial from April 1954 through October 1970 are presented in the following sections. Wastes were generated at the RFP primarily by plutonium, beryllium, uranium, and americium manufacturing, recovery, and treatment operations. In addition, plutonium production support activity wastes (i.e., maintenance, laboratory analyses, and R&D generated wastes) were dispositioned to the INEEL burial grounds, as well as the waste generated by non-plutonium operations. A substantial quantity of waste was also generated by “special order” work performed in Building 881 and the beryllium and uranium machining operations in Building 883. The vast majority of waste was generated from plutonium-related operations conducted in Buildings 559, 771, 774, 776, 777, and 779. A summary of the various containers of solid contaminated waste that was shipped from RFP to INEEL between 1954 and 1970 is presented in Table 4.1 (RF-C057, RF-U176). The number of containers, based on the estimated percent contribution for each type, is presented for the three types of generation areas: (1) Building 774, (2) the plutonium areas (e.g., Building 559, 771, 776, 777, and 779) and (3) for non-plutonium areas (e.g., Buildings 123, 441, 444, 881, 883, 889, and 991; RF-U176).

Table 4-1. Estimated number of containers shipped to the INEEL by generation area (RF-U176, RF-C057)

Generation type	55-gallon Drums	30-gallon Drums	40-gallon Drums	Crates or Boxes	Cartons (filters and boxed drums)
Building 774	47,498 (26%)	1,525 (21%)	63 (5%)	211 (3%)	4,841 (26%)
Plutonium Areas	100,999 (55%)	3,198 (44%)	621 (53%)	4,415 (71%)	5,623 (31%)
Non-plutonium Areas	35,557 (19%)	2,453 (34%)	451 (38%)	1,612 (26%)	7,827 (43%)
Total number of drums	184,111	7,207	1,174	6,238	18,290

Each RFP building identified as a generator in WasteOScope is described in detail in the following sections. The generator, and in some cases, sludge waste designations (e.g., 74 series sludges) for the wastes, were identified from the shipment records and load lists based on container prefixes as described in Section 3.2.1. The processes that generated the wastes, the physical form of the shipped wastes (identified by waste types), and the chemical and radionuclide waste constituents are included in the discussions.

4.1 Building 122

Building 122 was built in 1953 as a medical facility to provide treatment of industrial injuries, personnel decontamination, and routine physicals for RFP personnel (RF-U115).

4.1.1 Building 122 Waste Generating Operations

Waste from Building 122 was generated during treatment or decontamination of personnel who had been injured and/or contaminated on the job with plutonium, uranium, or other radioactive materials handled during RFP operations (RF-U115, RF-P085). Radionuclide sources used in Building 122 were disposed of in 1970.

4.1.2 Physical Waste Matrices Generated

A total of four containers (29 ft³) of debris waste were generated from activities conducted in Building 122. These numbers were compiled from the WasteOScope download (RF-U169) and grouped into the seven waste types as described in Appendix B and presented in Table 4-2. A more detailed presentation of the original waste type assignments entered into WasteOScope and delineation into the seven final waste types are presented in Appendix B.

Table 4-2. Wastes generated from Building 122 activities (RF-U169).

Waste Type	Building 122 Medical		
	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	4	29
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	0	0
III	Filters	0	0
IV	Inorganic sludges	0	0
V	Non-combustibles	0	0
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	0	0
Total		4	29

It is assumed that the wastes were radioactively contaminated PPE, wipes, and other common combustible debris waste forms generated during the decontamination of personnel. Waste from Building 122 is expected to have both radionuclide (e.g., plutonium, uranium) and chemical contamination as described in the following sections.

4.1.3 Chemical Constituents

It is assumed that common compounds used for decontamination of personnel, as well as other solutions used in medical treatment of injuries (i.e., potassium permanganate, isopropyl alcohol, ethanol, and hydrogen peroxide) may be present in the waste generated in this facility (RF-P085).

4.1.4 Radionuclides

The radioisotopes that may be present in wastes generated from Building 122 activities would include all isotopes handled or processed at the RFP and are listed in Table 4-3. Radioisotopic content for individual wastes or specific to RFP buildings cannot be determined; however, it is assumed that the waste generated from Building 122 activities will be low level and low level mixed waste. Therefore, it is assumed that the waste generated from any of the RFP buildings are potentially contaminated with all radioisotopes identified as used at the RFP and discussed in detail in Section 6.

Table 4-3. List of radionuclides for the RFP site as potential contaminants – Building 122.

Radionuclides			
Am-241	U-234	Pu-238	Pu-241
Cm-244	U-235	Pu-239	Pu-242
Np-237	U-238	Pu-240	U-233

4.2 Building 123

Building 123, the Health Physics (HP) Laboratory, was one of the first ten buildings constructed at Rocky Flats in 1953. The building was used as the central laboratory for analysis of environmental (soil, vegetation, water, and air), biological (urine, fecal matter, and nose swipes), health physics (room air), and industrial hygiene (beryllium and organic vapors in room air) samples; internal/external dosimetry; and instrument calibration activities. The building provided office space for radiation health specialists. Building 123 also housed medical research activities until construction of Building 122, the medical treatment facility, was completed later in 1953 (RF-P181).

4.2.1 Building 123 Waste Generating Operations

Ninety-five percent (95%) of the Building 123 waste generated from the HP laboratory operations consisted mainly of plutonium and HEU contaminated bioassay wastes (RF-U115). External Dosimetry and Health Physics Instrumentation contributed a small portion of wastes, along with the standard utility services. Contaminated items from severe plutonium and HEU contamination cases were also collected from Building 122, and usually transferred to Building 123 for packaging and disposal (RF-U115).

Building 123 was also used for R&D in support of nuclear weapons production. Although a wide variety of activities were conducted in the building, large quantities of radioactive materials were not handled (RF-P181).

4.2.2 Physical Waste Matrices Generated

A total of 83 containers (607 ft³) of debris waste were generated from activities conducted in Building 123. These numbers were compiled from the WasteOScope download (RF-U169) and grouped into the seven waste types (described in Section 5) and presented in Table 4-4. A more detailed presentation of the original waste type assignments entered into WasteOScope and delineation into the seven final waste types is presented in Appendix B.

Table 4-4. Wastes generated from Building 123 activities (RF-U169).

Building 123 Health Physics			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	30	217
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	0	0
III	Filters	0	0
IV	Inorganic sludges	0	0
V	Non-combustibles	53	390
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	0	0
Total		83	607

It is assumed that the debris wastes were composed of radioactive contaminated PPE, wipes, and other common combustible waste forms, and non-combustible wastes generated during routine analytical laboratory activities.

One of the Building 123 rooms was used for dog autopsy studies; however, no method or discussion of waste disposal was found. Based on a March 29, 1962, letter (RF-C100) from RFP to the University of Colorado Medical Center regarding acceptance of radioactively contaminated solid wastes with instructions that dead animal carcasses preserved with formaldehyde should be wrapped air-tight in polyethylene to keep the odor ‘nuisance’ to a minimum, it is assumed that RFP packaged animal carcasses for disposal in the same manner.

Waste from Building 123 laboratories is assumed to be both radiologically (e.g., plutonium, uranium) and chemically contaminated.

4.2.3 Chemical and Metal Waste Constituents

The chemicals used in laboratory processes that may be present as contaminants of the waste generated in Building 123 are listed in Table 4-5 (RF-P181).

Table 4-5. Chemicals used in Building 123 Health Physics Laboratory Operations (RF-P181).

Constituent	Use
Metals	
Arsenic	Analytical (RF-P181)
Beryllium	Analytical (RF-P181)
Cadmium	Analytical (RF-P181)
Chromium	Analytical (RF-P181)
Lead	Analytical (RF-P181)
Mercury	Analytical (RF-P181)
Potentially ignitable, reactive, or corrosive chemicals	
Ammonium hydroxide	Analytical Processes (RF-P181)
Hydrochloric acid	Analytical Processes (RF-P181)
Hydrofluoric acid	Analytical Processes (RF-P181)
Nitric acid	Analytical Processes (RF-P181)
Perchloric acid	Analytical Processes (RF-P181)
Sodium hydroxide	Analytical Processes (RF-P181)
Other Chemicals/Constituents	
Ammonium thiocyanate	Analytical Processes (RF-P181)
Isopropyl alcohol	Analytical Processes (RF-P181)
Methanol	Analytical Processes (RF-P181)
Oxalic acid	Analytical Processes (RF-P181)
Potassium permanganate	Analytical Processes (RF-P181)
Toluene	Analytical Processes (RF-P181)

4.2.4 Radionuclides

The radioisotopes that may be present in wastes generated from Building 123 processes include actinide elements, compounds, sources, and other radioactive materials historically used at the RFP including, but not limited to, the isotopes and radioactive decay products listed in Table 4-6. Radioactive spike solutions were used as an additive during preparation of most samples and radioisotopic sources were used in the determination of contamination as part of the normal operating HP procedures associated

with Building 123. Large Pu/Be neutron sources were disposed of from this building in 1972. The sources were sealed in a produce can, placed in DOT 6M containers, and then placed in a drum with plutonium-contaminated LGW. (RF-C138) Although this occurred after the time of waste disposal at the INEEL addressed by this report, it is assumed that similar sources from Building 123 could have been disposed of at the INEEL previously. Radioisotopic content for individual wastes or wastes specific to RFP buildings cannot be determined. Radioisotopic content for all RFP waste is discussed in detail in Section 6 (RF-P181).

Table 4-6. List of radionuclides for the RFP site as potential contaminants – Building 123 (RF-P181).

Radionuclides		
Am-241	Ni-63	Pu-242
Ba-133	Pb-210	Sr-90
Cf-250	Pu-238	U-234
Cm-244	Pu-239	U-235
Cs-137	Pu-240	U-236
H-3	Pu-241	U-238
Gd-148		

4.3 Building 331

Building 331 was built in 1953 as a vehicle maintenance garage and the site fire department. The building also housed a small metallurgical R&D laboratory (RF-P065).

4.3.1 Building 331 Waste Generating Operations

Waste from Building 331 was generated by the decontamination of fire fighting equipment and vehicles (on the vehicle maintenance side) that were contaminated with plutonium, uranium, or other radioactive materials handled during operations at RFP.

A small R&D laboratory also housed in this building was engaged in evaluating equipment and methods applicable to casting and fabricating DU items. A limited thorium project was also conducted in this facility (RF-U115).

4.3.2 Physical Waste Matrices Generated

A total of 161 containers (1,544 ft³) of debris were generated from activities conducted in Building 331. These numbers were compiled from the WasteOScope download (RF-U169) and grouped into the seven waste types, as described in Section 5 and presented in Table 4-7. A more detailed presentation of the original waste type assignments entered into WasteOScope and delineation into the seven final waste types are presented in Appendix B.

It is assumed that the debris wastes were composed of radioactive contaminated PPE, wipes, and other common combustible and non-combustible waste forms generated by the decontamination of vehicles and fire fighting equipment, and beryllium-contaminated waste generated during laboratory R&D activities.

Table 4-7. Wastes generated from Building 331 activities (RF-U169).

Building 331 Garage & Fire Station including R&D Laboratory			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	105	771
I & V	Combustibles & non-combustibles	0	0.00
II	Filter paper	0	0.00
III	Filters	0	0.00
IV	Inorganic sludges	1	7
V	Non-combustibles	53	568
VI	Organic wastes	0	0.00
VII (Be)	Beryllium-contaminated debris	2	197
Total		161	1,544

Waste from the Building 331 laboratories is expected to have both radionuclide (e.g., plutonium, uranium) and chemical contamination as described in the following sections.

4.3.3 Chemical and Metal Waste Constituents

Beryllium may be encountered in waste from rooms 114 and 117 of Building 331 as the result of R&D beryllium operations. The fire department also on occasion had detectable quantities of beryllium in decontamination solutions from fire fighting equipment after the equipment was returned from emergency response operations and cleaned (RF-P065).

Gasoline, diesel, oil, hydraulic fluids, and antifreeze may be present in waste from the vehicle maintenance side of the building. No other chemicals of concern were identified (RF-P065).

4.3.4 Radionuclides

The radioisotopes that may be present in Building 331 wastes include DU, thorium, and trace amounts of plutonium. Suspected plutonium contamination is based on a report that the fire department found radiological contamination on fire fighting equipment that had entered contaminated areas and that contamination was detected as the equipment was decontaminated (RF-U115, RF-P065). Radioisotopic content for individual wastes or specific to this building cannot be determined. However, radioisotopic content for all RFP waste is discussed in detail in Section 6.

4.4 Building 441

Building 441 (originally part of A-Plant) was a general analytical laboratory facility built in 1953. The primary purpose of this laboratory was to support the DU and beryllium operations conducted in Building 444. The laboratory provided uranium recycle R&D, and determination of uranium in waste products, as well as general site chemical analyses as described below (RF-P093, RF-U115):

- Uranium recycling was conducted to determine safe and economical recycling of special nuclear materials. Although uranium recycling was identified for Building 441, processes that might have been conducted in this building for this purpose were not described in any of the AK source documents reviewed to date. Although all uranium recovery and HEU component operations were

moved from RFP to ORNL in 1964, uranium recovery continued at RFP. The recovery operations involved leaching of site returns from ORNL, which contained HEU components (RF-P085).

- In the very early days at RFP, Building 441 housed the original Health Physics laboratories that were later located in Building 123 (RF-P084). Analyses of personnel dosimeters and all airborne sample analyses, including stack samples and general room air samples, were performed. Additionally, a number of other analyses were conducted in this building (such as waste water and production control samples from Building 444) prior to the transfer of those analytical responsibilities to Building 881 in 1964 (RF-P085).

In 1964, facility space became available in Building 881 because of the termination of HEU component manufacturing, and the analytical responsibilities were transferred from Building 441. In 1966, Building 441 was stripped out and converted to an administration building (RF-P093, RF-U043, RF-U115).

4.4.1 Physical Waste Matrices

All aqueous and organic liquids and solid wastes contaminated with uranium above the EDLs generated in this building (441) were sent to Building 771 for recovery. Liquid wastes below EDLs were sent to Building 774 for processing. Waste Types I, IV, V, and VI were identified as being generated in Building 441. Only a few drums of sludge waste per year were attributed to Building 441 in WasteOScope. It has not been determined exactly how sludge waste was generated in this building. However, contaminated sludge occasionally accumulated within processing equipment in other buildings (e.g., Buildings 881 and 444) and it is assumed that this may have been the case for the Type IV waste identified in WasteOScope as generated from Building 441.

Liquid waste generated in Building 441 was transferred to Building 774 for treatment. In December 1961, 14,200 gal of liquid waste from DU analyses conducted in Building 441 were transferred through Building 771 to the Liquid Waste Treatment Plant in Building 774. Additional information regarding waste volume and related waste shipment timeframes to the INEEL is included in WasteOScope. A specific waste generation rate for Building 441 is unavailable (RF-U043, RF-U155).

A total of 141 containers of debris and sludge wastes (1,049 ft³) attributed to Building 441 are recorded in WasteOScope as presented in Table 4-8 (RF-U169). These numbers were compiled from WasteOScope and are grouped into the seven waste types as described in Section 5. A more detailed presentation of the original waste type assignments entered into WasteOScope and the delineation into the seven final waste types are presented in Appendix B.

Based on the AK record regarding operations conducted in this building, the 22 containers of debris wastes consisting of uranium- and beryllium-contaminated gloves, wipes, and other common combustible waste forms and non-combustible Type V wastes were generated during common laboratory practices conducted in the building, as well as from routine and non-routine decontamination activities. Based on the AK record, the debris wastes are also contaminated with chemical constituents as described in the following section. The sludge waste (Type IV) is assumed to be solidified sludge contaminated with radiological and chemical constituents generated during laboratory operations that may have accumulated in equipment or the waste tank, or originated from machine shop cutting operations.

A limited amount of information is provided in WasteOScope. Specifics on the amount of cellulose, plastic, and rubber (CPR) present in waste containers are not provided. However, as a conservative measure, it may be assumed that the Type I combustible wastes are predominately CPR.

Table 4-8. Wastes generated from Building 441 activities (RF-U169).

Building 441 Production Support			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	22	192
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	0	0
III	Filters	0	0
IV	Inorganic sludges	3	17
V	Non-combustibles	115	833
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	1	7
Total		141	1,049

4.4.2 Chemical Constituents

There is limited information in the AK record regarding material inputs into the processes conducted in Building 441. It is assumed that the materials used in the Building 441 laboratory were the same as those used in other analytical laboratories (e.g., Building 881) at RFP during this time. The principal chemical or metal (non-radiological) contaminants of the wastes generated from Building 441 activities are beryllium, natural thorium from samples analyzed for special projects and in trace amounts, as well as other chemical inputs provided in the discussion of Building 881 activities and wastes (see Section 4.13; RF-U115). Polychlorinated biphenyls (PCBs) also may be present in paint chips, light ballasts, and oil containing equipment (RF-P093).

The chemicals used in Building 441 as identified in the AK record are listed in Table 4-9. Also included in the table is the process or use of the constituent (if known).

Table 4-9. Chemicals used in Building 441.

Constituent	Process/Use (if known)
Organic Solvents	
Methylene chloride	General laboratory use (RF-P093)
Trichloroethylene	Spent Solvent (RF-U115)
Perchloroethylene (PCE)	Spent Solvent (RF-U115)
Metals	
Beryllium	Analysis (RF-P093)
Lead	Used paint (RF-P093)
Mercury	Small volume mercury spills (RF-P093)
Silver	NDA analysis/film processing (RF-P093)
Potentially Ignitable, Reactive, Corrosive Chemicals	
Acids	General laboratory use (RF-P093)
Bases	General laboratory use (RF-P093)
Other Chemicals/Constituents	
Asbestos	Unknown (RF-P093)
PCB	Used paint, light ballasts (RF-P093)

4.4.3 Radionuclides

This laboratory was used primarily to support DU and beryllium operations. It was also used at one time to analyze natural thorium samples for a special project. The only radioisotopes identified in the AK record for Building 441 are the uranium isotopes consistent with depleted uranium and thorium isotopes incident in natural thorium samples, as listed in Table 4-10. There were no mixed fission products or pure beta emitters known to be used or handled in this building (RF-P093).

Table 4-10. List of radionuclides for the RFP site as potential contaminants – Building 441 (RF-U115).

Radionuclides	
U-234	U-238
U-235	Th-232

4.5 Building 444

The A-Plant, Building 444, began operations in 1953 for depleted uranium manufacturing. A short time later, limited R&D beryllium operations began and were conducted until 1958 when full-scale beryllium fabrication (machining) operations went into effect. During the early years, the majority of depleted uranium components manufactured in the A-Plant went directly to the Pantex Plant in Texas (RF-P085). Depleted uranium, depleted uranium alloys, and beryllium were the main metals used in parts manufactured in Building 444, although copper, stainless steel, aluminum, titanium, nickel, gold, silver, and magnesium were also used in some parts—or as coating or alloy materials (RF-P084, RF-P240).

In 1957, a change in concept of weapons production resulted in a shift in the relative amounts of the materials used in the triggers. The change required beryllium components, more plutonium, and less depleted uranium. In 1958, beryllium operations became a significant portion of RFP work. The weapons components manufactured in Building 444 no longer went directly to Pantex, but were sent to Building 777 for incorporation into the final assembly operations. Depleted uranium workload decreased significantly as the beryllium operations became more prevalent (RF-P084, RF-P085).

Operations in Building 444 included, but may not have been limited to, the processes described below:

- Beryllium component manufacturing was not part of the processes conducted in the first years of RFP operation. When the sealed hollow core concept was first implemented in the late 1950s, beryllium material was received at RFP in the shape of pressed-powder beryllium bowls. The bowls were heat-treated and machined to required dimensions in Building 444. When beryllium operations became part of the primary production line in 1958, the process changed, and the components were shaped by pressing and machining from blanks supplied by an outside vendor. Soon RFP began conducting its own casting of beryllium ingots (blanks) using a wrought process for economic reasons, and the RFP operations then included milling, turning, drilling, and polishing. The wrought process was used until the mid 1970s, and beryllium casting continued until 1980 (RF-P047, RF-U115, RF-P084, RF-P085).
- Depleted uranium operations were a significant part of the original manufacturing work performed at RFP. A process flow chart for DU fabrication is provided as Figure 4-1. Operations included casting and machining of depleted uranium components that were rich in the U-238 isotope. The DU rich in U-238 is often called D-38 or Tuballoy. Adoption of the implosion weapon concept brought about changes in fabrication operations that required additional processing of the components. Building 883 was built to fill the need for this additional processing. DU was still

cast in Building 444, but was sent to Building 883 to be heated and made into shapes to be sent back to Building 444 for turning, trimming, polishing, and coating. Completed components were shipped to other on-site facilities for final assembly (RF-P047, RF-U115, RF-P084, RF-P085).

- Beginning in 1966, R&D of depleted uranium-niobium alloys was conducted in Building 444. Full-scale production of this material did not occur until the early 1970s (RF-P047, RF-U115, RF-P084, RF-P085).
- Zero Power Physics Reactor (ZPPR) Fuel Plate Fabrication was conducted from 1967-1969. ZPPR fuel elements or fuel plates were manufactured for installation in the reactor at Argonne National Laboratory-West (ANL-W). The special uranium-molybdenum (U-Mo) alloy fuel elements were first fabricated and cast in Building 444. The U-Mo alloys were then sent to Building 771 to be alloyed with plutonium by casting into plates of various sizes. The ternary alloy plates were clad in stainless steel envelopes in Building 776/777 and sealed by welding. The plutonium used in this project originated in the United Kingdom and contained a higher percentage of Pu-240 than most RFP plutonium, so great care was taken to keep the material separate from other plutonium recovery and waste streams (RF-P085). ZPPR fast recycle residues were sent to the Hanford site for disposal (RF-P084, RF-P085, RF-C219). Only incidental contaminated debris waste or small quantities of liquid waste from the ZPPR project may have been included in one of the 774 sludges.
- In 1954, approximately 14,000 gal of sour coolant contaminated with uranium were stored in Building 444 awaiting disposal. In an effort to reduce waste oil volume, research was conducted into oil evaporation on a pilot-scale basis. The resulting condensate was sent to the Building 774 waste treatment system and the still bottoms were either drummed and buried, burned in outdoor burning pits, or stored at the 903 Pad. In the late 1970s or early 1980s, this system was replaced with a centrifuge system (RF-P084).
- Coating and plating operations conducted in Building 444 were performed on non-nuclear parts, such as stainless steel and copper. These operations were not part of the DU and beryllium parts fabrication, and were not considered to be special projects or a part of R&D. Coating consisted of cleaning the parts, drying to remove excess moisture, and coating with erbium nitrate. Production plating activities consisted of etching and plating War Reserve (WR) and special order parts. This process required five different solutions (e.g., a silver plating solution, a sulfuric acid etch bath, a nickel-plating tank, an alkaline cleaning solution, and an electropolish nickel-plating solution). After parts were plated, they were rinsed in one of several rinse solutions. The rinsate used for gold-plated parts contained cyanide. Spent potassium/gold/cyanide plating solution was generated from this process (RF-P084). Additionally, in the R&D plating laboratory, cyanide was used in the plating of cadmium and other metals. Cyanide bath solutions used in the plating processes were made by mixing cadmium salts with cyanide solutions (RF-P084, RF-P085, RF-U115).

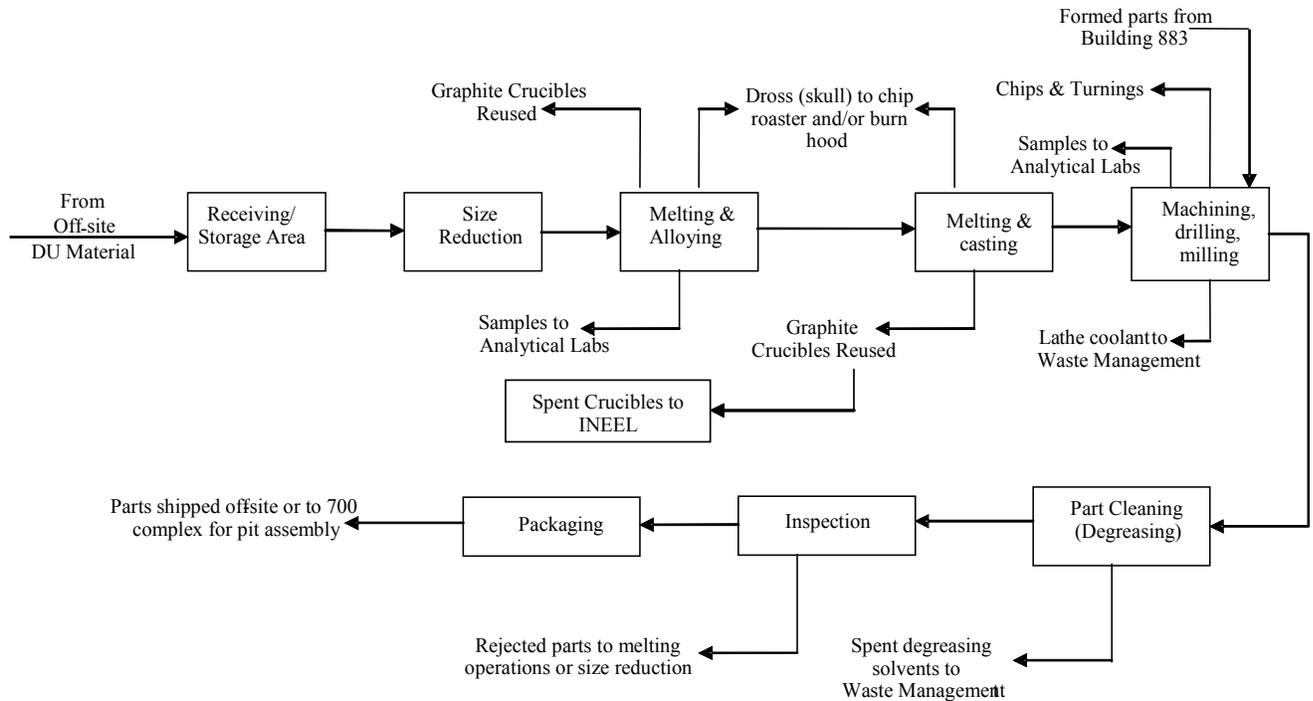


Figure 4-1. Depleted uranium fabrication—RFP Building 444 (RF-P105).

4.5.1 Physical Waste Matrices Generated

A total of 25,054 waste containers (233,538 ft³) were generated from activities conducted in Building 444. These numbers were compiled from WasteOScope (RF-U169) and grouped into the seven waste types, as described in Section 5 and presented in Table 4-11. A more detailed presentation of the original waste type assignments entered into WasteOScope and the delineation into the seven final waste types are presented in Appendix B.

Table 4-11. Wastes generated from Building 444 activities (RF-U169).

Building 444 A-Plant, DU, & Be Metalurgy			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	5,874	60,898
I & V	Combustibles & non-combustibles	600	3,996
II	Filter paper	861	5,200
III	Filters	1,067	6,767
IV	Inorganic sludges	165	1,176
V	Non-combustibles	12,963	129,210
VI	Organic wastes	1,112	7,067
VII (Be)	Beryllium-contaminated debris	2,412	19,224
Total		25,054	233,538

Waste Type I consists of combustible debris including large quantities of sandpaper and emery cloth, butcher paper used to cover worktables during coating, and other paper, plastic, and rubber materials. To estimate the amount of CPR contained in the waste generated from Building 444 activities, the following assumptions were made:

- Because the Type I waste consists of combustibles including paper products, plastics, and rubber items, the contents of the drums identified as Type I are assumed to be predominantly CPR.
- Type II filter paper is also combustible debris waste, as are the Type III CWS filters generated prior to 1957, therefore, CPR waste (RF-D001). After the 1957 fire in Building 771, all combustible-type CWS filters in all buildings across RFP were replaced with fire-resistant and HEPA filters (RF-P265, RF-U057).
- As a conservative measure, one half of the wastes identified under the combined I and V waste types will be assumed to be Type I combustible debris, and so be predominantly composed of CPR materials.

All aqueous and organic liquids and solid wastes generated in Building 444 were contaminated with uranium and beryllium. Liquid wastes contaminated with uranium were sent to Building 774 for processing, and solid debris wastes (Types I, I&V, II, III, and V) were directly packaged as wastes. Building 444 equipment and/or apparatus that moved air and/or displaced air had CWS and/or HEPA filtering system(s), including furnace vacuum pump exhausts. The spent filters were contaminated with beryllium or beryllium oxide and disposed of as Type III waste (RF-P084, RF-U115, RF-D001).

Metal bricks that were used to line the furnaces were contaminated with depleted uranium, and were discarded as Type V waste. Graphite molds were sent for cleaning to remove residual metal, powdered graphite, and yttrium. Wastes from the cleaning process were (RF-U115):

- Graphite dust disposed of on-site in the RFP landfill.
- Spent graphite molds, generally disposed of as whole molds (RF-P105).
- Coating reaction failure of the molten beryllium and/or DU with the graphite produced a hole in the mold. Clean-up included the melt, firebrick, graphite, crucible, and other clean-up materials. The materials were consolidated into drums or boxes. The depleted uranium was written off as NOL.
- Waste Type V also may include obsolete equipment (lathes, drill presses, etc.) (RF-P047).

Additional wastes from uranium machining/casting operations included:

- Vacuum pump oil used in the house vacuum system either incinerated at RFP or sent to 774 for processing (RF-P105)
- Non-hazardous batteries
- Uranium oxide residues (scull)
- Light metals, such as aluminum and steel (RF-P105, RF-U155).

Early wastes (1954 to 1960) generated in Building 444 included contaminated graphite molds, crucibles, small tools, paper wipes, gloveboxes, and equipment (RF-P047) which may be represented in WasteOScope under the combination I & V waste type. After 1960, depleted uranium oxide (fines, turnings, etc.) stored from previous operations and subsequent operations, were included with other depleted uranium waste sent to the INEEL for disposal (RF-P047, RF-P084, RF-U115). Depleted uranium waste (machining chips, turnings, and fines) incineration in Building 447 converted the pyrophoric metal to a stable oxide (U_3O_8) or roaster oxide (RO) prior to INEEL shipment. The conversion (roasting) process is discussed in detail in Section 4.6, Building 447. The practice does not preclude the possibility that pyrophoric material may still be present in the DU contaminated wastes. Although early waste shipments, those prior to the advent of converting DU to a stable oxide in 1965, would have the greatest potential to contain pyrophoric metal, later drums may contain RO with incomplete oxidation (RF-C129, RF-P047). Two incidents of fire were reported that involved uranium chips in Building 444; uranium chips caught fire in a crusher in June 1955, and there was a fire involving uranium chips and perchloroethylene in November 1956 (RF-U143). Two additional incidents of ignition of other metals in Building 444 were ignition of lithium chips in July 1963, and metallic beryllium chips involved in a fire in February 1964 (RF-U143). The potential for pyrophoricity in RFP waste is discussed in greater detail in Section 5.3.1. Roaster oxide waste was generally assigned an RO or Waste Type V designation.

Waste Type VII is described in Section 3.2.12 of this report as consisting of beryllium-contaminated debris, which includes beryllium or beryllium oxide waste in the form of skulls (casting residue); impure or damaged castings that could not be salvaged were periodically included in waste containers. Other beryllium-contaminated wastes identified as Waste Type VII are assumed to include broken and obsolete graphite molds, crucibles, tool bits, chucks, coolant, filters, sweepings, wipe cloths, and other miscellaneous items (RF-P047). Graphite molds and crucibles too large to fit into a 55-gal drum were placed in $4 \times 4 \times 7$ ft crates (RF-U115).

Machining oils used to prevent airborne contamination and degreasing agents (trichloroethane, etc.) contaminated with Be were processed through Building 774 and are included in the 743 organic sludge in WasteOScope. Waste containers were identified in WasteOScope for both inorganic sludge (Waste Type IV) and organics (Waste Type VI) for this Building (Table 4-12). The Waste Type VI for contaminated organic waste was identified in the late 1950s (RF-C124). It is assumed that this sludge was from an accumulation of liquid waste material within processing equipment (RF-U169, RF-U115).

4.5.2 Chemical Constituents

Chemicals and other potential waste constituents used in Building 444 are listed in Table 4-11. Cleaning solvents and other chlorinated compounds used in Building 444 operations included trichloroethylene (TCE), tetrachloroethylene (PCE), chlorofluoro-hydrocarbons (CFCs) such as Freon, chloroform, tetrabromoethylene, and 1,1,1-trichloroethane. Spent solvents and other liquid wastes were sent to Building 774 for recycle and reuse or treatment and disposal. The spent salt baths contaminated with uranium oxide were identified as Type IV sludge waste either for this building, as shown in Table 4-9 for Building 774, or identified as 745 sludge (RF-U115).

Metals were identified as used in Building 444 processes such as metal etching and plating operations, or treatment of uranium parts prior to coating. The metals identified as potentially present in Building 444 waste are listed in Table 4-12 (RF-P085).

Table 4-12. Chemical and metal constituents reported as used in Building 444 operations.

Constituent	Process/Use (if known)
Organic Compounds	
1,1,1-Trichloroethane (TCA)	Replaced PCE for cleaning, Machining, Chemistry Technology (RF-U115, RF-P084)
Acetone	Parts cleaning (RF-P085)
Chlorofluorocarbons	Cleaning solvent (RF-U115)
Chloroform	Chemistry Technology (RF-P085)
Ethanol	Chemical Inventory (RF-C215)
Freons: Freon TF-113 Freon TF	Parts cleaning – Physical Metallurgy (RF-P084, RF-P040)
Kerosene	Unknown – Chemical Inventory (RF-C215)
Methanol	Joinings & Coatings (RF-P040)
Tetrabromoethylene	Float sink separation process media in conjunction with Beryllium work (RF-P085)
Tetrachloroethylene (Perchloroethylene [PCE])	Used to clean coolants off of machined parts (RF-P084). Used to remove the dye penetrant from parts (RF-C215).
Trichloroethylene	Cleaning solvent and degreasing (RF-U115)
Trichloromethane	(RF-P084)
Metals (Non-radioactive)	
Aluminum	Physical Metallurgy (RF-P085)
Beryllium	Physical Metallurgy (RF-P085)
Brass	Physical Metallurgy (RF-P085)
Cadmium	Physical Metallurgy and electroplating (RF-P085)
Chromium	Physical Metallurgy (RF-P085)
Copper	Physical Metallurgy (RF-P085)
Gold	Parts, casting, or alloy (RF-P085)
Lead (lead fluoroborate and lead oxide)	Physical Metallurgy (RF-P085)
Mercury	Physical Metallurgy (RF-P085)
Molybdenum	
Nickel	Parts, casting, or alloy (RF-P085)
Silver	Physical Metallurgy (RF-P084)
Magnesium	Physical Metallurgy (RF-P085)
Titanium	Parts, casting, or alloy (RF-P085)
Tungsten	Manufacturing
Vanadium	Physical Metallurgy (RF-P085)
Potentially Ignitable, Reactive, Corrosive Chemicals	
Ammonium hydroxide	Uranium neutralization and precipitation from acid solutions
Hydrochloric acid	Unknown

Constituent	Process/Use (if known)
Hydrogen peroxide	Acid etching, solution mixture HNO ₃ , hydrogen peroxide, deionized water (RF-P085)
Nitric acid	Metal etching and plating operations (RF- P085)
Phosphoric acid	Physical Metallurgy (RF-P085)
Sodium hydroxide	Unknown, Chemical Inventory (RF-P085)
Sulfuric acid	Physical Metallurgy (RF-P085)
Other Chemicals/Constituents	
Calcium fluoride ^(RF-U115)	Coating Be molds
Celvacene Grease	Miscellaneous Materials
Cimcool	Coolant used in DU machining (oil) (RF-P084)
Developer Rack Cleaner (sodium thiosulfate and sodium ferricyanide)	Used photo processing chemical (RF-C215)
Developer System Cleaner	Used photo processing chemical (RF-C215)
Dubl-Chek	Used photo processing chemical (RF-C215)
Duo Seal	Unknown
GS-3	Used photo processing chemical (RF-C215)
Kodak Developer	Used photo processing chemical (RF-C215)
Kodak Fixer	Used photo processing chemical (RF-C215)
Magnaflux no.1 Gray Powder	Used photo processing chemical (RF-C215)
Molykote (molybdenum sulfide)	Unknown
Motor Oil 20-W	Unknown
Oakite 162	Non-chlorinated solvent-Chemistry Technology (RF-U208)
Silicone	Unknown – Chemical Inventory (RF-C215)
Sulfur hexafluoride	Unknown – Chemical Inventory (RF-P085)
Terry Cleaner	Unknown
Texico CX	Coolant – petroleum based water soluble coolant (RF-P084)
Trim Rinse detergent	Non-chlorinated solvent Chemistry Technology (RF-P084)
Used Dye Penetrant	Used photo processing chemical (RF-C215)
Used Freon	Used photo processing chemical (RF-C215)
Yttrium oxide(RF-U115)	Coating Be molds (RF-P084)
ZC-79 (in a spray can)	Used to clean Magnaflux No.1 gray powder from parts (RF-C215)
ZP-9	Used photo processing chemical (RF-C215)
Zyglö Developer (ZP-5)	Used photo processing chemical (RF-C215)
Zyglö Emulsifier (DP-50)	Used photo processing chemical (RF-C215)
Zyglö Emulsifier (ZE-2)	Used photo processing chemical (RF-C215)
Zyglö Penetrant (DP-50)	Used photo processing chemical (RF-C215)

4.5.3 Radionuclides

Building 444 conducted non-plutonium operations that generated radioactive, low level wastes. The only radiological contamination related to the Building 444 wastes shipped to INEEL is depleted uranium (Table 4-13). From 1954 until April 1978, these wastes were included in shipments of plutonium-contaminated wastes shipped to the INEEL for disposal (RF-P047).

Table 4-13. List of radionuclides for the RFP site as potential contaminants – Building 444 (RF-U115).

Radionuclides	
U-234	U-238
U-235	

4.6 Building 447

Building 447 was constructed in 1956 to provide additional manufacturing space for Building 444 operations, and to house Chip Roaster Operations for treatment of depleted uranium turnings and waste materials (RF-P084). Building 447 housed both assembly-related processes and waste-related processes related to the manufacture of depleted uranium and beryllium component manufacturing. War Reserve and special order parts were assembled, inspected, packaged, and shipped from this building as illustrated in the process flow chart (Figure 4-2). Metal parts manufactured or processed in Building 447 consisted of depleted uranium, uranium alloys, beryllium, niobium, stainless steel, aluminum, copper, and brass. Parts and assemblies were received from Buildings 444, 865, and 883 for processing. Depleted uranium, beryllium chips, and turnings from machine operations in those buildings were sent to Building 447 for waste processing, as shown in the process flow chart (Figure 4-3). The depleted uranium metal turnings were cleaned, oxidized in the chip roaster, packaged, and shipped off-site for disposal or recovery. Beryllium chips and turnings or metal contaminated with beryllium were cemented, packaged, and shipped off-site for disposal (RF-P084).

War Reserve and special order parts were produced, cleaned, assembled, and inspected in whole and in part in Building 447. In addition, special projects and waste handling processes were performed in this building (RF-P084).

Operations in building 447 involved four primary processes, as follows:

- Assembly — Electron beam welding operated in a vacuum chamber, involved welding beryllium, aluminum, depleted uranium, stainless steel and War Reserve production, and special order assemblies. Electrochemical milling operations, performed in an enclosed chamber using aqueous electrochemical processing, was used mainly on parts fabricated from stainless steel. On a lesser scale it involved milling tungsten, brass, copper, aluminum, beryllium, and depleted uranium. Heat treatment operations provided treatment to relieve internal stresses and “work hardening” induced by machining processes. The vacuum arc melt furnace melted material for casting consumable electrodes in copper molds. This process was performed inside a vacuum chamber. Parts- and assembly-cleaning operations occurred at various stages throughout the assembly process (RF-P084; RF-U115).
- Inspection — Consisted of non-destructive testing operations and material analysis. These processes most likely produced very little, if any, waste materials (RF-P084).

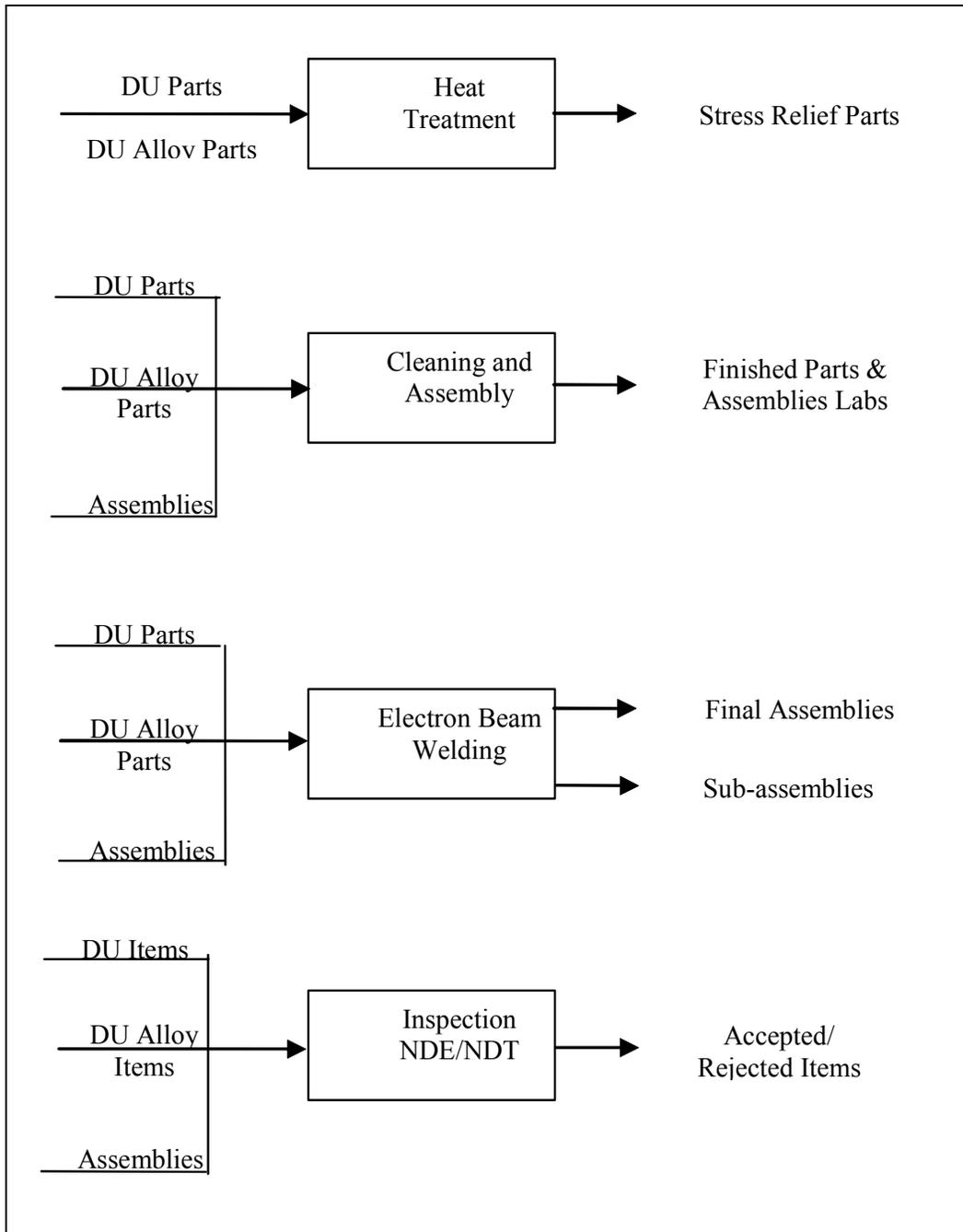


Figure 4-2. Depleted uranium fabrication — RFP Building 447 (RF-P105).

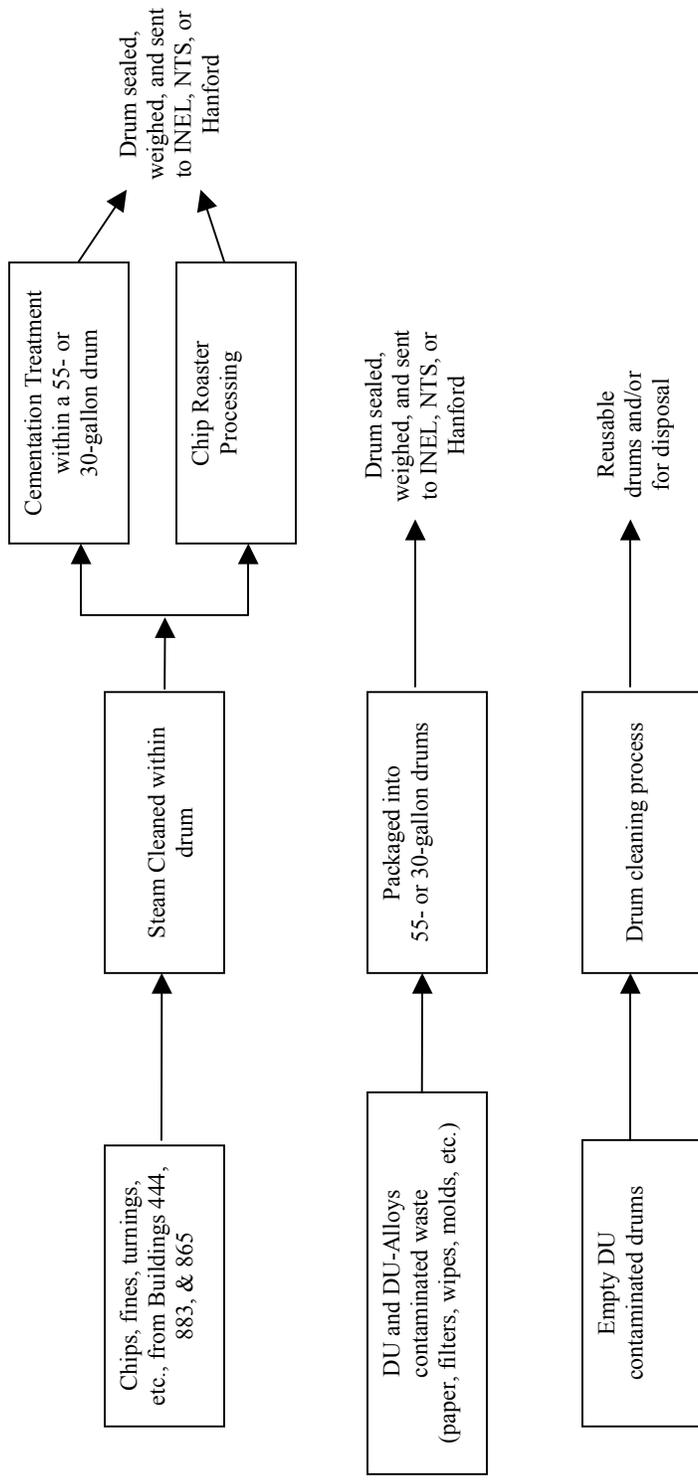


Figure 4-3. Depleted uranium LLW/LMW processing operations—RFP Building 447 (RF-P105).

- Grit Blasting — Special projects included a grit blast machine as well as a lapping machine. No additional information on these processes could be found (RF-P084).
- Waste handling — Essentially involved oxidation of depleted uranium chips “chip roaster,” compositing waste chips in cement, drum cleaning, low-level waste packaging and handling, and liquid waste disposal.
 - Chip roaster-depleted uranium metal turnings were cleaned, oxidized in the chip roaster, packaged, and shipped off-site. The chip roaster, sometimes referred to as the chip incinerator or the ore roaster, was used to oxidize depleted uranium chips so that these wastes could be safely transported for off-site disposal. The chip roaster began operations in 1956 and operated consistently with the exception of 1959 through 1961. During this period, there was an 8-month halt in using the roaster until a problem with the filter system could be corrected. During that time, floor sweepings of material were stored in drums outside of Building 447 until chip roasting operations resumed. In April 1961, it was recommended that 27 55-gal drums and 16 30-gal drums of discarded depleted uranium stored in the west yard of Building 447 be disposed of by on-site burial. The material in the drums consisted of 5,472 kg of depleted uranium in the form of saw chips and floor sweepings, plus foreign matter and coolant. These drums of depleted uranium chips may have been disposed of in trenches on plant-site, although the exact fate of the drums is unknown (RF-P084).
 - Composite waste chip cementation. This process involved compositing waste chips by cementing them. The cemented material consisted of uranium chips and turnings or metal contaminated with beryllium. The waste materials came from various machine operations in Building 444 and other manufacturing buildings. The cementation process involved mixing turnings with Portland cement, sand, and water. Then, a layer of pure cement was placed in an unlined 55-gal drum followed by a layer of cemented turnings. These chips and turnings consisted of depleted uranium, stainless steel and aluminum coated with small amounts of TrimSol machine coolant, machine cutting oil, and Freon 113. This waste was processed as low-level hazardous waste (RF-P084).
 - Drum cleaning, handling, and packaging operations involved steam cleaning the external drum surface with solutions of water, Mariko detergent, and a non-hazardous commercial cleaning detergent. Handling and packaging operations involved placing previously sealed low-level radioactive waste drums into shipping containers (RF-P084).
 - Liquid wastes from groundwater sumps, sinks, drains, the elevator pit line, and various processes in Building 447 were collected and filtered in building 447 prior to discharge. The wastes were then discharged to the sanitary sewer or to the Building 774 waste collection system, depending on the waste’s origin and content. Some of these liquid wastes contained trace contaminants of beryllium, Freon 113, depleted uranium, Trim sol machine coolant, Mariko, and Oakite cleaner. Liquid wastes from the cooling water system that was used to provide cooling water to various pieces of equipment may be contaminated with chlorine bleach, calcium hypochlorite, Nalco 2826 (to kill bacteria and algae) and Nalco 2536, which is a rust inhibitor consisting of borate, silicate, and nitrate.

4.6.1 Physical Waste Matrices Generated

Only one (1) container (215 ft³) of Type V non-combustible debris waste was shipped to the INEEL with Building 447 identified as the generator (Table 4-14). However, all processes conducted in Building 447 were included in the previous discussion because they may have contributed to waste

streams associated with other buildings. These processes included DU, DU alloy, Be, and BeO contaminated waste generation. Wastes that may have been related to Building 447 processes are the Type V roaster oxide (RO) wastes that are shown on the shipping records as having come from Buildings 444 and 883, and empty drums (designated by 746) generated from Building 774. The majority of the RO waste was identified as generated from Building 444. Because 746 was a designator for empty drums, it is assumed that these drums were contaminated with RO and/or sludge residue and may also contain miscellaneous cleaning materials such as wipes used during the cleaning process. Liquid wastes from Building 447 were sent to Building 774 for treatment and eventual shipment to INEEL under the designator of 743 solidified organic wastes. 743 sludges are not identified in WasteOScope as having beryllium contamination. However, because liquid wastes generated from Building 447 processes most likely were beryllium-contaminated, some of the 743 sludge wastes are assumed to be contaminated with beryllium.

Table 4-14. Waste volumes shipped from Building 447 (RF-U169).

Waste Type	Building 447 Manufacturing		
	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	0	0
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	0	0
III	Filters	0	0
IV	Inorganic sludges	0	0
V	Non-combustibles	1	215
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	0	0
Total		1	215

The 742 sludges (Second Stage Sludge) were produced from aqueous based lathe coolants that were employed with DU machining operations for fire prevention purposes. These spent aqueous lathe coolants were transferred to Building 774 for disposal via the second stage precipitation process. Additional buildings/designators that shipped beryllium-contaminated wastes are 221, 331, 441, 771, and 778 (RF-U169, RF-P047, RF-P117, RF-P115).

A limited amount of information is provided in WasteOScope. It is assumed that there is no CPR present in the Building 447 waste container identified above. The waste is identified as Type V non-combustible debris and is assumed to be metal scrap, brick, or Roaster Oxide (RF-U169).

4.6.1.1 Prohibited Items. Waste generated from Building 447 may contain prohibited items including depleted uranium waste in the form of machining chips, turnings, and fines. Although this type of waste was incinerated to convert the pyrophoric uranium metal to a stable oxide prior to INEEL shipment, pyrophoric metal was found in RFP waste containers at the INEEL. There are several reports of fires occurring in the INEEL burial ground in 1966 that involved waste containers of which at least one was identified as originating from Building 444. The presence of copper (plated on both sides with cadmium), copper cadmium alloys, plastics (such as polystyrene and nylon in the form of rods and diced pieces loaded with uranium oxide), and high-fired uranium oxide in sample results from the Building 444 container indicated roaster oxide and incomplete oxidation of the uranium. The samples of prime interest appear to be melted slag with uranium oxide present (RF-P221, RF-P047).

4.6.2 Chemical Constituents

The chemicals used in the Building 447 waste generating processes are listed in Table 4-15 and the related process or use.

Table 4-15. Chemical and metal constituents reported as used in Building 447 operations.

Constituent	Process/Use (if known)
Organic Compounds	
Acetone	Cleaning solvent
Ethanol (ethyl alcohol)	Cleaning surfaces (RF-P084)
Freon	Physical Metallurgy
Methylene chloride	Painting, paint stripping
Trichloroethane	Machining oils
Ignitable, Reactive Corrosives	
Nitric Acid	Parts cleaning & laboratory analyses (RF-P085)
Metals	
Aluminum	Physical Metallurgy (RF-P047)
Beryllium	Physical Metallurgy (RF-P047)
Copper	Physical Metallurgy (RF-P047)
Lead	Casting and back machining (RF-U115)
Niobium	Physical Metallurgy (RF-U115)
Titanium	Physical Metallurgy (RF-P047)
Other Constituents	
Calcium hypochlorite	Bactericide/algaecide (RF-P084)
Chlorine bleach	Bactericide/algaecide (RF-P084)
Mariko	Steam cleaning outside of drums
Nalco 2826	Bactericide/algaecide (RF-P084)
Noxon metal polish	Finishing part surfaces (RF-P084)
Oakite	Cleaning (RF-P084)
Sodium carbonate	Physical Metallurgy (RF-P084)
Sodium chloride	Physical Metallurgy (RF-P084)
Sodium nitrate	Physical Metallurgy (RF-P084)
Trim Sol	Machine coolant (RF-P084)

4.6.3 Radionuclides

The radioisotopes that may be present in the waste generated from Building 447 are the same as those listed for Building 444 (Table 4-13). The total activity of each isotope identified in the waste is unknown. Radioisotopic content for all RFP waste is discussed in detail in Section 6.

4.7 Buildings 551 and 553

Building 551 was constructed in the 1950s to provide warehousing of equipment, materials, and supplies for the RFP. The building received and stored supplies before they were distributed throughout the site. Most of the building was used for storage, but also housed several offices and a chemical dispensary. An addition was added onto the north end in the 1960s that included a fabrication and service shop, and an area used for mock-up testing and training. The north side also contained a large, metal equipment/tool crib/cage (RF-P042).

Building 553, shown in Figure 2-1, was an addition located on the southeast end of Building 551 and appears to have been an annex (RF-P085). Because it was a small building attached to Building 553, it is assumed to have been a small storage or support building for the warehouse or other services that were provided in this area of the RFP.

Although Building 551 was not a radiological facility and there were no routine historical or special radiological surveys (total and/or removable) available, the addition on the north side of the building was reported as radiologically contaminated at one time and the past contamination was cleaned up (RF-P042). Based on this information, there is a potential that radioactively-contaminated waste was generated in the fabrication or service shop areas of the building. The shipping records, as recorded in WasteOScope, indicate drums containing a combination of Type I and Type V debris wastes sent to the INEEL were generated in Building 551 (RF-U169).

Buildings 551 and 553 were located in the maintenance area of RFP. This is not considered a production area of the plant, but a service and support area that normally would have had no radioactivity associated with waste generated unless there was a need to clean-up an unintended release or other waste associated with maintenance and service kinds of activities. Since the warehouse did receive all shipments prior to their disbursement to the fabrication and production areas of the plant, it is possible that some type of radioactive contamination was inadvertently released in these buildings and subsequently cleaned up.

Based upon the historical use of the building, the waste generating processes most likely came from the fabrication and service area of the building. All contents of the building's interior were considered non-contaminated (RF-P042). At this time, no specific information on the types of components handled by the fabrication shop is available. The building's history indicates that the waste generated inside either originated from the fabrication/service area, or resulted from a spill or release of some type in the warehouse storage areas (RF-P042).

Since it is likely that the radioactive waste from these buildings was either generated in the fabrication area of Building 551 or as the result of a spill or accidental release, it is also likely that the material input for the waste stream was a fabrication metal such as aluminum, brass, copper, gold, nickel, stainless steel, tin, or zinc (RF-P042). If the waste resulted from a spill or unintended release, the waste is likely to include normal clean-up waste inputs, such as absorbent materials, combustible materials (cotton gloves, cheesecloth pads, Kimwipes, paper, wood), plastics (gloves, rubber, tape), and possibly materials used to wipe or scrub surfaces such as steel or plastic cleaning pads, sponges, cloth, brushes, and other similar items.

There are no process flow diagrams provided for Building 551 or Building 553. Both buildings were non-radioactive facilities (warehouse and small ancillary building; RF-P042) and did not house any processing activities.

4.7.1 Physical Waste Matrices Generated

A total of 18 containers (3,680 ft³) of Type V debris waste were generated from Building 551 activities and two containers (224 ft³) of Types I and V debris waste were generated from activities conducted in Building 553. These numbers were compiled from WasteOScope (RF-U169), grouped into waste types as described in Section 5, and presented in Table 4-16. A more detailed presentation of the original waste type assignments entered into WasteOScope and the delineation into the seven final waste types are presented in Appendix B.

Table 4-16. Waste volumes shipped from Buildings 551 and 553 (RF-U169).

Waste Type	Waste Description	Building 551 General Warehouse		Building 553 Building 551 Annex	
		Container Count	Volume (ft ³)	Container Count	Volume (ft ³)
I	Combustibles	9	920	1	112
I & V	Combustibles & non-combustibles	0	0	0	0
II	Filter paper	0	0	0	0
III	Filters	0	0	0	0
IV	Inorganic sludges	0	0	0	0
V	Non-combustibles	9	920	1	112
VI	Organic wastes	0	0	0	0
VII (Be)	Beryllium-contaminated debris	0	0	0	0
Totals		18	1,840	2	224

4.7.2 Chemical Constituents

Based on the small amount of waste shipped from these facilities and the origin of these drums, it is unlikely that the wastes would contain any chemical constituents. It may be assumed that the only chemical constituents present in the debris waste generated in these buildings would be related to decontamination, housekeeping activities, or equipment maintenance.

4.7.3 Radionuclides

As described above, data from the radiological surveys of the building found no contamination on the interior surfaces of the building (RF-P042). Without information on the type of radioactivity present in the building when the waste was generated, it is impossible to determine the radioactivity in the waste without some indication of where it originated at RFP. It is assumed that any or all of the various radionuclide contaminants found in other incidental wastes generated at the RFP may be present in the debris wastes from Buildings 551 and 553. A detailed discussion of radionuclide content in RFP wastes is presented in Section 6.

4.8 Building 559

Building 559 was constructed in 1967 as a plutonium analytical laboratory to support plutonium production operations (RF-P047, RF-P085). Laboratory operations included spectrochemical and chemical analyses of gas, liquid, and solid samples from process areas, as well as for environmental monitoring and waste characterization. Samples included plutonium metal, sludges, precipitates, and

solutions. The facility was divided into separate laboratories to segregate organic and inorganic analyses. Each laboratory was equipped with gloveboxes and hoods to aid in the safe handling of radioactive samples.

The analyses performed in the organic laboratories involved identification and quantitative determination of both radioactive and non-radioactive compounds in product, environmental, and waste samples. The inorganic laboratories were equipped for radiochemistry, wet chemistry analysis, metals analysis, thermal analysis, physical testing, as well as sample preparation activities for both radioactive and non-radioactive samples analyses.

4.8.1 Physical Waste Matrices Generated

All liquid and solid waste contaminated with plutonium above the EDL were processed through plutonium recovery in Building 771. Solids were packaged for INEEL shipment (RF-P085, RF-U115). It is assumed that the debris waste generated from laboratory operations in this building consist of personal protective equipment, wipes, and other common combustible waste forms, and non-combustible waste generated during routine analytical laboratory activities.

A total of 982 containers (9,596 ft³) of debris waste containers were generated from Building 559 activities as shown in Table 4-17. These numbers were compiled from WasteOScope (RF-U169) and grouped into waste types as described in Section 5. A more detailed presentation of the original waste type assignments entered into WasteOScope and the delineation into the seven final waste types are presented in Appendix B.

Table 4-17. Waste volumes shipped from Building 559 (RF-U169).

Building 559 Plutonium Analytical Lab			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	491	3,269
I & V	Combustibles & non-combustibles	4	19
II	Filter paper	0	0
III	Filters	1	7
IV	Inorganic sludges	0	0
V	Non-combustibles	486	6,301
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	0	0
Total		982	9,596

4.8.2 Chemical Constituents

Chemicals used in laboratory processes conducted in Building 559 may be present as waste contaminants generated in Building 559, and are listed in Table 4-18.

4.8.3 Radionuclides

The primary radionuclides that may be present in waste generated from Building 559 processes include plutonium, americium, uranium, and neptunium, as well as ingrowth and daughter products (RF-P094, RF-P085). Radioisotopic content for individual wastes or RFP buildings cannot be determined. A detailed discussion of radionuclide content in RFP wastes is presented in Section 6.

Table 4-18. Chemical and metal constituents reported as used in Building 559 operations.

Constituent	Process/Use (if known)
Organic Compounds	
1,1,1-Trichloroethane	Laboratory (RF-P085)
Carbon Tetrachloride	Laboratory (RF-P085)
Chloroform	Laboratory (RF-P085)
Formaldehyde	Laboratory (RF-P085)
Methylene Chloride	Laboratory (RF-P085)
Tetrachloroethylene	Laboratory (RF-P085)
Metals	
Beryllium (oxide)	Laboratory (RF-P085)
Chromium (chloride, nitrate, oxide, potassium sulfate, sulfate, trioxide)	Laboratory (RF-P085)
Lead (acetate, chloride, metal nitrate, oxide, powder)	Laboratory (RF-P085)
Mercury (nitrate)	Laboratory (RF-P085)
Nickel (powder, nickelous chloride, nitrate, oxide, sulfate)	Laboratory (RF-P085)
Ignitables, Reactives, Corrosives	
Nitric acid	Laboratory (RF-P085)

4.9 Building 771

Building 771 (originally referred to as the C-Plant or Building 71) was constructed and placed into operation in 1953. It was designed as a totally self-contained plutonium production facility to provide plutonium component manufacturing, plutonium recovery, and plutonium purification (RF-P047, RF-P084, RF-P085, RF-P091, RF-P260, RF-P262, RF-P264). Fabrication of plutonium components was conducted in Building 771 from 1953 until 1957 when plutonium fabrication and component assembly operations were moved to Building 776/777. By the mid-1950s, increasing complexity of the plutonium part fabrication processes necessitated the construction of a dedicated plutonium fabrication facility, Building 776 (originally Building 76). A large plutonium casting residue fire occurred in the development laboratory on September 11 and 12, 1957, which seriously contaminated the metals laboratory and most of Building 771 (RF-P047, RF-P085, RF-P091, RF-P108, RF-P265).

Decommissioning of the Building 771 original production line began in late 1958 or early 1959, and was completed by 1962.

In 1957, the primary mission of Building 771 became plutonium recovery and purification (RF-P047, RF-P084, RF-P085, RF-P091, RF-P260, RF-P262, RF-P264). Recovery operations in Building 771 included recovery of fissionable radioisotopes as well as recovery of solvents for reuse. Early recovery operations were conducted in gloveboxes and consisted of simple manually operated equipment. By 1957, a small incinerator located in Building 771 was used to reduce the bulk of combustible waste materials by incineration. A larger incinerator and off-gas system replaced the original incinerator in 1961. The combustion was sometimes incomplete in both incinerators. In the small incinerator and the first few runs of the larger incinerator, the feed to the incinerator was anything that would burn. This included PVC plastic, polyethylene, rubber (glovebox) gloves, paper, some graphite, rags, wood, and ion exchange resins. Later, glovebox gloves and PVC plastic were excluded because they caused plugging of the CWS filters and equipment corrosion (RF-P107, RF-P162, RF-U114).

Between 1962 and 1965, expansion and changes occurred to some of the recovery processes. Dissolution lines, filtrate recovery, batching, calcinations, and fluorination operations were all added at this time. The various recovery processes available (i.e., the slow and fast cycle recoveries and later molten salt extraction in Building 776) allowed plant operators to select the optimal recovery technology for residues bearing plutonium above the EDL.

Waste generating operations in Building 771 included plutonium part fabrication, plutonium recovery, plutonium purification, anion exchange processing, chemical recovery, americium recovery, and various support activities, as follows:

- Plutonium part fabrication in Building 771 included foundry, casting, machining, coating, inspection and testing, radiography, holding, and shipping. Plutonium casting and machining operations generated the following line-generated residues: casting scull, split copper molds, drybox gloves, worn or obsolete equipment, cutting oil and solvent, glovebox filters, CWS filters, combustible materials such as paper, plastic, and rags, and spent cutting oil and solvent. These residues were processed through the recovery processes on the north side of the facility. The spent cutting oil and solvent were drummed, originally for shipment and later for storage (RF-C055, RF-P047, RF-P085, RF-P091, RF-P108, RF-P265).
- Recovery operations in Building 771 included recovery of fissionable radioisotopes as well as recovery of solvents for reuse. The plutonium recovery and purification process is illustrated in Figure 4-4. The recovery operations were composed of essentially two processes termed the fast recycle or fast side process and slow recycle or slow side process (RF-P084, RF-P085, RF-P091, RF-P099, RF-P103, RF-P108, RF-P116, RF-P162, RF-P262, RF-P264, RF-U157).

The feed to the fast recycle process was residues having high plutonium concentrations, such as casting scull, impure metal, plutonium oxide, and site-return plutonium metal. The materials were dissolved in a series of dissolution steps and treated to produce a final plutonium metal "button." Recovery liquid wastes generated by fast cycle recovery were either transferred over to slow cycle recovery or sent to Building 774 for treatment, provided sampling of the liquid wastes demonstrated that radioactivity concentrations were within acceptable levels for release and subsequent treatment.

Slow recycle recovery operations involved different types of processes depending on the nature of the feed wastes to be handled. Examples of the feed waste used in the slow cycle process are:

- Metal contaminated with plutonium was processed through a metal leach process
- Combustible residues except glovebox gloves, graphite molds, and used ion exchange resin were incinerated to reduce the volume and convert the plutonium to an oxide
- The incinerator ash, some graphite, graphite scarfings, incinerator firebrick scarfings, sand, slag, & crucible (SS&C), insulation, tantalum, glass, and filter sludge were leached with a nitric-hydrofluoric acid mixture
- Glovebox gloves and CWS and HEPA filters were rinsed with dilute nitric acid, allowed to dry, and packaged for disposal.

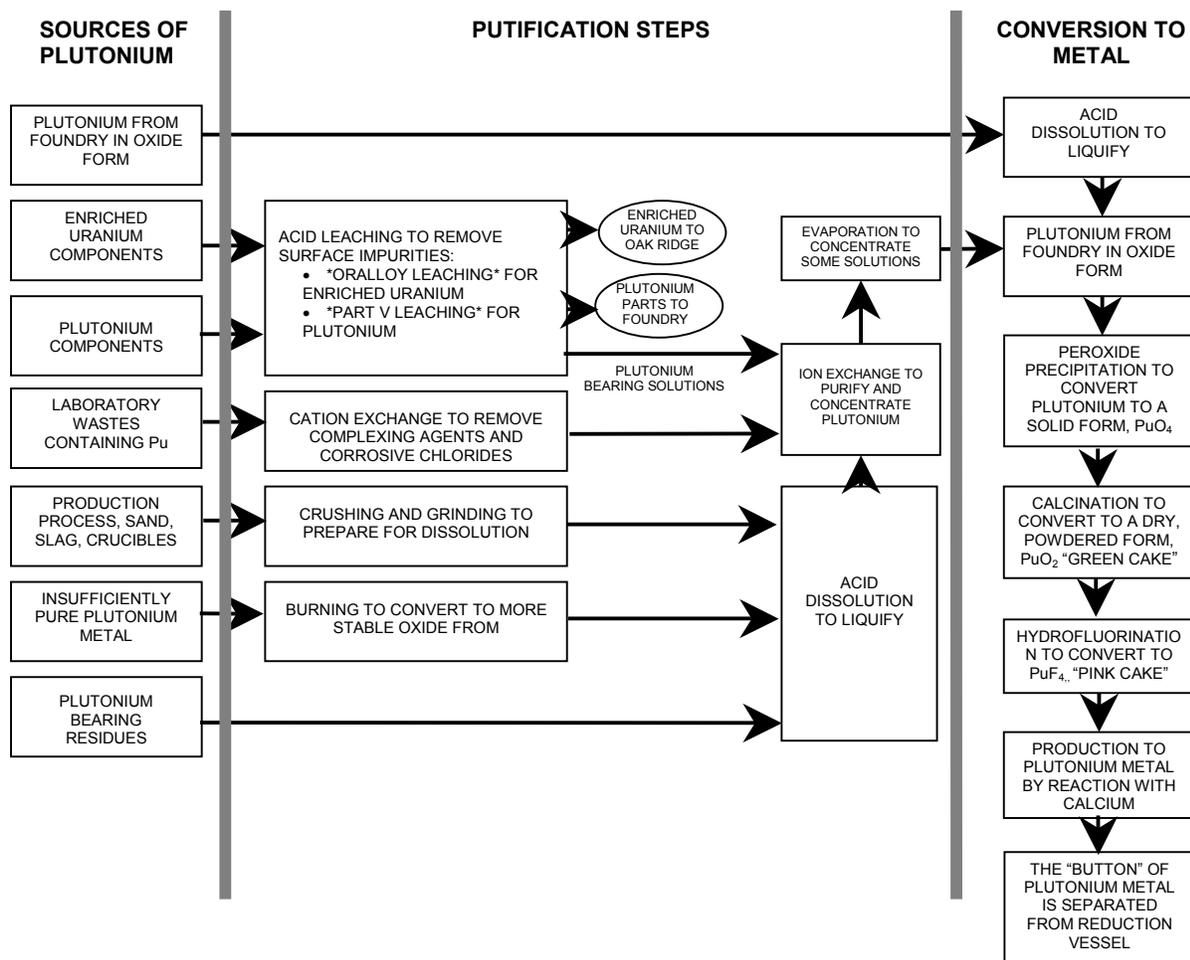


Figure 4-4. Building 771 plutonium recovery and purification process flow (RF-P085).

Feed wastes to slow recycle recovery operations were often treated before being sent through the recovery process. The treatment or pre-conditioning processes were based on the physical form and chemical or radiochemical content of the feed materials. Treatments or preconditioning processes consisted of:

- Crushing and grinding in the case of sand, slag, & crucible (SS&C) and other solid residues
- Recovery of plutonium containing materials from filters in the form of floor sweepings from the removal of material from filters by tapping on the floor during change out
- Feed evaporation and/or batching to concentrate plutonium in low-level solutions
- Peroxide precipitation to convert plutonium in solution to a solid form
- Calcinations to convert plutonium peroxide to plutonium oxide and drive out residual water
- Hydrofluorination.

- Plutonium purification was performed using a modification of the PUREX process followed by cation exchange. The process consisted of extraction, conditioning, and back-extraction steps. Tributyl phosphate (TBP) was used as the extractant, with the hydrocarbon Gulf BT as the diluent. The processing resulted in an aqueous product (raffinate) that contained little plutonium and was transferred to Building 774 for treatment and a “loaded” organic product that contained the recovered plutonium. The plutonium-containing product solution was passed through a column of cation exchange resin as the concentration step. The plutonium was eluted with a nitric acid/sulfamic acid solution. The cation column effluent was sent to Building 774 for treatment. In 1958, solvent extraction was replaced by an anion exchange process (RF-P264).
- The anion exchange process was used to purify and concentrate plutonium-bearing solutions resulting from residue dissolution and leaching processes, solution recycle from conversion to metal processes, and solutions transferred from laboratories (RF-P084, RF-P091). A new system was installed in 1965 in response to a need for increased capacity. Plutonium separation was performed in two independent column banks; each column bank was equipped with four feed tanks for batching and preparing solutions for anion exchange. Prior to 1969, waste ion exchange resins were sent to the incinerator or water washed and packaged for disposal. In 1969, ion exchange resins were water washed and mixed with cement on a 1.5 part resin to 1 part cement basis for shipment in 55-gal drums to the INEEL for burial. Because chlorides in the lab wastes created severe corrosion problems for the anion exchange equipment, beginning around 1970, the complex analytical residues were precipitated with anhydrous hydrogen fluoride, filtered, and dissolved in a nitric acid-aluminum nitrate solution. The filtrate generated was then sent to Building 774 for treatment (RF-P084, RF-P091, RF-U115, RF-U134).
- Chemical recovery processes were conducted from October 1958 through September 1960 with preliminary laboratory-scale distillation of acetone and carbon tetrachloride being performed in Building 771 Analytical Laboratory. In March 1959, an equilibrium still for distillation of the carbon tetrachloride-Shell Vitrea (a machining/cutting oil) mixture began operations. In May 1960, a production-scale still was installed in Building 771 to recover carbon tetrachloride from the oil-solvent mixture generated during plutonium machining in Building 776 and some drums from the 903 storage area (pad). Other liquids included in this process were hydraulic oils, vacuum pump oil, trichloroethylene, perchloroethylene, silicone oils, acetone still bottoms, ethanolamine, and other fluids. Recovered carbon tetrachloride was reused in Building 776, and the still bottoms were drummed, originally for shipment to the INEEL for burial, and later were drummed for storage. By September 1960, severe corrosion of the equipment was caused by the hydrolysis of carbon tetrachloride to hydrochloric acid. Additionally, the presence of ethanolamine in the carbon tetrachloride product rendered it unusable and the operation was shutdown (RF-C147, RF-C207, RF-C233, RF-U123, RF-U133, RF-U254).
- Americium recovery began in 1954, when equipment for laboratory-scale process development was installed in Building 771. The equipment was abandoned within six months of operation. Until an efficient process was emplaced, americium-containing sludge generated from the plutonium recovery peroxide precipitation step effluent was backlogged for future recovery (RF-P085, RF-U115). In 1957, a nitric acid solution ion exchange americium recovery process was installed to process the backlog americium sludge. This processing was not completed until 1967. In 1959, Americium recovery was further developed in response to an increased americium ingrowth in site-returns. The anion exchange effluent from plutonium recovery was sent to the americium recovery process to separate americium from the plutonium. In about 1965, an americium recovery line was installed and consisted of a multiple stage anion and cation exchange process that produced americium oxide as a product. After 1968, Building 776 initiated a process called molten salt extraction (MSE) to remove americium from plutonium from site returns. The

salts from the MSE process were packaged and transferred to Building 771 as feed to the recovery process. The waste water containing chloride salt was sent to Building 774 for treatment and the nitric acid residues, based on radionuclide content, column eluates were sent to the plutonium recovery process or to Building 774 for processing. A process flow chart of americium recovery and the changes to the process overtime is presented in Figure 4-5. Over 200 L of solution were produced for every gram of americium as pure oxide. In addition, the americium recovery rate was as low as ten to twenty percent, with the other americium remaining in the waste stream sent to Building 774 for processing (RF-P073, RF-P084, RF-P085, RF-P091, RF-P099, RF-P108, RF-P116, RF-U157, RF-P262, RF-P264).

- Major support operations conducted in Building 771 included several laboratories, research and development, and shipping and counting operations that generated waste that may have been sent to the INEEL. The following are brief descriptions of these operations.
 - Plutonium Metallurgy Research (Plutonium Fabrication R&D) was conducted in Building 771 by the plutonium metallurgy group and consisted of casting, heat-treating used oil, rolling, forming, forging, sizing, swaging, mechanical, and electro-polishing plutonium metal. Supporting operations included metallography, X-ray diffraction, tensile testing, density measurements, and powder metallurgy. Carbon tetrachloride was used throughout the polishing as a lubricant. Prior to 1963, when trichloroethylene was used for degreasing, acetone, isopropanol, and other solvents were used. Other chemicals used during metallurgy research were phosphoric acid, 2-ethyleneoxyethanol, ethylene glycol, glycerol, acetone, alcohol, and hydrochloric acid (RF-P084, RF-P218, RF-P2241, RF-U201, RF-U202, RF-U203, RF-U210, RF-U217).
 - Production and Manufacturing Technical (Manufacturing Engineering) support operations performed plutonium recovery from electrorefining salts and crucible residues beginning in 1965. Between 1964 and 1966, this group operated the drum counter for the measurement of the plutonium content of certain types of discernable waste (RF-P018, RF-U139, RF-U212).
 - Product Research and Development group performed experiments to determine suitability of the various materials for use in the plutonium areas. Examples of work performed by this group include tests performed to find a replacement for carbon tetrachloride as a degreasing solvent in the plutonium buildings. Solvents tested and used are included in Table 4-19, Chemicals Used in Building 771 (RF-P187, RF-U117).

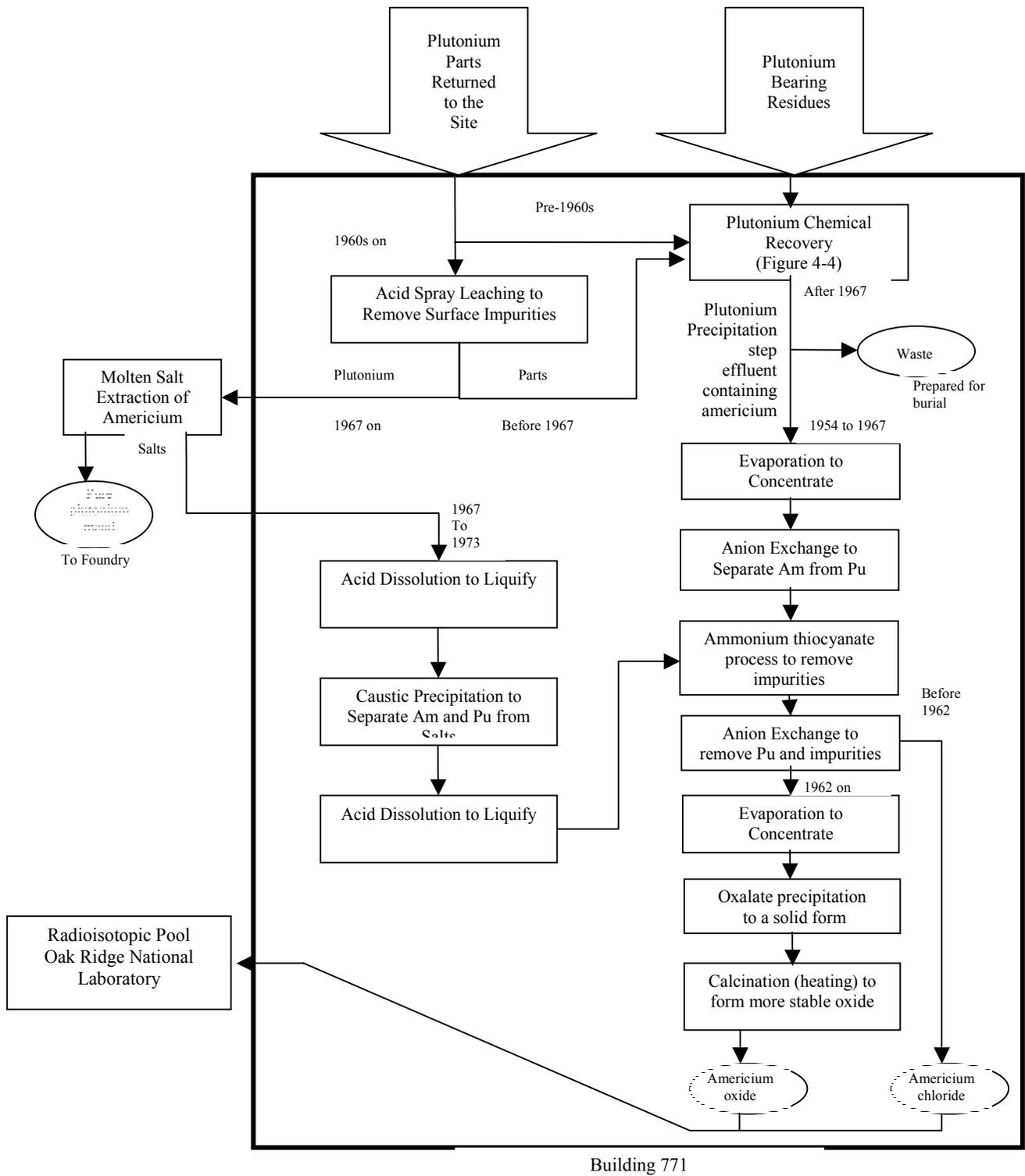


Figure 4-5. Building 771 americium recovery process (RF-P085).

- Plutonium Support Laboratories (Plutonium Analytical, Emission Spectroscopy, Mass Spectrometry, and Chemical Standards). Liquid and solid samples were received by or prepared in the Building 771 analytical and mass spectrometry laboratories. Samples were analyzed for plutonium, americium, uranium, neptunium, and other radioactive isotopes, as well as soluble residues in various solvents and solvent mixtures. Analyses were also performed on various recovery effluents prior to transfer to Building 774 for treatment and on Building 774 effluents prior to discharge or transfer for further processing. Small liquid and sludge samples were prepared for analysis in “B” boxes that could be opened to the room. Analyses were also performed on plutonium samples received from buttons after thermite reduction and from the various R&D groups in Building 771 to identify the isotopic composition and any impurities in the samples. Sample analysis involved the use of hydrochloric acid, nitrous oxide, and hexane in some cases. The Chemical Standards laboratory prepared standards representing five categories of residues suitable for drum counting and five different categories suitable for can counting (RF-P084, RF-U117, RF-U212).
- Solvents used by the laboratories included acetone, carbon tetrachloride, and trichloroethylene. Sample analysis involved the use of hydrochloric acid, nitrous oxide, and hexane (RF-P084, RF-U117, RF-U212).
- Plutonium chemical technology (Chemistry R&D) in Building 771 supported and developed improved methods for recovering, separating, and purifying actinides from acidic streams. One of the primary operation studies by this laboratory was dissolution. The chemicals used are included in Table 4-19, Chemicals Used in Building 771 (RF-P084, RF-P137).
- Special Recovery Operations (SRO) capabilities included all recovery processes, solvent extraction, and mixed actinide recovery. The SRO functions of Manufacturing Technology were absorbed into Chemistry Research and Development (R&D) in 1967. Between 1966 and 1968, studies in Building 771 by the SRO included tracer isotope studies using neptunium-237, uranium-233, and Oralloid in fluoride chemistry research; development of special alloying processes; and recovery of off normal recycle material. Tracer alloy preparation procedures generated scrap and residues that could not be processed by routine recovery and metal recycle processes. Consequently, the plutonium-tracer generated scrap and residues were processed by SRO and/or sent to Savannah River. Residues included mixed oxides, SS&C, and graphite molds. The majority of line-generated combustible wastes were incinerated and the ashes leached for plutonium recovery (RF-P084, RF-P091, RF-P260, RF-U115).
- Uranium-233 Recovery Processing consisted of oxide dissolution in nitric acid followed by a thorium strike using fluoride ions. The U-233 was precipitated as a peroxide, calcined, hydrofluorinated, and reduced to uranium metal with calcium metal and an iodine booster. Machining scrap was burned to an oxide. The metal reduction residues were leached with nitric acid for uranium removal. The uranium was precipitated with ammonium hydroxide and was calcined. Items that did not contain a significant quantity of U-233 were declared waste and were shipped to the INEEL for burial. All combustible wastes were shipped to the INEEL for burial. Liquid wastes were transferred to Building 774 for treatment (RF-U115).
- Neptunium Recovery Processing was used to prepare neptunium-plutonium alloys by co-reducing mixtures of neptunium and plutonium tetrafluoride using calcium metal beginning in 1964. The processes used for neptunium recovery included the following (RF-P260, RF-P263, RF-P264):

- ◇ Neptunium Oxide and Residue Dissolution was conducted in Building 771 using the thermite reduction process to convert neptunium tetrafluoride to neptunium metal. This process produced calcium fluoride, calcium iodide, slag, and neptunium-contaminated magnesium oxide crucible and sand. Several other types of residue, such as uranium-neptunium alloy scrap, uranium oxide-neptunium oxide mixtures, neptunium oxide-zirconium oxide mixtures, and neptunium-tin alloy, were also processed (RF-P260).
 - ◇ Neptunium-Solution Processing involved reduction of the neptunium tetrafluoride and neptunium oxide to neptunium metal, the ferrous ion and hydrazine in strong ($>5N H^+$) nitric acid solutions, and ascorbic acid and hydroxylamine nitrate in weak ($<5N H^+$) nitric acid solutions (RF-P260, RF-P262, RF-P264).
 - ◇ Precipitation Processes were used to separate neptunium from gross quantities of uranium. This technique involved sequential fluoride and oxalate-precipitation steps. Final neptunium purification was accomplished using anion-exchange techniques. A multi-step process was required because a single precipitation step did not provide sufficient uranium decontamination (RF-P260).
 - ◇ Anion Exchange Processes were used to separate actinides using three different anion-exchange processes: nitrate anion, chloride anion, and a combination of the two. When a high-purity neptunium product was desired, the two processes were combined (nitrate followed by chloride) resulting in the removal of both actinide and nonactinide impurities (RF-P260, RF-P262, RF-P264).
 - ◇ Calcination using porcelain calcination boats in muffle furnaces. The process was the same as the one used for plutonium (RF-P260).
 - ◇ Hydrofluorination was used to convert neptunium oxide to neptunium tetrafluoride using anhydrous hydrogen fluoride gas. Two systems were originally used for the conversion process: one for processing uranium-235 and the other for a converted thermogravimetric balance. These systems were eventually replaced with a hydrofluorination system specifically designed for conversion of small batches (RF-P260).
- Curium recovery began in June 1966 to obtain curium-244 for use in the preparation of internally traced plutonium nuclear-test devices. Several categories of scrap and waste were generated from the alloy production operations; the major residues being scrap metal and casting skull. Processing of plutonium-curium residues did not begin until 1967, and then only in laboratory-scale equipment. A full-production-scale facility was not completed until 1975 (RF-U119, RF-P260).
 - Between 1952 and 1966, an acceptable measurement technique to establish plutonium content in many types of plutonium residues did not exist. A drum counter for non-destructive assay became operational in 1966 in Building 771. A can or ash counter was installed in 1965, and provided for the bulk measurement of plutonium-contaminated items in small (gal size or less) containers. The use of these two counting systems reduced the load on the laboratory, but required a large amount of computational effort to convert the raw data into plutonium measurements. About 1968, the helix counter, a refined version of the can counter, was placed into limited service by the Chemistry R&D group (RF-P005, RF-P018, RF-P047, RF-P099, RF-P108, RF-U172, RF-U212).

- Experimental processes examined at Building 771 included direct oxide reduction and fluidized bed fluorination. Direct Oxide Reduction (DOR) was first investigated at RFP in 1967, but was not successful because only partial reduction took place with little or no plutonium metal formed. A semi-continuous reduction facility was designed and installed but never started (RF-P264). Fluidized-bed fluorination was designed to furnish the capability of handling an increased workload expected in 1969 and 1970 due to processing Poseidon program residues. It also offered a capability to handle new beryllium-contaminated residues. The first step in the fluidized-bed process was the conversion of the scrap plutonium oxide to plutonium hexafluoride gas. By January 1966, a small static-bed installation had been built and experimentally tested. A 2-in. diameter fluidized-bed pilot plant was designed and experiments began in 1967, operations began between 1968 and 1969 (RF-U147, RF-P264).

4.9.1 Physical Waste Matrices Generated

According to WasteOScope, the historical waste volume generated at Building 771 and shipped to Idaho was 973,949 ft³ in a total of 91,167 containers (RF-U169). The waste types represented in this total are presented in Table 4-19, which also includes the breakdown of the number of containers by waste type. Containers used to ship waste from Building 771 to the INEEL included 30- and 55-gal drums and wooden boxes.

Table 4-19. Waste volumes shipped from Building 771 (RF-U169).

Building 771 C-Plant, Plutonium Recovery			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	52,329	461,759
I & V	Combustibles & non-combustibles	5,644	45,584
II	Filter paper	1,152	10,760
III	Filters	4,240	72,769
IV	Inorganic sludges	1,265	10,776
V	Non-combustibles	26,524	372,206
VI	Organic wastes	6	44
VII (Be)	Beryllium-contaminated debris	7	51
Total		91,167	973,949

Two general waste types were generated in plutonium production facilities such as Building 771: line-generated and nonline-generated. Line-generated wastes originated inside the glovebox lines and included combustibles [including Kem wipes (or kimwipes), paper, rags, plastic, rubber, rubber gloves (glovebox gloves), graphite molds, filters (HEPA, CWS, Ful-Flo, etc.) insulation, etc., and non-combustibles (including tantalum crucibles, scrap metal, broken glass, heavy rubber items, small process equipment, tools, and gloveboxes, etc.)]. Nonline-generated wastes consisted of wastes not originating in the glovebox lines or not in contact with plutonium; however, because these items were in the plutonium area, they were suspect and were treated as contaminated waste. Examples of nonline-generated wastes include office equipment, waste paper, roughing filters on ventilation inlets, electronic equipment, lead shielding, lead glass, surgeon's gloves, Benelex shielding, cinderblocks, sheet rock, ceiling panels, electrical cords, structural metal, and conduit (RF-C044, RF-P047).

Boxed waste consisted of spent process equipment from gloveboxes, ductwork, piping, etc., that was too large to place in 55-gal drums. These items were cleaned prior to removal from the glovebox;

however, this equipment, ductwork, and piping had many inaccessible areas that could retain substantial amounts of plutonium. Sections of ductwork and piping, when removed, were immediately sealed and placed in a box without cleaning inside. Equipment, piping, and ductwork may have come into contact with any or all of the chemicals and radiological constituents listed in Table 4-20 (RF-C044, RF-U172, RF-P108).

Table 4-20. Chemicals used in Building 771.

Chemicals	Known Processes in Building 771 Using the Chemicals
Nitric acid	Dissolution, Calcliner Scrubber, Anion Exchange, Batching, Peroxide Precipitation, Americium Recovery
Hydrofluoric acid Ammonium thiocyanate Hydrogen peroxide (35 and 50%) Hydrochloric acid	Dissolution Americium Precipitation Peroxide Precipitation Americium Cation Exchange, Np Precipitation, Laboratory
Potassium hydroxide Oxalic acid Magnesium chloride Magnesium oxide Aluminum nitrate Hydrazine Ferrous sulfate Ferrous sulfamate Hydroxylamine nitrate Hydroxylamine hydrochloride Ascorbic acid Hydroiodic acid Anhydrous hydrogen fluoride Hydrofluoric acid Calcium metal Calcium fluoride Iodine Sulfuric acid Fluosilicic acid Ammonium sulfate Tributyl phosphate Gulf BT Dodecane Nitrous oxide Hexane (cyclohexane) Denatured alcohol Separan (a polyacrylamide) Calcium-zinc alloy Ammonium hydroxide Calcium chloride Sodium fluoride Nickel Carbonyl	Anion Exchange, Americium Recovery Oxalate Precipitation Molten Salt Extraction (B776) Thermite Reduction Anion Exchange Neptunium Anion Exchange Neptunium Anion Exchange Anion Exchange, Np Anion Exchange Np Anion Exchange, Np Precipitation Neptunium Precipitation Neptunium Precipitation Neptunium Anion Exchange, Np Precipitation Hydrofluorination, Fluid-Bed Fluoridation Dissolution Thermite Reduction Dissolution Thermite Reduction Peroxide Precipitation, Neptunium Dissolution Formed in Anion Exchange Peroxide Precipitation Solvent Extraction Solvent Extraction Uranium-Plutonium Solvent Extraction Analytical Laboratory Analytical Laboratory Peroxide Precipitation Peroxide Precipitation Direct Oxide Reduction U-233 Recovery Direct Oxide Reduction Fluidized-Bed Fluorinator Nickel Plating (to at least 1963)

Table 4-20. (continued).

Chemicals	Known Processes in Building 771 Using the Chemicals
Sodium Hydroxide Sulfamic acid Magnesium perchlorate/sulfuric acid “Amercoat” paint Hydroxylamine sulfate Sodium peroxide Nickel Powdered magnesium Potassium iodate Benzene Toluene Perchloric acid Chromic acid Acetic acid Phosphoric acid 2-ethyleneoxyethanol Ethylene glycol Glycerol Ammonium thiosulfate Silver Solder (contained cadmium) Carbon Tetrachloride	Solvent Extraction, Peroxide Precipitation Solvent Extraction, Dissolution Laboratory scrubber Floor and Equipment Paint Solvent Extraction Thermite Reduction Production Plating, R&D Plating Thermite Reduction Thermite Reduction Radiation Instrument Group until 7/1956 Radiation Instrument Group after 7/1956 Laboratory Plutonium Metallurgical R&D Plutonium Metallurgical R&D Plutonium metallurgical R&D Plutonium Metallurgical R&D Plutonium Metallurgical R&D Plutonium Metallurgical R&D Peroxide Precipitation Maintenance Plutonium Machining, Plutonium Metallurgical R&D, Product R&D, Analytical and Mass Spec. Labs, Chemistry R&D
Machining, coolant, vacuum pump oils	Plutonium Machining, plant operations, Plutonium Metallurgical R&D, Product R&D, Chemistry R&D
Perchloroethylene (Chlorothene®, Chlorothene NU®, Chlorothene VG®, Tri-Ethane 314®, Tri-Ethane 324®)	Product R&D, Chemistry R&D
Trichloroethylene (Neu-Tri®, Blacosolv, Alk-Tri®, Ex-Tri®)	Cleaning concrete, Plutonium Metallurgical R&D, Product R&D, Analytical and Mass Spec. Labs
Acetone	Plutonium Metallurgical R&D, Analytical and Mass Spec. Labs (until 1967)
1,1,1-Trichloroethane Trichloroethane-perchloroethylene mixture (Dowclene EC®, CSM-320®)	Product R&D Product R&D
Trichlorotrifluoroethane (Genesolv D®, Freon MF®, Freon TF®)	Product R&D, Degreasing, Cleaning, Density Balances
Trichlorotrifluoroethane-ethylene glycol monobutyl ether mixture (Freon TB-1®)	Product R&D
Fluorinert liquids (FC-40, FC-43, FC-75, FC-77, FC-78, FC-88) Freon 12 Freon 113 Alcohol Chloroform Methylcellosolve	Product R&D Refrigeration Density Balance Plutonium Metallurgical R&D Analytical and Mass Spec. Laboratories (after 1967) Analytical and Mass Spec. Laboratories (after 1967) Waste Packaging

Table 4-20. (continued).

Chemicals	Known Processes in Building 771 Using the Chemicals
Magnesia cement Shell Vitrea oil Isopropyl alcohol Isopropanol Hollingshead 333 Cocoon Silver Molybdenum Anhydrous hydrogen fluoride Beryllium	Plutonium Machining Laboratory, Peroxide Precipitation Plutonium Metallurgical R&D Paint stripping, contamination fixative Plating ZPPR Hydrofluorinator Technical Staff (1960), Spectrograph (1964), Site Returns
Carbon Palladium Cadmium salts (RF-C211) Sodium 2, 4-Dihydroxyazbene (RF-C211)	Plutonium Metallurgical R&D Plutonium Metallurgical R&D Unknown Unknown

The number of waste containers for each waste type (Type I through Type V, LGW, Graphite, M, SH, U233, Be, C, FW, and Empty) are listed in WasteOScope. Because Type I waste consisted of combustibles, plastics, and rubber, most of the contents of those drums listed as Type I could be CPR wastes. Type II filter paper is also combustible. Waste types LGW, Graphite, M, SH, U233, Be, C, and FW do not have enough information to make a determination concerning the amount of CPR (RF-C154, RF-D001, RF-U169).

A large plutonium casting residue fire occurred in the development laboratory on September 11 and 12, 1957, which seriously contaminated the metals laboratory and most of the building. The fire also burned combustible-type filters in both a booster plenum and the exhaust plenum. Decontamination of the building, except Room 180, took approximately three months. Room 180 was decontaminated by 1960 (RF-P047, RF-P085, RF-P091, RF-P108). Prior to the 1957 fire, the Booster and Exhaust plenums in Building 771 all contained combustible CWS filters (i.e., Type III waste). After the 1957 fire, all combustible-type CWS filters in all buildings across RFP, except the old part of Building 881, were replaced with fire resistant glass filters, and ordinary paper prefilters installed ahead of CWS filters were replaced with fire-resistant paper or fire-resistant glass prefilters. Eventually, all filters were replaced with fire-resistant filters and HEPA filters (RF-P265, RF-U057). Therefore, all Type III CWS filters generated prior to 1957 are assumed to be combustible waste.

The exhaust filters were modified to provide improved filter seals and repair heat stress damage after the fire. The fire traveled west, consuming plastic boxes, igniting the small press box, tensile tester, and centrifuge, including unknown quantities of Shell Vitrea-plutonium sludge being salvaged in that area; igniting and destroying the lathe box and igniting Shell Vitrea oil in the lathe pan; and east, consuming Plexiglas windows in the new inspection box up to the cold storage box of the conveyor box. The windows of the cold storage box were softened, but not consumed. As soon as there was excessive heat and flame in the conveyor box, the box exhaust filters began coking and burning. This carried additional heat and sparks to the Booster system. The Booster filters probably caught fire at an early stage. The room air exhaust carried heat and fumes directly to the main Exhaust plenum as soon as the fire got big enough to reach the exhaust outlets. Heat and sparks from either the Booster system filters and/or the room air exhaust filters coked and ignited the main Exhaust plenum filters. A water spray cooled the Plexiglas sufficiently to minimize rekindling so that the fire in room 180 was extinguished at 10:38 p.m. At 10:39 p.m., an explosion occurred in the Exhaust plenum, strong enough to knock all personnel in room 180 and the adjacent hallway to the floor. This ruptured and bent ductwork all the way to the exhaust plenum, and heavy smoke was observed rolling out of the stack. Water was applied to the

plenum at 11:15 p.m. and the fire was under control by 2:00 a.m. The fire was declared out at 11:28 a.m. on September 12, 1957 (RF-P265, RF-U057).

The AEC regulations for disposing of the equipment from the fire were: after decontamination had been effected, the surface contamination remaining was less than 500 disintegrations per minute per 100 square centimeters, the material or equipment was considered uncontaminated; if, after decontamination, the surface had a higher count than that previously listed, disposal was to the INEEL (RF-U057).

Prohibited items that may be present in waste generated from Building 771 activities may include free liquids, including ignitable and corrosive liquids. There is also the possibility that unpunctured aerosol cans may be in some of the waste containers, because they were used in the Building 771 process area and there was no prohibition concerning their disposal. Unvented nickel carbonyl or other gas bottles may also have been included in the waste sent for burial, and may include spent carbon dioxide fire extinguishers used during the 1957 fire (RF-P047).

4.9.2 Chemical Constituents

Because of the wide range of operations conducted, a variety of chemicals may be present in the waste shipped from Building 771. A list of chemicals used in the building, and the processes in which they were used, is provided in Table 4-20.

4.9.3 Radionuclides

Activities within building 771 included a wide range of plutonium processing, recovery, and purification; process development; support; and experimental development operations. For example, several different transuranic elements were handled in the Chemistry R&D Laboratory areas and Special Recovery areas throughout the history of the building. RFP also produced components from other metallic radionuclides (including neptunium-237, americium-241, plutonium-238, and curium-244) on a limited basis for incorporating into pits as “Special Order” operations. Consequently, any or all of these radionuclides could be present in the wastes in trace quantities generated during their processing, including waste generated during recovery operations (RF-P085, RF-P091, RF-P108, RF-P265). Radionuclides identified in waste from Building 771 are listed in Table 4-21, together with the process areas in which they may have been used.

Table 4-21. Radionuclides used in Building 771.

Radionuclides	Process/Areas
Plutonium	All Manufacturing and Recovery Operations
Americium-241	Americium Recovery
Depleted Uranium	Site Returns
Enriched Uranium	Site Returns, Special Recovery
Uranium-233	Special Recovery and Chemistry R&D
Curium-244	Special Recovery and Chemistry R&D
Neptunium-237	Special Recovery and Chemistry R&D

4.10 Building 774

When Building 774 was constructed in 1952, its primary purpose was to support Building 771 by treating its radioactive liquid wastes. Secondly, it treated radioactive and/or chemically contaminated liquid waste from the rest of the Plant. The facility was divided into two separate areas or “stages.” The 1st stage received and treated only plutonium and americium contaminated aqueous liquid wastes. The 2nd stage received and treated enriched and depleted uranium contaminated aqueous liquid wastes, plus treated plutonium and americium contaminated wastes from the 1st stage. Aqueous waste solutions that did not meet the feed specifications for the 1st or 2nd stage treatment processes were processed in an open tank and set up directly in the drum. Originally listed as either 741 or 742 sludge, in 1967, the sludge was listed as 744 sludge, Special Setups. Also in 1967, the “Grease Plant” began processing backlog and newly generated organic liquid wastes. This sludge was listed as 743 sludge. Installed in 1966 and in service in 1967, an evaporator and double-drum dryer began to treat liquids that had accumulated in the solar evaporation ponds. The dry salt produced was packaged in drums and was listed as 745 sludge (RF-P047, RF-P085, RF-P098, RF-P260, RF-P264, RF-U115).

The treatment operations were for the purpose of liquid waste disposal to reduce the volume of wastes and convert them to a form acceptable for transportation to off-site burial grounds or for release to off-site surface waters. Treatment operations in Building 774 did not include recovery of plutonium or other radionuclides. Liquid waste processing involved relatively consistent technology over the years, with only some refinements to achieve greater treatment capacity and eliminate off-site discharges (RF-P047, RF-P085, RF-P260, RF-P264, RF-U115).

The Building 774 facility was initially divided into two separate areas or “stages,” as illustrated in Figure 4-6. Additional stages and refinements were added over time to reflect the expanded scope described below (RF-P047, RF-P085, RF-P098, RF-P260, RF-P264, and RF-U115):

- **1st Stage Precipitation (1st Stage Sludge) – 741 Sludge**

The 1st stage received and treated only plutonium and americium contaminated aqueous liquid wastes from the Building 771 plutonium recovery area. These wastes were made up of ion column effluent, distillate, cooling waters, caustic scrub solution from the vacuum pumps, condensates, and miscellaneous solutions (americium ion column effluent was added later) and were high in fluoride. Two methods of handling the wastes were used, depending on the nature of the waste stream. High salt content (containing large amounts of nitric acid) wastes were batch-treated, neutralized using lime or caustic and filtered; low salt wastes were treated in the flocculator (RF-P098, RF-P260, RF-P264, RF-U110).

The pH of the high salt wastes was adjusted to pH 11.0, which caused a precipitate to form. The precipitate was removed by vacuum drum filtration and drummed, and the effluent from the filter was fed directly to the flocculator for treatment with ferric hydroxide and the liquid was recirculated. Reagents used in the first stage process are presented in Table 4-28. Low salt content wastes were fed directly to the flocculator for treatment. In the batch treatment method, which was used for ion column effluents, distillates, and miscellaneous wastes, ferric sulfate and lime were added to the wastes in a treatment tank and the liquid was recirculated. After recirculation, the ferric hydroxide floc was allowed to settle to the bottom of the tank. The ferric hydroxide sludge (floc) was fed to the vacuum drum filter for de-watering and drumming for off-site disposal. The supernatant was decanted and treated again. The final effluents from the flocculator and the batch treatment tanks were filtered through sand filters and sent to the 2nd stage for further treatment. The filtrate from the vacuum filter was also sent on to the 2nd stage (RF-C132, RF-P098, RF-P260, RF-P261, RF-P264, RF-U110).

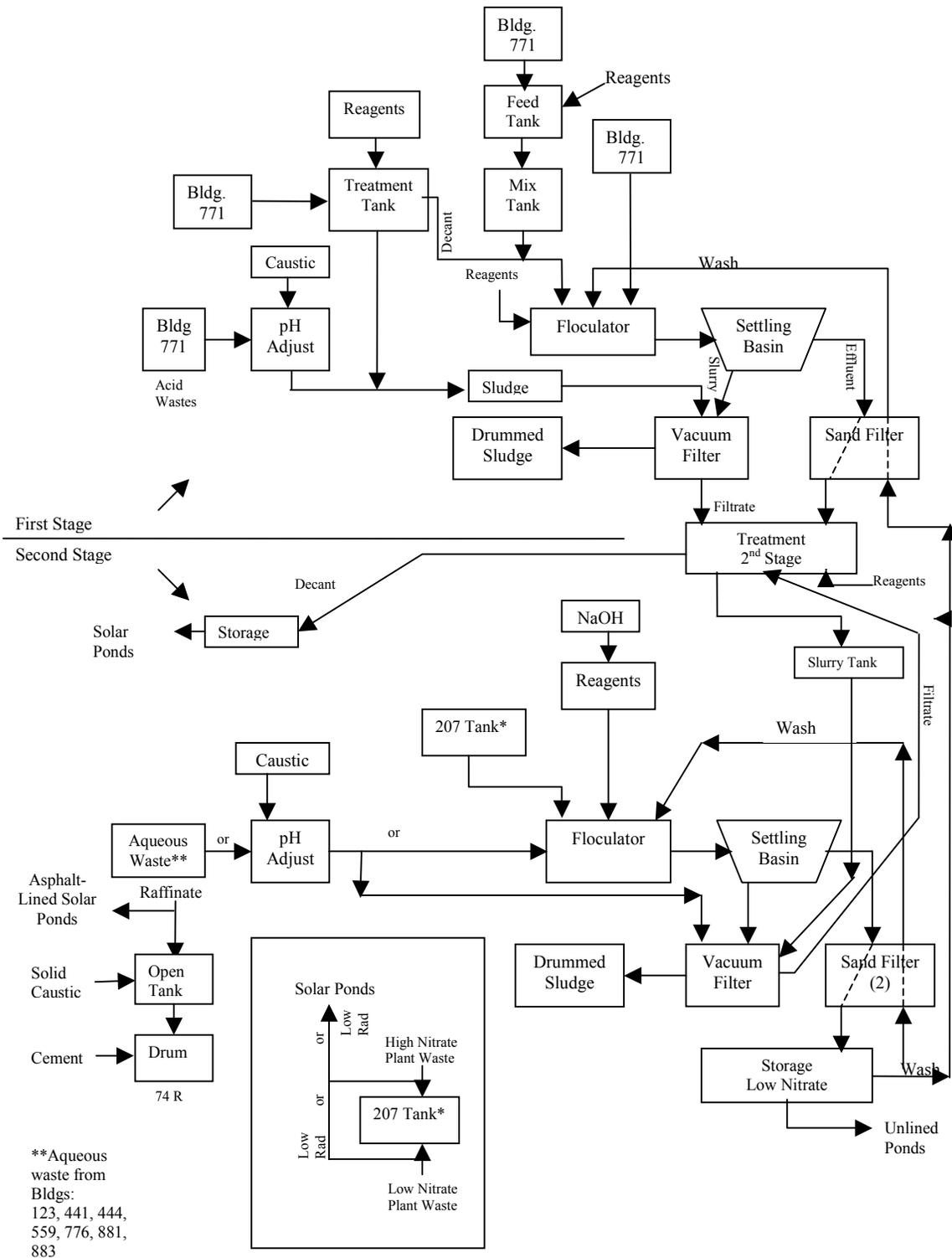


Figure 4-6. Separate stages of Building 774 (RF-U110).

The filtered and drummed filter cake made up the 1st Stage sludge. Dry portland cement was interspersed with the sludge during the drum filling cycle and was placed in the drum and liner bags. After completing the filling cycle, the liners were taped closed and a quantity of dry Portland cement was placed on top of the liner. The drum was closed with a 12 gauge bolted ring closure system (RF-C055, RF-C149, RF-P049, RF-P108, RF-P119, RF-P260, RF-P261, RF-P264, RF-U115).

- **2nd Stage Precipitation (2nd Stage Sludge) — 742 Sludge**

The 2nd stage received and treated all other aqueous plant process wastes, including enriched and depleted uranium contaminated aqueous liquid wastes, plus treated plutonium and americium contaminated wastes from the 1st stage. Based on radionuclide and nitrate content, laundry and laboratory wastes (Buildings 123, 441, 444, 559, 776, 881, and 883), liquid waste from Building 776 photo laboratory, and plant process waters were processed through the 2nd stage or were transferred to the asphalt-lined solar evaporation ponds (RF-C001, RF-C133, RF-P047, RF-P098, RF-P165, RF-P260, RF-P264, RF-U061, RF-U126).

Precipitate from the flocculator was processed using a vacuum drum filter. Activity, pH, nitrate, fluoride, and hexavalent chromium determinations were made before the treated wastes were released. The filtrate from the drum filter was combined with the 1st stage filtrate and received additional batch treatment. The filtered and drummed filter cake from this treatment made up the 2nd stage sludge (RF-P098, RF-P260, RF-P264, RF-U110).

Liquid wastes were transferred to the treatment facility by tanker truck, waste line, and in bottles from the on-site generating facilities. The empty bottles were packaged in drums for shipment off-site. Dry portland cement was interspersed with the sludge during the drum filling cycle and was placed in the drum and liner bags. After completing the filling cycle, the liners were taped closed and a quantity of dry Portland cement was placed on top of the liner. The drum was closed with a 12 gauge bolted ring closure system (RF-C055, RF-C149, RF-P098, RF-P108, RF-P119, RF-P260, RF-P264, RF-U115).

Originally Building 881 raffinate was processed through the 2nd stage, but a gel formed when the waste was neutralized and was difficult to filter. This processing took up too much processing time needed by other waste streams, and the neutralized waste was pumped to a 55-gal drum where cement was mixed into the solution. The cemented mixture was allowed to stand for 24-hours and was generated in 1954 as 74R sludge. Later, the raffinate was sent to 2nd stage for neutralization and processing through the vacuum drum filter only. When the solar evaporation ponds were lined with asphalt, the raffinate, along with miscellaneous and scrubber wastes, were disposed of in the on-site evaporation ponds (RF-C001, RF-C133, RF-P047, RF-P098, RF-P165, RF-P260, RF-P264, RF-U061, RF-U126).

- **Grease Plant (Organic Sludges) – 743 Sludge**

Large quantities of coolant (made up of solvents primarily carbon tetrachloride, but also perchloroethylene, trichloroethylene, acetone, and Freon TF) and oil (Shell Vitrea and Texaco Regal oils) were used in plutonium and enriched uranium machining. Solvents were also used for cleaning and degreasing. Attempts to separate the carbon tetrachloride from the oil for reuse were unsuccessful and, eventually, the organic liquids were simply treated by filtration and solidification and put into long-term storage.

Shakedown operations of a treatment process for organic liquids using Cab-O-Sil began in 1965 with the construction of a filtering set-up at the 903 Building at 903 Pad. The filtered oil was trucked to Building 774 for treatment. The ful-flo filter system at 903 Building never worked properly, and Cab-O-Sil was not adequate. In 1967, the oil was re-drummed at 903 Pad and trucked to Building 774 for treatment. The Cab-O-Sil was replaced with hydrous calcium silicate [Micro-Cel (E)]. At this time, processing of backlog and newly generated organic liquid wastes began in the portion of Building 774 known as the "Grease Plant." The resulting sludge was identified as 743 sludge (RF-C117, RF-C233, RF-P085, RF-P097, RF-P108, RF-P119, RF-P260, RF-P261, RF-P264, RF-U115).

Contaminated lathe coolant and other organic fluids were transferred at a controlled rate into a continuous self-cleaning mixer/processor in which they were combined with Micro-Cel (E). Following mixing, the solidified product was extruded from the mixer into lined 55-gal drums. Approximately two drums of carbon tetrachloride – oil mixture produced three drums of grease (RF-C099, RF-C117, RF-C233, RF-P085, RF-P097, RF-P108, RF-P119, RF-P260, RF-P261, RF-P264, RF-U115).

- **Special Setups (Cemented Liquid Waste) – 744 sludge**

Aqueous waste solutions, such as complexing agents, organic raffinates, and hydrochloric acid, incompatible with the 1st or 2nd Stage treatment processes were isolated from other liquid waste and processed in an open tank using dry magnesia and Portland cements and set up directly in 55-gal drums. Originally identified as either 741 or 742 sludge in 1967, the sludge began being identified as 744 sludge, Special Setups (RF-C001, RF-C055, RF-C133, RF-P047, RF-P108, RF-P260, RF-P261, RF-P264, RF-U061, RF-U111, RF-U115).

- **Evaporator Salts – 745 sludge**

Operations at Building 774 were further expanded in 1966 with the installation of an evaporator and double-drum dryer in a new wing to treat high nitrate-chemically contaminated wastes and the wastes in the 207A and 207B (i.e., solar) ponds. The distillate and other materials evolved from the evaporator were untreated and discharged to the atmosphere. The evaporator bottoms were transferred to the double-drum steam-heated dryer. A dust scrubber system pulled any fumes off the dryer and the scrubbing solution was processed through the evaporator. The dried salts were placed in 55-gal drums for shipment off-site. Placed into service in 1967, the dry salt produced was packaged in drums and were identified as 745 sludge. Under normal operating conditions, production of evaporator salts amounted to approximately 18,280 ft³ per year, containing negligible plutonium (RF-P085, RF-P108, RF-P260, RF-P261, RF-P264, RF-U126, RF-U127).

Due to limited evaporator capacity, wastes were stored initially in the solar evaporation ponds. Occasionally, low nitrate wastes containing fluorides or hexavalent chromium that would raise the level of the effluent from the site above the drinking water standards. When this was the case, these wastes were also sent to the solar ponds and treated (RF-P098, RF-P260, RF-P264, RF-U110).

- **Additional Processes**

Initially, an attempt was made to decontaminate and recover Shell Vitrea and carbon tetrachloride mixtures using a batchwise extraction process in a solvent still. Carbon tetrachloride was stripped out of the Shell Vitrea in the still, drummed, and reused for production purposes. The still bottoms were drummed and eventually solidified in the Grease Plant as 743 sludge. The facilities described

in the source document were not constructed as described in 1963. However, a solvent still was constructed and operated in Building 774 at some time after 1963 (RF-C099, RF-C152, RF-P165). Containers identified as 743 sludge during the delineation of the waste types as identified in WasteOScope were placed under the Type VI organic sludge waste for this report.

Empty drums generated during treatment of contaminated oils on 903 Pad through the Grease Plant were drum counted for plutonium. If they contained <2 grams they were partially filled with Oil-Dri and Micro-Cel (E), the bung was sealed, the drum was packaged in a plastic bag and a cardboard carton, and identified as 746 waste (RF-C055, RF-P265, RF-U115).

4.10.1 Physical Waste Matrices Generated

Wastes generated from Building 774 were primarily sludges and were identified in WasteOScope under several designations. The number of total containers and estimated volumes of waste shipped to the INEEL as recorded in WasteOScope are presented in tables for each generator designation. The numbers were compiled and grouped into the seven waste types as described in Section 5. A more detailed presentation of the original waste type designations entered into WasteOScope and the delineation into the seven final waste types are presented in Appendix B. The waste containers, as entered into WasteOScope, are described for each designation identified for waste generated from Building 774.

4.10.1.1 Waste Designation 774. A total of 1,694 containers (17,723 ft³) were attributed to the 774 waste designations in WasteOScope as presented in Table 4-22.

Table 4-22. Waste volumes shipped to INEEL designated 774 (RF-U169).

Waste Type	Building 774 Process Waste Treatment		
	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	20	2,183
I & V	Combustibles & non-combustibles	3	336
II	Filter paper	0	0
III	Filters	13	842
IV	Inorganic sludges	689	3,201
V	Non-combustibles	969	11,161
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	0	0
	Total	1,694	17,723

It is assumed that the debris wastes (Types I, II, III, and V) are composed of contaminated gloves, wipes, and other common combustible waste forms, filters and filter paper, and non-combustible wastes generated during the liquid waste processing and was not specific to any one type of sludge or waste treated in Building 774. It is also assumed that these wastes were contaminated with radionuclides (plutonium, uranium, americium, etc.) and chemicals common to this facility and to the RFP buildings from which the liquid wastes were generated. Waste Type IV is assumed to be solidified inorganic sludge. Waste Type V included 935 containers of cemented resins which were identified as non-combustible wastes.

4.10.1.2 741 & 742 sludges. In WasteOScope, a total of 9,778 containers (67,928 ft³) and 15,941 (118,442 ft³) were attributed to the 741 and 742 sludge waste designations, respectively. The waste breakdowns are presented in Table 4-23.

Table 4-23. Waste volumes shipped to INEEL designated 741 and 742 (RF-U169).

Waste Type	Waste Description	741 First Stage Sludge		742 Second Stage Sludge	
		Container Count	Volume (ft ³)	Container Count	Volume (ft ³)
I	Combustibles	675	4,788	675	4,788
I & V	Combustibles & non-combustibles	1	4	1	4
II	Filter paper	0	0	0	0
III	Filters	4	15	4	15
IV	Inorganic sludges	8,861	61,697	8,861	61,697
V	Non-combustibles	237	1,414	237	1,414
VI	Organic wastes	0	0	0	0
VII (Be)	Beryllium-contaminated debris	0	0	0	0
Totals		9,778	67,918	9,778	67,918

It is assumed that the debris wastes (Types I, II, III, and V) shown in Table 4-23 for the First and Second Stage sludge wastes were generated during the waste processing specific for these wastes. The containers of inorganic sludges (Waste Type IV) are the processes of wet slurries from the precipitation of radioactive contaminants and reagents processed using a rotary vacuum drummed filter. The sludge removed from the filter contained 60–65% water by weight. The finished sludge was firm (RF-C055, RF-C149, RF-P108, RF-P119, RF-P260, RF-P261, RF-P264, RF-U115).

Additional items were periodically added to the 742 sludge drums. Sludge waste drums were filled approximately 1/3 full, the bottle of chemical or other item was placed in the drum, cement was added, and the drum was filled with sludge. Examples of items that were added to the 742 sludge aRe: small amounts of mercury in 0.5 liter bottles, tissue samples from a study performed by Colorado State University, and during 1965, eight radioactive sources (1–5 mCi radium/beryllium neutron sources). The sources had radiation levels of approximately 100mR/hr gamma at the surface and were wrapped in lead shielding prior to being placed in the drums (RF-P047).

4.10.1.3 743 sludge. In WasteOScope, a total of 8,439 containers (62,037 ft³) were attributed to the 743 sludge waste designation. The waste breakdowns are presented in Table 4-24.

Table 4-24. Waste volumes shipped to INEEL designated 743 (RF-U169).

743 Grease Plant Sludge & Waste			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	2	15
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	0	0
III	Filters	0	0
IV	Inorganic sludges	0	0
V	Non-combustibles	0	0
VI	Organic wastes	8,437	62,022
VII (Be)	Beryllium-contaminated debris	0	0
Totals	Total	8,439	62,037

It is assumed that the two debris waste drums are comprised of radioactively and chemically contaminated combustible debris from organic liquid waste treatment. Waste Type VI, Organic Sludge, was generated when contaminated lathe coolant and other solvent liquid wastes were mixed with Johns-Manville Micro-Cel (E), a synthetic calcium silicate, to form a grease-like substance. Oil-Dri absorbent was used in the bottom of the drum liner and on top of the waste prior to sealing the drum. The finished waste form had the consistency of soft putty (RF-C117, RF-C233, RF-C149, RF-P047, RF-P085, RF-P097, RF-P108, RF-P119, RF-P260, RF-P261, RF-P264, RF-U115).

4.10.1.4 744 sludge. In WasteOScope, a total of 1,483 containers (10,881 ft³) were attributed to the 744 sludge waste designation. The waste breakdowns are presented in Table 4-25.

Table 4-25. Waste volumes shipped to INEEL designated 744 (RF-U169).

744 Special Setups (Solidified – Bottle Process)			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	314	2,292
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	0	0
III	Filters	0	0
IV	Inorganic Sludges	1,084	7,965
V	Non-combustibles	85	624
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	0	0
Totals	Total	1,483	10,881

It is assumed that the debris waste containers (Waste Type I) are comprised of radioactively and chemically contaminated combustible debris from Special Setups waste treatment. Some of the Special Setup liquids were received from the generators in bottles. The emptied bottles were packaged in drums and shipped for disposal and are assumed to be contained in some of the Type V waste containers attributed to this designation.

Prior to 1967, this sludge was identified as 741 or 742 sludge and containers assigned that designation in WasteOScope for early shipments may contain Special Setups sludge. Dry Portland cement was put in the bottom of the drum liner and on top of the 744 sludge waste prior to sealing the drum. The

finished waste form had the consistency of wet boiler cement (RF-C133, RF-C149, RF-P047, RF-P108, RF-P260, RF-P261, RF-P264, RF-U061, RF-U111, RF-U115).

4.10.1.5 745 sludge. In WasteOScope, a total of 5,749 containers (42,243 ft³) were attributed to the 745 sludge waste designation. The waste breakdowns are presented in Table 4-26.

Table 4-26. Waste volumes shipped to INEEL designated 745 (RF-U169).

745 Evaporator Salts			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	31	227
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	0	0
III	Filters	0	0
IV	Inorganic sludges	5,685	41,764
V	Non-combustibles	82	743
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	0	0
Total		5,798	42,734

It is assumed that the debris waste containers (Waste Type I and V) are comprised of radioactively and chemically contaminated combustible and non-combustible debris wastes generated during treatment of the evaporator salts waste. Wastes treated through the evaporator and double-drum dryer formed a dry, granular substance containing less than 10% water by weight. The salt was primarily a nitrate salt. No hardener was required (RF-C149, RF-P047, RF-P085, RF-P108, RF-P260, RF-P261, RF-P265, RF-U126, RF-U127).

4.10.1.6 746 Empty Containers. In WasteOScope, a total of 6,893 waste containers (107,642 ft³) were attributed to the 746 waste designation. The waste breakdowns are presented in Table 4-27.

Table 4-27. Waste volumes shipped to INEEL designated 746 (RF-U169).

746 Empty Contaminated Drums and Associated Waste			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	1,542	40,947
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	0	0
III	Filters	1	185
IV	Inorganic sludges	0	0
V	Non-combustibles	5,347	66,488
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	3	22
Total		6,893	107,642

It is assumed that the waste identified in WasteOScope under the Waste Type I, III, and VII designations consist of combustible debris generated incidental to sludge removal from drums, and the handling of empty containers (Type V waste). The breakdown of the containers included in WasteOScope for Type V includes 3,348 containers identified as 'Empty,' 13 containers identified as RO (roaster oxide), and 1,944 designated Type V, which is assumed to contain additional empty drums. The

containers included in WasteOScope for Type V are a combination of 55-gal drums and boxes. The empty drums were emptied of (oil or sludge) waste and cleaned until there was <2–3 grams of plutonium remaining. Oil-Dri and Micro-Cel (E) were added to the drums prior to packaging in plastic bags and cardboard boxes. It was estimated that 1,948 empty drums packaged in cartons (one per carton) were shipped in 1967, and 3,548 empty drums in cartons were shipped in 1968 (RF-C055, RF-P265, RF-U115).

It is assumed that the waste identified under Waste Type I consisted primarily of combustibles, plastics, and rubber, and that the one container identified for Type III waste contained filters (CWS and/or HEPA) is conservatively assumed to have been generated prior to 1957 and contains combustible material(s). Therefore, it is assumed that the majority of the wastes identified with these designations consist of CPR materials (RF-U169).

4.10.2 Chemical Constituents

Building 774 was a waste treatment facility responsible for treating liquid wastes generated at Rocky Flats. The wastes generated from this building may contain any of the chemicals used across the site as well as the chemicals used to treat (solidify) the liquids. A list of chemicals used is provided in each building section. The list of chemical reagents used in the Building 774 1st and 2nd stage sludge processes is provided in Table 4-28. A comprehensive list of chemicals used at RFP during the 1954 through 1970 timeframe has been included in Section 5.

Table 4-28. Reagents used in Building 774 1st and 2nd Stage Processing.

Approximate Timeframe	Co-precipitation Reagents	Coagulation Reagents	Neutralizing Agents	Other
1953-54 ^(C132, U110)	Ferrous chloride and calcium hydroxide	Separan®	Lime or caustic	unk
1954-55 ^(U111)	Ferric hydroxide or aluminum hydroxide	Separan 2610®	Lime or caustic	Activated carbon for adsorption
1955-61 ^(U111, U283)	Ferrous sulfate (aluminum hydroxide may be used)	Separan 2610®	Lime and caustic soda	Activated carbon for adsorption, Super Cell used as filter aid
1959 ^(U048)	Ferrous sulfate	H.T.H. and Norite A	Lime and sodium hydroxide	unk
1963 ^(C096, P098, P108, P165)	Ferric sulfate	Separan®	Lime and sodium, calcium, or potassium hydroxide	Activated carbon for adsorption
1964-70 ^(P047, P260, P265, U115, U136)	Ferric sulfate and calcium chloride or magnesium sulfate	Purifloc 501®	Lime and sodium or potassium hydroxide	unk

For 743 sludge, Cab-O-Sil was used initially in the pre-production runs of the Grease Plant, but did not work well with the equipment in place. Use of Cab-O-Sil was then replaced by Johns-Manville Micro-Cel (E) calcium silicate. The majority of the drums produced by the Grease Plant were solidified using Micro-Cel (E) (RF-C015, RF-P047, RF-U115). In 744 sludge, liquid wastes requiring neutralization

were neutralized using caustic soda, lime, sodium hydroxide, or potassium hydroxide (RF-P047, RF-U115).

Although there was no documentation of PCB use or the presence of PCBs in waste for this time frame, PCB contaminated oils may have been processed through the Grease Plant between 1967 and 1970. Sampling and analysis data collected from 1979 through 1986 for Grease Plant sludge waste had a UCL₉₀ exceeding 50 ppm PCBs. The PCB contamination was attributed (at least in part) to the inclusion of mineral oils in the feed waste to the treatment process. Additionally, it was reported post-1970 that PCB containing liquid wastes from the maintenance shop located in Building 334 were processed through the Grease Plant until 1979. It is assumed that PCB-contaminated oils may have also been processed in Building 774 prior to 1970 and are therefore a constituent of the 743 sludge waste. One of the large metal presses in Building 883 was filled with oil containing PCBs, but it is not known whether oil from this machine was ever treated in the Grease Plant. In addition, transformer oils used on site contained PCBs during this time (RF-P047, RF-P084, RF-P090, RF-U115).

Packages of sodium cyanide and potassium cyanide pellets, small amounts of mercury in 0.5-L bottles (every 1 or 2 years), expended batteries, and unused chemicals both with and without containers were also reported as added to 742 sludge drums. No further information concerning the types of unused chemicals has been located. From 1953 to 1967, complexing chemicals were added to the 742 sludge and were also used later in the 744 sludge. Occasionally, toxic materials were reported to be put in the 744 waste. One such report detailed the inclusion of 10 to 20 gal of MOCA [4,4'-methylenebis (2-chloroaniline), a suspect human carcinogen curing agent for polyurethane and epoxy resins] packaged in ice cream cartons, hardened, double-bagged, and placed in drums of 744 sludge (RF-C055, RF-P047, RF-U121, RF-U125).

4.10.3 Radionuclides

Waste treatment operations in Building 774 produced all liquid process wastes generated in Building 771 plus all other plant liquid process wastes that did not meet the requirements for off-site release. Radioactive contaminants in the liquids thus reflected all radionuclides that could be present at Rocky Flats and included enriched uranium, depleted uranium, plutonium, small amounts of americium, and trace amounts of curium-244, neptunium-237, and uranium-233 from R&D, production, and processing areas. The radionuclides that may be present in wastes generated from Building 774 and their relative impacts are listed in Table 4-29 (RF-P260, RF-P264).

Seventy (70) grams of americium-241 a month was present in the waste stream sent to Waste Treatment in the late 1960s because the americium recovery line in Building 771 did not have the capability to recover all of the americium that was present in the waste stream. This americium would be captured in the 741 sludge. The amount of americium in the Building 774 Series 741 sludge in FY1969 was 4.8755 kilograms. In April 1969, a significant increase in gamma radiation dose was noticed for some of the Building 774 personnel as a result of an increase in americium-241 content in the waste sludge. In January 1970, a gamma detector was installed in the 1st stage drum filter in Building 774 to help protect against "surprise" processing of americium-rich sludges (RF-U128, RF-U135, RF-U157).

Table 4-29. Radioisotopes present in Building 774 wastes (RF-P260, RF-P264).

Radionuclides
Plutonium
Americium-241
Depleted Uranium
Enriched Uranium
Uranium-233
Curium-244
Neptunium-237

4.11 Buildings 776/777

Buildings 776 and 777 are a combined complex (referred to as Building 776/777), sharing a common wall, utilities, and maintenance, that was completed in 1957 to accommodate plutonium technological changes and designs. In the late 1950s, a change in the weapon concept occurred which resulted in an increase in plutonium relative to uranium content. In addition, different shapes of plutonium with closer dimensional tolerances were also required. Thus, more rolling, forming, and machining of plutonium was required than in the earlier years of production (RF-P047, RF-P084, RF-U015).

These facilities contain foundry, machining, plutonium storage, and assembly operations (RF-P116). As a result of the new construction and expansion of the C-Plant (Building 771), and the 1957 fire in Building 771, the plutonium foundry and machining operations were transferred to Building 776 from Building 771 in 1958. Likewise, the assembly and certification operations were transferred to Building 777 from Building 991 (RF-P047, RF-P084, RF-U115).

The mission of Building 776 was plutonium components manufacturing, including casting and plutonium parts fabrication from 1958 through 1969. This building was the main manufacturing facility for plutonium weapons components. The production pyrochemical operation was also located in Building 776 and the operation was expanded in 1967 to accommodate the MSE process. The MSE process was used to remove americium, and the spent pyrochemical salts were used as the feed source for the americium purification process (RF-P084, RF-P085, RF-U115). The mission of Building 777 was assembly and parts inspection for the Part IV weapon design, and some disassembly of site-returned parts containing plutonium and other metal components (RF-P084, RF-U115).

Building 776/777 waste generating operations included:

- Fabrication Operations housed in Building 776 involved either direct machining of part ingots or cast shapes produced in the foundry, or conducting a wrought process, which further prepared the material for machining operations. All production operations were carried out in gloveboxes that were interconnected by a series of conveyors. The four principal glovebox systems used during 1957 to 1969 were the North Foundry Line, the South Foundry Line, the Center Line, and the North-South-East Machining Line. In addition, conveyors served the North and South Briquetting Presses and provided a way to return scrap or machining chips to the casting furnaces (RF-C184, RF-P084). In the 1950s and early 1960s, plutonium components were cast followed by machining to final configuration. However, with changes in weapon design, component casting was replaced with wrought processing of plutonium ingots. The wrought process involved rolling the ingots into sheets and cutting them into circle blanks to be passed through the Center Line for pressing. The pressed blanks were then annealed in furnaces prior to machining. Machining operations involved taking cast or wrought parts and performing a sequence of operations including debrimming or removing spurs, contouring, drilling, and milling (RF-P084, RF-U115).

- Building 776 Foundry Operations cast plutonium either as ingots suitable for rolling and further wrought processing or into shapes amenable to direct machining operations. Foundry operations also included collecting, reprocessing, and remelting of machine turnings and solid scrap. The foundry also included gloveboxes for graphite mold handling, including preparation and coating. Additional responsibilities included preparation and transfer of samples to the analytical laboratory, operation of an MSE facility, and filtration of waste machining oil and turning degreasing solvent (RF-C180, RF-P084). After the 1969 fire, Building 776 casting operations ceased, its casting furnaces were removed, and Building 707 was expanded to include casting operations (RF-P084).
- Machining Operations conducted in Building 776 involved taking cast or wrought parts and performing a sequence of operations including debrimming or removing spurs, contouring, drilling, and milling. The line contained Ex-Cell-O machines [numerical control (N/C) contouring lathes installed in gloveboxes], various types of lathes, a radius generator, and a milling machine (RF-C180, RF-P084, RF-U205). In 1958, oil was added to the plutonium machining process to enable more rapid machining with less chance of spontaneous combustion. In very early operations, Shell Vitrea cutting oil was used, followed by a perchloroethylene (PCE) washing. Shortly thereafter, PCE was replaced with carbon tetrachloride because PCE caused degradation of the gloves in the gloveboxes and created a gummy residue that interfered with inventory control. However, PCE was still used in Building 776 as late as 1966 (RF-C195). Later, the Shell Vitrea oil was replaced with Texaco Regal oil because it was less costly (RF-P084).
- A centralized oil/carbon tetrachloride collection system for Building 776 was part of the machining line (RF-C180). The oil was filtered, and used filters were sent to Building 771 for plutonium recovery. Disposal of the waste oil after approximately 1966 was accomplished through a solidification process in Building 774. However, prior to the operation of the Building 774 solidification process implemented in 1965, plutonium-contaminated waste oil was stored on-site (RF-P084).
- Inspection and Assembly operations were located in Building 777. Assembly activities included drilling, welding, brazing, turning, and polishing plutonium and uranium metals, as well as non-nuclear materials such as steel, beryllium, copper, monel (a white copper-nickel alloy), and silver (RF-U038, RF-U124). Prior to assembly, all components were thoroughly cleaned with ethyl alcohol, isopropyl alcohol, or acetone, and inspected. Plutonium parts were cleaned by dipping them in trichloroethylene (TCE) tanks until the introduction of ultrasonic cleaning units in approximately 1960-1961. From 1963-1964, all Building 777 cleaning activities were conducted using TCE. After assembly, completed units were packed and shipped off-site, or to Building 991, for final processing, storage, and shipping (RF-P084).
- Disassembly operations were also conducted in the Building 777 assembly area. Site-return work began in 1958, and increased activities began in the late 1960s as old weapon designs were retired and disassembled to recover valuable materials. After disassembly, parts were inspected for unusual conditions and segregated according to material type. Plutonium materials were returned to the Building 776 foundry where they were cast into feed ingots. Depending on assay specifications, the ingot was then sent to the MSE facility for americium removal. Otherwise, the ingot was sent to Building 771 for chemical purification and returned to the foundry. Enriched uranium parts were shipped to Building 881 for recovery, and DU and inert components were packaged at off-site disposal sites. Classified waste generated from disassembly of stockpile returns was shipped off-site to Hanford and the Nevada Test Site (RF-P084, RF-U115).

- Recovery Operations were focused on processing plutonium scrap, turnings, and residues. Machining and fabrication operations produced two types of plutonium scrap, machining residues such as chips and turnings, and solid pieces of plutonium metal resulting from plate croppings, debrimming operations, and/or reject items. Alloyed scrap from rejected parts, Center Line scrap, other classified scrap, and alloyed turnings, were collected and processed in the briquetting process conducted in Building 776/777. Briquetting produced a hockey-puck size briquet from machine turnings and scrap plutonium to be recast into ingots in Building 776, or transferred to Building 771 for further processing (RF-C184, RF-P084, RF-P116).
- A carbon tetrachloride recovery system, located in Building 776, was used to collect, filter, and distribute waste carbon tetrachloride for reuse or disposal. Waste carbon tetrachloride and machining oil was collected and pumped through a filtration system to a large storage tank. The oil was then pumped through another filtration unit and sampled to ensure that the sample was below the radioactive discard limit and then drummed for storage or transferred to Building 774 for treatment (RF-P084).
- Pyrochemical Operations at RFP:
 - In the early 1960s, an in-situ electrorefining process was developed. A production-scale electrorefining facility consisting of six furnaces was established in 1966 in Building 776. In this process, non-specification plutonium metal was electrorefined through the oxidization of a magnesium chloride, potassium chloride, and sodium chloride mixture to produce purified plutonium(III). Americium from the feed metal was concentrated in the salt phase. In late 1970, electrorefining was discontinued because 70 to 75% plutonium yields from the process were deemed unacceptable compared to the Building 771 aqueous process that could produce 90 to 95% yields. The following residues were generated from pyrochemical operations: electrolyte salts, ceramic or tantalum crucibles, tantalum stirrers, tungsten electrodes, and slag (RF-P084, RF-P262, RF-P264, RF-U141).
 - Direct oxide reduction (DOR) research at RFP began in 1967. DOR produced plutonium metal from plutonium oxide without aqueous processing, eliminating the potentially high radiation exposure step of hydro fluorination that occurred in Building 771. The process involved batch processing of plutonium oxide feed through a high temperature calciner to remove moisture and drive off volatiles. The feed consisted of plutonium oxide, calcium metal, and cast calcium chloride salt. If the resulting plutonium button was pure, it was sent to production operations; if not, it was sent to electrorefining for additional refining. The residual calcium salts were sampled for plutonium and stored for possible aqueous recovery (RF-P084).
 - The MSE process located in Building 776 was used to remove americium contamination from site return plutonium metal parts. Undesirable americium-241 contamination of plutonium metal results from the spontaneous decay of the plutonium-241 present in War Reserve (WR) plutonium. The americium extraction process took advantage of the relative thermodynamic stabilities of the chloride salts of americium and plutonium. The process involved placing the plutonium metal in an argon-inerted crucible with an oxidant salt and a solvent salt in an electrically heated furnace. The process produced a purified plutonium "button," and a contaminated chloride salt. Historically, several salt mixtures incorporating magnesium chloride in the equimolar sodium chloride/potassium chloride diluent were used. Over time, the MSE process was modified to maintain or increase efficiency of plutonium recovery, and reduce the quantity of waste salts generated. The waste salt was packaged in small cans, packed in lead-lined drums, and shipped to Building 771 for americium recovery

(RF-P084, RF-P264, RF-U115). Tantalum wastes were also generated from Building 776/777 processes, such as the plutonium foundry and recovery operations, as well as the MSE americium separation process, which generated tantalum metal waste in the form of crucibles (RF-P047).

- General maintenance activities also generated wastes that may have been shipped to the INEEL during the 1954-1970 timeframe. Just prior to conducting monthly physical inventory of plutonium in the processing line, the equipment and gloveboxes were given a thorough cleaning by wiping with Kimwipes, rags, etc., to get the area as clean as possible without a major tear-down of equipment (RF-C184).
- 1969 Fire Clean-Up: On May 11, 1969, a fire occurred in the plutonium production area of Building 776. The fire started when pressed plutonium briquettes self-ignited in the metal container stored in the foundry area, and resulted in the contamination and/or damage of 26,000 linear ft of gloveboxes, including machining and fabrication stations and 230,000 ft³ of floor space in both buildings. Some of the Plexiglas windows and Benelex on the gloveboxes melted or burned, allowing escape of contaminants to the building. In addition to gross contamination of the production facility, the heat from the fire warped some vertical structural columns and overhead beams (RF-P047, RF-P084, RF-U115). Clean-up of the facility consisted of plutonium removal from affected areas for accountability purposes, and cleaning and decommissioning of material and equipment from foundry, machining, and inspection glovebox lines. Parts retrieved during the removal phase were wiped off with Alk-Tri-grade TCE and cheesecloth, wrapped in foil, and bagged out. Contaminated materials were transferred to Building 779A for further cleaning and treatment to preclude plutonium burning through the bottom of the container should ignition occur (RF-C183). Wastes from the fire clean-up that were packaged for disposal were:
 - Fire fighting water drained from gloveboxes and equipment and collected in Raschig ring filled vessels (RF-C191, RF-U163). The liquids were sampled and batched prior to transfer to Building 774 for treatment (RF-C171).
 - Solutions from decontamination of gloveboxes, equipment, and the building structure with foam, scrubbing, and rinsing. Formula 409 solution was used for decontamination operations (RF-U167).
 - Ceiling tiles and other damaged materials. These were put into plastic bags, removed from the area, and placed in wooden boxes for disposal (RF-C191).
 - Building ventilation ducting that was not able to be decontaminated was removed for disposal (RF-U163) (RF-C189).
 - Light gauge ducting was smashed and packaged into boxes during building decontamination activities (RF-P047).
 - Filters were removed following normal filter change procedures (RF-U163).
 - Tools and equipment used in size reduction equipment to perform cutting and strip out operations; such as: saw blades, the hydro form press, briquetting presses, rolling mill, casting furnace, and gloveboxes. Wooden shoring and bracing was used for heavy items in approximately 10% of the waste boxes. Generally, fire waste was cut up, double wrapped in plastic, taped closed, and placed in waste boxes. The waste boxes were usually 4 × 4 × 7 ft, although some larger and smaller boxes were used when needed, particularly in the early

stages of clean-up. Liberal amounts of Oil-Dri were used where oils or other liquids were seen or expected (RF-P047, RF-P084).

- A large number of gloveboxes containing machining equipment and tools were disconnected from the main conveyor glovebox line and boxed whole for shipment. The dimensions of the waste boxes varied, depending on the size and weight of the glovebox and associated equipment. All visible plutonium was removed from easily accessible locations on the machines. However, the machines were not dismantled, and there may be hidden pockets of plutonium chips in some machines, possibly in kilogram quantities. However, no pieces of plutonium larger than machining chips or lathe turnings should be found, and all plutonium should be in the oxidized form by now. However, it is possible that small amounts of unoxidized (metallic) plutonium may be found trapped in the machine cooling oil, such as in the vacuum pots connected to each machining station (RF-P047).
- Twenty engine lathes, including all tools, jigs, chucks, fixtures, motors, coolant pumps, and exterior gloveboxes were included in the waste. The gloveboxes were approximately 4 × 14 × 8 ft high. In early cleanup, waste boxes were constructed around the lathes and their exterior gloveboxes. Later, the lathes and gloveboxes were cut up to fit 4 × 4 × 7 ft waste boxes (RF-P047).
- Lead, leaded glass, and Benelex and Plexiglas of various thicknesses from gloveboxes and conveyor lines were removed during fire clean-up (RF-P084).
- Strippable paint used for removing surface contamination. Criticality guidelines required the paint to be applied no thicker than 1 in., or create a volume no greater than 1 gal (RF-C171).

In 1969, waste operations began in Building 776, originally initiated for the purpose of disposing of the 1969 fire contaminated material. On October 18, 1971, clean-up activities for the 1969 fire were completed. The empty spaces in Building 776 resulting from the fire were mostly filled with waste-related operations, which focused on waste reduction. The waste management department was formed in late 1970 as an outgrowth of the 1969 fire. The establishment of this department started a trend towards better waste management practices (RF-P047, RF-P084).

Following the fire, the majority of the foundry and fabrication operations in Building 776/777 were transferred to Building 707. Production operations in Building 776 were limited to special projects and disassembly of stockpile returned pits. The main focus became waste and residue treatment. A manual size reduction facility was established in a previous plutonium storage vault as an outgrowth of the 1969 fire recovery operations (RF-P084, RF-U115).

4.11.1 Physical Waste Matrices Generated

A total of 27,317 containers (477,427 ft³) and 11,696 containers (207,637 ft³) of debris and sludge wastes were generated from activities conducted in Buildings 776 and 777, respectively. These numbers were compiled from WasteOScope (RF-U169) and grouped into the seven waste types, as described in Section 5 and presented in Table 4-30. A more detailed presentation of the original waste type assignments entered into WasteOScope and the delineation into the seven final waste types are presented in Appendix B.

Table 4-30. Waste volumes shipped to INEEL designated 776 and 777 (RF-U169).

Waste Type	Waste Description	Building 776 Assembly & Manufacturing		Building 777 Assembly & Manufacturing	
		Container Count	Volume (ft ³)	Container Count	Volume (ft ³)
I	Combustibles	15,531	222,116	8158	107,410
I & V	Combustibles & non-combustibles	678	6,868	37	2,792
II	Filter paper	42	4,080	5	351
III	Filters	960	19,889	144	6,887
IV	Inorganic Sludges	69	505	5	37
V	Non-combustibles	10,024	223,874	3,347	90,160
VI	Organic wastes	13	95	0	0
VII (Be)	Beryllium-contaminated debris	0	0	0	0
Total		27,317	477,427	11,696	207,637

It is assumed that the debris wastes were composed of plutonium-, uranium-, and beryllium-contaminated gloves, wipes, and other common combustible waste forms, filters, and filter paper from routine change out of ventilation systems, and non-combustible wastes generated during manufacturing and other operations conducted in the building as well as from routine and non-routine decontamination activities. It is also assumed that the debris waste would also be contaminated with chemical constituents as listed below. The Type VI waste is assumed to be solidified sludge or aqueous liquids generated during R&D operations contaminated with radiological and chemical constituents.

Specifics on the amount of CPR present in waste containers are not provided in the AK record. However, as a conservative measure, it may be assumed that the Type I combustible and Type II filter paper wastes are predominately CPR, and that some of the Type III filter waste was generated prior to 1957 and is combustible. It should also be assumed that one-half of the waste identified for the combination of Type I and V is also comprised of CPR (RF-D001).

There are no written reports of munitions or firearms identified as being placed in waste containers. However, there is testimony by RFP personnel that there were as many as four revolvers confiscated from guards by Health Physics on the day of the Building 776 1969 fire (RF-P047).

4.11.2 Chemical Constituents

A variety of chemicals used during operations conducted in Building 776/777, and the associated process and/or use are presented in Table 4-31.

Table 4-31. Chemicals used in Building 776/777 operations.

Constituent	Process/Use (if known)
F-Listed Organic Solvents	
1,1,1-Trichloroethane	Components cleaning (RF-P084).
Acetone	Components cleaning (RF-C167, RF-P084).
Carbon Tetrachloride	1957–1969: Cleaning and degreasing machined parts (RF-C234, RF-P047, RF-P084, RF-U143).

Constituent	Process/Use (if known)
Tetrachloroethylene [Perchloroethylene (PCE)] Trichloroethylene (TCE)	Cleaning and degreasing (RF-C195, RF-P084). 1957–1969: Cleaning plutonium parts in assembly process (RF-C196, RF-P084).
Metals	
Chromium (includes chromium trioxide)	Anti-microbial additive to Kathene air drying system (RF-P084).
Lead	Shielding in the form of lead and leaded glass; leaded rubber gloves; welding rods (RF-P047, RF-P084, RF-U124, RF-U167).
Lithium metal	Special order work (RF-P064).
Silver	Metal component (RF-P084).
Ignitable, Reactives, Corrosives	
Ethanol	Components cleaning (RF-P084).
Formula 409	Decontamination and fire clean-up (RF-U167).
Isopropyl alcohol	Cleaning activities until 1963–1964 (RF-P084).
Nitric acid	(RF-U143).
Other Chemicals/Constituents	
Beryllium – trace	Metal component (RF-P084, RF-U038, RF-U124, RF-U150).
Lithium chloride (Kathene)	Solution used for air-drying system (RF-P084).
Shell Vitrea cutting oil	Machining in Building 776 (RF-P084).
Strippable Paint	Fire clean-up contamination removal (RF-C171).
Texaco Regal Oil	Machining (RF-P084).
Magnesium chloride	Molten Salt Extraction.
Potassium chloride	Molten Salt Extraction.
Sodium chloride	Molten Salt Extraction.

4.11.3 Radionuclides

Weapons grade plutonium, enriched uranium, and depleted uranium were commonly used in the Building 776/777 processes. These radioisotopes and related isotopes that may be present in wastes generated from Building 776/777 are listed in Table 4-32. Radioisotopic content for individual wastes or specific to RFP buildings cannot be determined. However, radioisotopic content for all RFP waste was estimated and is discussed in detail in Section 6.

Table 4-32. Radioisotopes expected to be present in Building 776/777 wastes (RF-P084, RF-P085, RF-U115).

Radionuclides	
Am-241	Np-237
Pu-238	Pu-241
Pu-239	U-234
Pu-240	U-235
Pu-242	U-238

4.12 Building 779

Building 779 was constructed in 1965 as a plutonium R&D facility. The primary purpose was to gain more knowledge of the chemistry and metallurgy of plutonium and its interactions with other materials that might be used in the manufacturing processes. Methods to improve manufacturing processes and find new ways to recover plutonium and associated actinides were also researched in Building 779 (RF-P040, RF-P085). Process flow diagrams are not provided for Building 779 waste generating activities because the processes were associated with research and development and not a linear progression of activities characteristic of other RFP processes.

Building 779 housed R&D and support operations that are separated into five primary areas, as follows:

1. **Chemistry Technology:** Chemistry laboratories were used in weapons process development, stockpile reliability testing, plutonium aging, and methods development for recovery, separation, and purification of actinides from waste streams and residues (RF-P040, RF-P085, RF-U152, RF-U208).
2. **Physical Metallurgy:** Research was conducted on various metals, alloys, and materials involving tensile testing, casting dynamics, electron microscopy, X-ray analyses, hardness testing, etching, and dimensional dynamics, and supported various research groups, design agencies, site production, and metallurgical studies of materials and manufacturing techniques (RF-P040, RF-P085, RF-U152).
3. **Machining and Gaging:** Activities were conducted in three shops, two general machine shops and a general machining laboratory. Activities conducted supported the joining process; produced tooling, fixtures, and special order parts; supported building operations; and provided high precision machining of special orders, machining tests, and general machining jobs (RF-P040, RF-P085, RF-U152).
4. **Joining and Coatings:** Activities included electron-beam welding, gas-tungsten arc welding, pressure gas-metal arc welding, gas welding, brazing, metallography, machining, dimensional inspection, and electronics development. The function of the coatings process was to define the required parameters associated with the deposition of various metals onto specified substrate geometries (RF-P040, RF-P085, RF-U152).
5. **Hydriding:** Removal of recoverable amounts of plutonium from parts in the form of plutonium hydride. The hydride was then dehydrided and converted to plutonium metal or plutonium oxide (RF-P040, RF-P085, RF-U152).

A maintenance shop also present in Building 779 was used to provide building systems maintenance, equipment cleaning and repair, and general support of other building processes (RF-P040, RF-P085, RF-U152).

4.12.1 Physical Waste Matrices Generated

A total of 949 containers (8,676 ft³) of debris and sludge wastes were generated from activities conducted in Building 779, as recorded in WasteOScope (RF-U169). These numbers were compiled from WasteOScope (RF-U169) and grouped into the seven waste types as described in Section 5 and presented in Table 4-33. A more detailed presentation of the original waste type assignments entered into WasteOScope and the delineation into the seven final waste types are presented in Appendix B.

Table 4-33. Waste volumes shipped to INEEL designated 779 (RF-U169).

Waste Type	Building 779 Plutonium Development		
	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	495	4,427
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	1	7
III	Filters	33	355
IV	Inorganic sludges	11	81
V	Non-combustibles	408	3,802
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	1	4
Totals		949	8,676

It is assumed that the debris wastes were composed of plutonium-, uranium-, and beryllium-contaminated gloves, wipes, and other common combustible waste forms, filters, and filter paper from routine change out of ventilation systems, and non-combustible wastes generated during manufacturing and other operations conducted in the building as well as from routine and non-routine decontamination activities. It is also assumed that the debris waste is also contaminated with chemical constituents as listed below. The Type VI waste is assumed to be solidified sludge or aqueous liquids generated during R&D operations contaminated with radiological and chemical constituents.

Specifics on the amount of CPR present in waste containers are not provided. However, as a conservative measure, it may be assumed that the Type I combustible and Type II filter paper wastes are predominately CPR, and that some of the Type III filter waste was generated prior to 1957 and is combustible. (RF-D001) Building 779 was constructed in 1965 as a plutonium R&D facility.

4.12.2 Chemical Constituents

A variety of chemicals were used in Building 779 processes that may be present in the wastes, as shown in Table 4-34.

Table 4-34. Chemicals used in Building 779 operations.

Constituent	Process/Use (if known)
Organic Compounds	
1,1,1-Trichloroethane	Chemistry Technology (RF-P040)
Acetone	Unknown – Chemical Inventory (RF-C215)
Carbon Tetrachloride	Chemistry Technology, Physical Metallurgy (RF-C223, RF-P085, RF-U188)
Chloroform	Chemistry Technology (RF-P085)
Freon	Physical Metallurgy (RF-P040)
Methanol	Joining and Coatings (RF-P040)
Methyl Ethyl Ketone	Physical Metallurgy (RF-P040)
Methylene Chloride	Physical Metallurgy (RF-P040)
Tetrachloroethylene	Unknown (RF-U188)
Trichloroethylene	Unknown – Chemical Inventory (RF-C215)
Xylene	Unknown – Chemical Inventory (RF-C215)
Metals	
Chromium	Chemistry Technology, Physical Metallurgy (RF-P085, RF-U208)
Lead	Unknown (P085)
Mercury	Unknown – Chemical Inventory (RF-C215)
Silver	Unknown – Chemical Inventory (RF-C215)
Characteristic for ignitability, reactivity, or corrosivity	
Ammonium Hydroxide	Chemistry Technology (RF-P040)
Dimethylamine	Chemistry Technology (RF-P040)
Ethanol	Unknown – Chemical Inventory (RF-C215)
Hydrazine	Chemistry Technology (RF-P040, RF-P085)
Hydrochloric Acid	Chemistry Technology (RF-P040, RF-U208)
Hydrofluoric Acid	Joining and Coatings (RF-P040)
Lithium Perchlorate	Chemistry Technology (RF-U208)
Nitric Acid	Chemistry Technology, Physical Metallurgy, Joining and Coatings (RF-P040, RF-P085)
Perchloric Acid	Chemistry Technology (RF-U208)
Phosphoric Acid	Joining and Coatings (RF-P040)
Potassium Chromate	Unknown (RF-P085)
Potassium Dichromate	Physical Metallurgy (RF-P085)
Sodium Dichromate	Chemistry Technology (RF-P085)
Sodium Hydroxide	Joining and Coatings (RF-P040)
Sulfuric Acid	Joining and Coatings (RF-P040)
Other Chemicals/Constituents	
Calcium Chloride	Chemistry Technology (RF-P040)
Copper Sulfate	Joining and Coatings (RF-P040)
Kerosene	Unknown – Chemical Inventory (RF-C215)
Lube Oil/Coolants	Physical Metallurgy (RF-C223)
Nickel (nickel sulfate crystals)	Chemistry Technology (RF-P085)
Oakite	Unknown (RF-U188)
Oxalic Acid	Physical Metallurgy, Joining and Coatings (RF-P040)
Silicone Oil	Unknown – Chemical Inventory (RF-C215)
Soda Lime	Chemistry Technology (RF-P040)
Xenon Trioxide	Chemistry Technology (RF-U208)

4.12.3 Radionuclides

Actinide elements, compounds, and other radioactive materials encountered in the process chemistry laboratories included the isotopes listed in Table 4-35 as well as other associated tracer isotopes or radioactive decay products. Radioisotopic content for individual wastes or specific to RFP buildings cannot be determined. However, radioisotopic content for all RFP waste is discussed in detail in Section 6.

Table 4-35. Radioisotopes expected to be present in Building 779 wastes (RF-P040, RF-P084, RF-P085, RF-U115).

Radionuclides	Additional Radionuclides
Am-241	Co-60
Pu-238	H-3
Pu-239	Np-237
Pu-240	Pu-241
Pu-242	Th-232
U-238	U-234
Sr-90 (Y-90)	U-235

4.13 Building 881

Building 881 was constructed in 1952 and began operations as a HEU manufacturing and recovery facility in the summer of 1953. Originally called the “B-Plant,” Building 881 included a chemical facility, which complemented the manufacturing operations for recycled HEU metal from fabrication and foundry residues. The recovery operations used depended on the type of starting material; in most instances, recovery processes involved solubilization of uranium from residues to convert the uranium from a liquid to a solid oxide, and then to metal (RF-P064, RF-P084, RF-P085). Precision stainless steel operations began in 1966 in support of the plutonium-based weapons operations until 1984 (RF-P064, RF-P084).

Manufacture of nuclear weapon components used a HEU alloy (Oralloy). The foundry, machining, inspection, chemical recovery, and metal recycling operations were carried out in Building 881. The rolling and forming operations were housed in Building 883B, and an analytical laboratory was housed in a portion of Building 881.

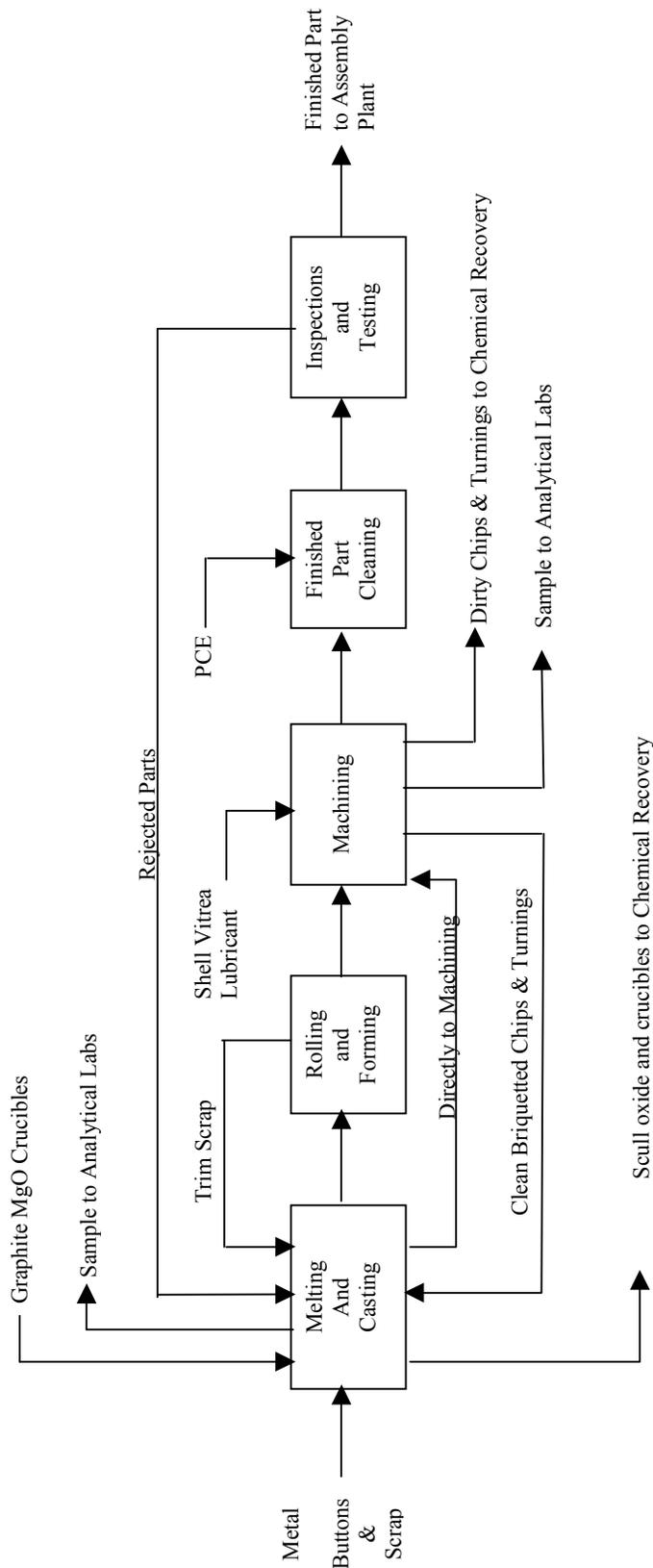
The manufacturing of HEU components in Building 881 was terminated in 1964. The cleanout of HEU material continued for several more years. Use of Building 881 was transferred to R&D projects, the manufacture of non-radioactive reservoir components, and included relocating laboratory facilities from B-444 used to support depleted uranium and beryllium operations. Related operations in Building 883B were also terminated and the area was converted for DU and beryllium operations.

Operations in Building 881 involved three primary processes, as follows:

- **Manufacturing or Fabrication Support:** Fabrication support for enriched uranium included the foundry (for casting of shapes and ingots), machining, and inspection. A process flow diagram depicting the HEU fabrication process, which applies to operations conducted in both Building 881 and Building 883, is provided in Figure 4-7. No chemicals are known to have been used in foundry operations (RF-P064, RF-P084, RF-P105). Fabrication operations were performed in the open rather than in enclosed gloveboxes like the plutonium operations. Between 1952 and 1957, milling machines and lathes were used to shape the first weapon design. Machining was conducted with Shell Vitrea Oil as a coolant that was circulated by a centralized system operated

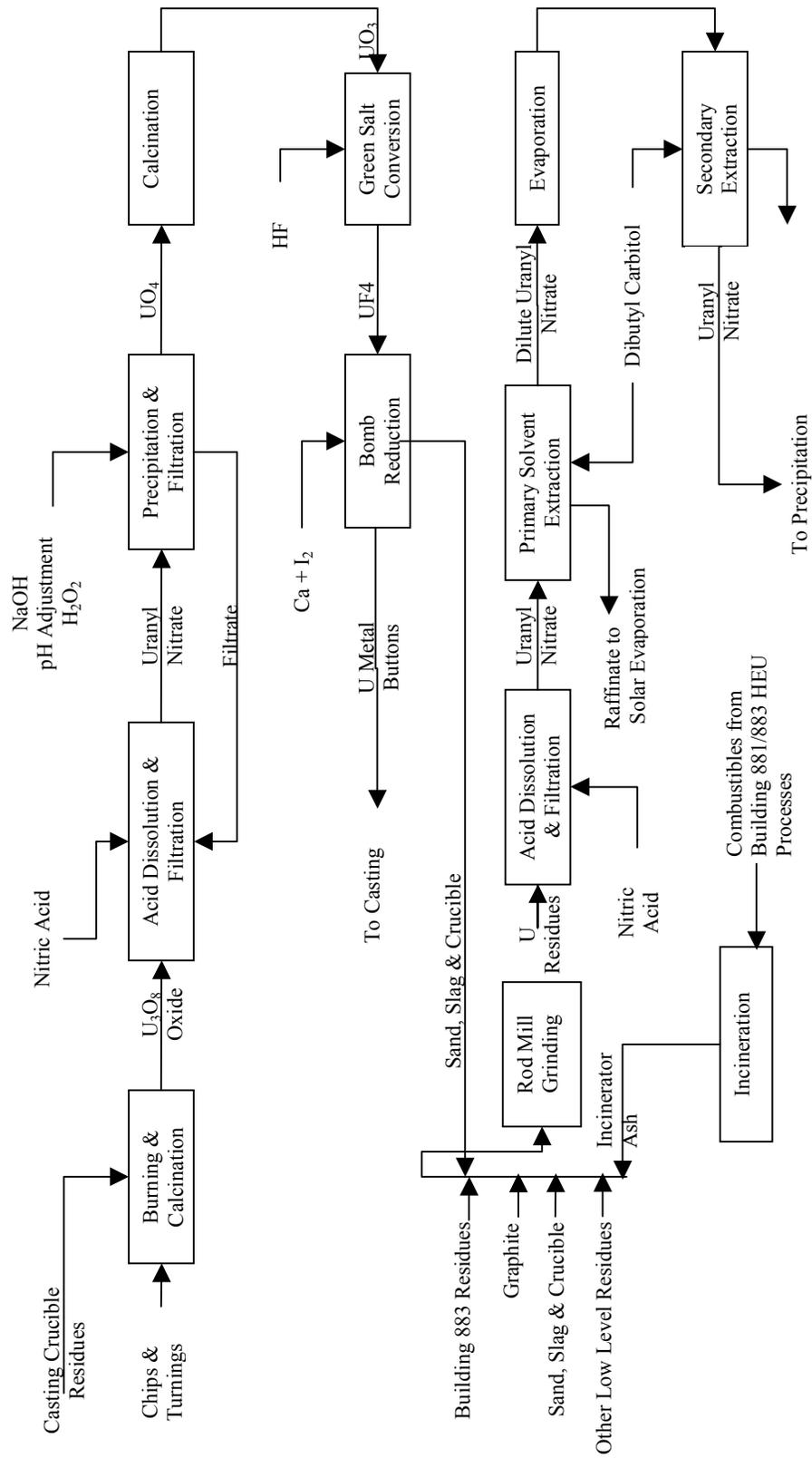
in Room 304. Some waste oil was burned; and some was drummed, sent to the mound area, and later moved to the 903 Pad drum storage area. After machining, the parts were cleaned by dipping them into tanks containing PCE and allowing them to drip-dry. Each machine had a dedicated dip tank that was changed out when impurities warranted (RF-P064, RF-P084).

- **Metal Product Support:** Metal Product Support included HEU recovery and recycle processes to dissolve uranium from various residues, convert the uranium from liquid to solid, and then to convert the solid to a metal. The recovery and recycle process flow is illustrated in Figure 4-8 (RF-P064, RF-P084, RF-P105). Three incinerators were used and the resultant ash was sent to the recovery process. After 1960, returned or rejected parts were processed for recovery. Pure uranium scraps from machining were cleaned with TCE and PCE, pressed into briquettes, and reintroduced to the casting furnace. Uranium fines were recovered from the oil coolant system once a year by draining the coolant, pumping the lines full of nitric acid, and then processing the solution. The coolant lines were reconditioned by pumping PCE through them (RF-P064, RF-P084).
- **Chemical Recovery Operations:** These operations included an “oralloy leaching” operation in which returned or rejected HEU weapons parts were leached by spraying hot nitric acid on the parts to remove residual plutonium surface contamination. Some amount of uranium was also removed by the leaching process. The resulting solutions were treated to concentrate the isotopes into a precipitate. The plutonium oxide product that was sufficiently high in plutonium content was sent to the Savannah River Plant. The oxide with low plutonium content was sent to the Oak Ridge Y-12 Plant for uranium recovery (RF-P085).



Note: Combustible wastes went to chemical recovery for incineration (in Building 881).
 Process off-gases went to caustic scrubbing and HEPA filtration systems.
 Spent lathе coolant was collected in drums and shipped to Building 774 for solidification and/or went to the burning pits based on uranium concentration level.
 Spent cleaning (degreasing) solutions were drummed and stored and/or shipped to Building 774 for solidification.
 Rolling and forming were carried out in Building 883 Side B.
 Materials too low in U-235 to recover were packaged for shipment off-site to INEEL and Hanford.
 PCE (perchloroethylene) used in cleaning.

Figure 4-7. Highly enriched uranium fabrication process—RFP Buildings 881 and 883 (RF-P105).



Note: Process off-gases went to caustic scrubbing and HEPA filtration systems.
 Combustible wastes went to chemical recovery for incineration (in Building 881).
 Materials too low in U-235 to recover were packaged for shipment off-site to INEEL & Hanford.

Figure 4-8. Highly enriched uranium recovery and recycle process flow—RFP Building 881 (RF-P105).

- **Special Projects and R&D:** Building 881 also housed special projects and R&D activities. After 1967, beryllium ingots were sealed into stainless steel containers that were fabricated in Building 881. Some radionuclide traces and other radioisotopes were used in Building 881 for special projects work. The tracers included neptunium, curium, and cerium. Also, some of the first neptunium processing occurred in Building 881. Thorium-containing components were manufactured as well, as a short duration project from the late 1950s to the early 1960s. Another short-term special project involved the oxidation of three grams of curium-244 metal. Uranium-233 was handled (20 kilograms) in Building 881 for two projects along with thorium 228 (RF-P084). The following R&D projects were also conducted in Building 881 (RF-P064, RF-P084):
 - Tracer Components.
 - Uranium-233 Processing.
 - Lithium Fabrication—Some special order work involved lithium metal with a total of about 10 to 15 kilograms being handled in 1966; lithium was usually pressed and machined in Building 777, but was handled in Building 881(RF-P064).
 - Recovery of Fuel Rods—A special recovery project involved dissolving rejected beryllium-coated uranium fuel rods; several thousand rods were handled (RF-P064).
 - Distillation—Solvent stills designed to recycle spent solvents, oils, and mixtures were operated from about 1958 to 1962; the ‘heels’ of the stills were scrubbed with nitric acid to reclaim uranium and were then discarded (RF-P064).
 - Cadmium plating of uranium parts.
 - Inertial fusion.
 - Tantalum special order work.
 - Special Weapons Project Group.
 - Corrosion testing.
 - Instrumentation and Special Projects.
 - Polymer solidification development.
 - Wastewater treatability studies.

4.13.1 Physical Waste Matrices Generated

A total of 11,968 containers (247,787 ft³) were generated from activities conducted in Building 881 and shipped to INEEL for disposal according to WasteOScope. Available documentation indicates Building 881 generated debris waste identified under Waste Types I, II, III, IV, V, VI, and VII(Be). The waste according to the waste groupings described in Section 3.4 is provided in Table 4-36. Documentation identifying annual waste generation is unavailable (RF-C223, RF-P040, RF-P047, RF-U169). A more detailed presentation of the original waste type assignments entered into WasteOScope and the delineation into the final waste types are presented in Appendix A.

Table 4-36. Waste volumes shipped to INEEL designated 881 (RF-U169).

Building 881 B-Plant, HEU Recovery & Manufacturing			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	2,842	88,858
I & V	Combustibles & non-combustibles	66	485
II	Filter paper	11	183
III	Filters	2,934	17,058
IV	Inorganic Sludges	376	2,775
V	Non-combustibles	5,687	138,052
VI	Organic wastes	37	266
VII (Be)	Beryllium-contaminated debris	15	110
Total		11,968	247,787

It is assumed that the debris wastes were composed of uranium- and beryllium-contaminated gloves, wipes, and other common combustible waste forms, filters and filter paper from routine change out of ventilation systems, and non-combustible wastes. These wastes were generated during manufacturing and other operations conducted in the building as well as from routine and non-routine decontamination activities. It is also assumed that the debris waste would also be contaminated with chemical constituents as listed below. The Type VI waste is assumed to be solidified sludge or aqueous liquids generated during machining operations contaminated with radiological and chemical constituents.

A limited amount of information is provided in WasteOScope. Specifics on the amount of CPR present in waste containers are not provided. However, as a conservative measure, it may be assumed that the Type I combustible and Type II filter paper wastes are predominately CPR, and that some of the Type III filter waste was generated prior to the Building 771 fire and is combustible (RF-D001).

4.13.2 Chemical Constituents

Building 881 used a variety of chemicals within its waste generating processes. The chemicals and the corresponding process or use, if known, are listed in Table 4-37.

Table 4-37. Chemicals and other materials used in Building 881 processes.

Constituent	Process/Use (if known)
F-Listed Organic Solvents	
Trichloroethylene	Unknown – Chemical Inventory (RF-C227)
Metals	
Chromium (includes chromium trioxide)	Unknown – Chemical Inventory (RF-C227)
Ignitable, Reactives, Corrosives	
Hydrazine	Unknown – Chemical Inventory (RF-C227)
Ammonium Hydroxide	Unknown – Chemical Inventory (RF-C227)
Hydrofluoric Acid (HF-H ₂)	Unknown – Chemical Inventory (RF-C227)
Nitric Acid	Unknown – Chemical Inventory (RF-C227)

Table 4-37. (continued).

Constituent	Process/Use (if known)
Ignitable, Reactives, Corrosives	
Sodium Hydroxide	Unknown – Chemical Inventory (RF-C227)
Other Chemicals/Constituents	
Oxalic Acid	Unknown – Chemical Inventory (RF-C227)
Acetic Acid	Unknown – Chemical Inventory (RF-C227)
Alcohol	Unknown – Chemical Inventory (RF-C227)
Aluminum Oxide	Unknown – Chemical Inventory (RF-C227)
Aluminum Nitrate	Unknown – Chemical Inventory (RF-C227)
Ammonium Bifluoride	Unknown – Chemical Inventory (RF-C227)
Beryllium	Unknown – Chemical Inventory (RF-C227)
Boric Acid	Unknown – Chemical Inventory (RF-C227)
Cadmium Oxide	Unknown – Chemical Inventory (RF-C227)
Cupric Sulfate	Unknown – Chemical Inventory (RF-C227)
Helium	Unknown – Chemical Inventory (RF-C227)
Magnesium Oxide	Unknown – Chemical Inventory (RF-C227)
Magnesium Zirconate	Unknown – Chemical Inventory (RF-C227)
Potassium Chloride	Unknown – Chemical Inventory (RF-C227)
Potassium Hydroxide	Unknown – Chemical Inventory (RF-C227)
Sodium Bicarbonate	Unknown – Chemical Inventory (RF-C227)
Texaco Soluble D	Unknown – Chemical Inventory (RF-C215)
Transul Tex 210	Unknown – Chemical Inventory (RF-C215)
Sani-Phene Disinfectant (composed of isopropyl alcohol 23.0%, vegetable oil, O-Benzyl P-chlorophenol, methyl salicylate.	Unknown – Chemical Inventory (RF-C215)
Winterfene disinfectant	Unknown – Chemical Inventory (RF-C215)
Genesolv-D (trichlorotrifluoroethane)	Unknown – Chemical Inventory (RF-C215)
Anchorlube	Unknown – Chemical Inventory (RF-C215)
Uranyl Nitrate	Enriched Uranium Recovery (RF-P084)
Hydrogen Peroxide 30%	Enriched Uranium Recovery (RF-P084)
Malonic Acid	Enriched Uranium Recovery (RF-P084)
Citric Acid	Enriched Uranium Recovery (RF-P084)
Dibutylcarbitol	Enriched Uranium Recovery (RF-P084)
Ammonia Gas	Enriched Uranium Recovery (RF-P084)
PCE	Enriched Uranium Recovery (RF-P084)
Lithium	Enriched Uranium Recovery (RF-P064, RF-P084)
Cadmium	Enriched Uranium Recovery (RF-P084)
Freon (unspecified)	Enriched Uranium Recovery (RF-P084)
Nitradd	Enriched Uranium Recovery (RF-P084)
Lubricating Oil	Special Projects (RF-P084)

Table 4-37. (continued).

Constituent	Process/Use (if known)
Freon 12	Special Projects (RF-P084)
Freon 113	Special Projects (RF-P084)
Ethanol	Special Projects (RF-P084)
Epoxy Glues	Special Projects (RF-P084)

4.13.3 Radionuclides

The radioisotopes that may be present in waste generated from Building 881 are listed in Table 4-38; however, specific concentrations of each isotope are unknown (RF-P064, RF-P084). HEU production started in 1953. Beginning in 1964, HEU work was curtailed in Building 881 and 883 as the RFP mission of producing HEU components was transferred to ORNL. Limited operations associated with shut down and clean-up of residual HEU in Building 881 continued through 1967 (RF-P084, RF-P105). Some radionuclide traces and other radioisotopes were used in Building 881 for special projects work. The tracers included neptunium, curium, and cerium. Also, some of the first neptunium processing occurred in Building 881. Thorium-containing components were also manufactured as a short duration project from the late 1950s to the early 1960s. Another short-term special project involved the oxidation of three grams of curium-244 metal. Uranium-233 was handled (20 kg) in Building 881 for two projects along with thorium-228 (RF-P084). Radioisotopic content for all RFP waste is discussed in detail in Section 6.

Table 4-38. Radionuclides expected to be present in Building 881 waste.

Radionuclides	
Cerium-(tracer)	U-232
Cu-244 (RF-P084)	U-233
Co-60	U-234
Np-237	U-235
Thorium-(tracer)	U-236
Th-228	U-238
Th-232	

4.14 Building 883

The mission of Building 883 was the manufacturing of HEU and DU components in two parallel fabrication processes. The primary production beginning in 1957 was the formation of metal shapes in two parallel uranium fabrication operations as illustrated in Figure 4-9. The principal production was forming parts that were supplied to Buildings 444 and 881 for machining. Operations involved use of presses, rolling mills, salt baths, and annealing furnaces. HEU operations were discontinued between 1964 and 1966, when all HEU work was moved to ORNL. Limited operations associated with shut down of the HEU processes and clean-up of residual HEU continued through 1967. Beryllium was rolled, formed, cast, and cut into shapes. Beryllium processing began in 1962 and ended in the mid-1980s (RF-P015, RF-P084, RF-P105).

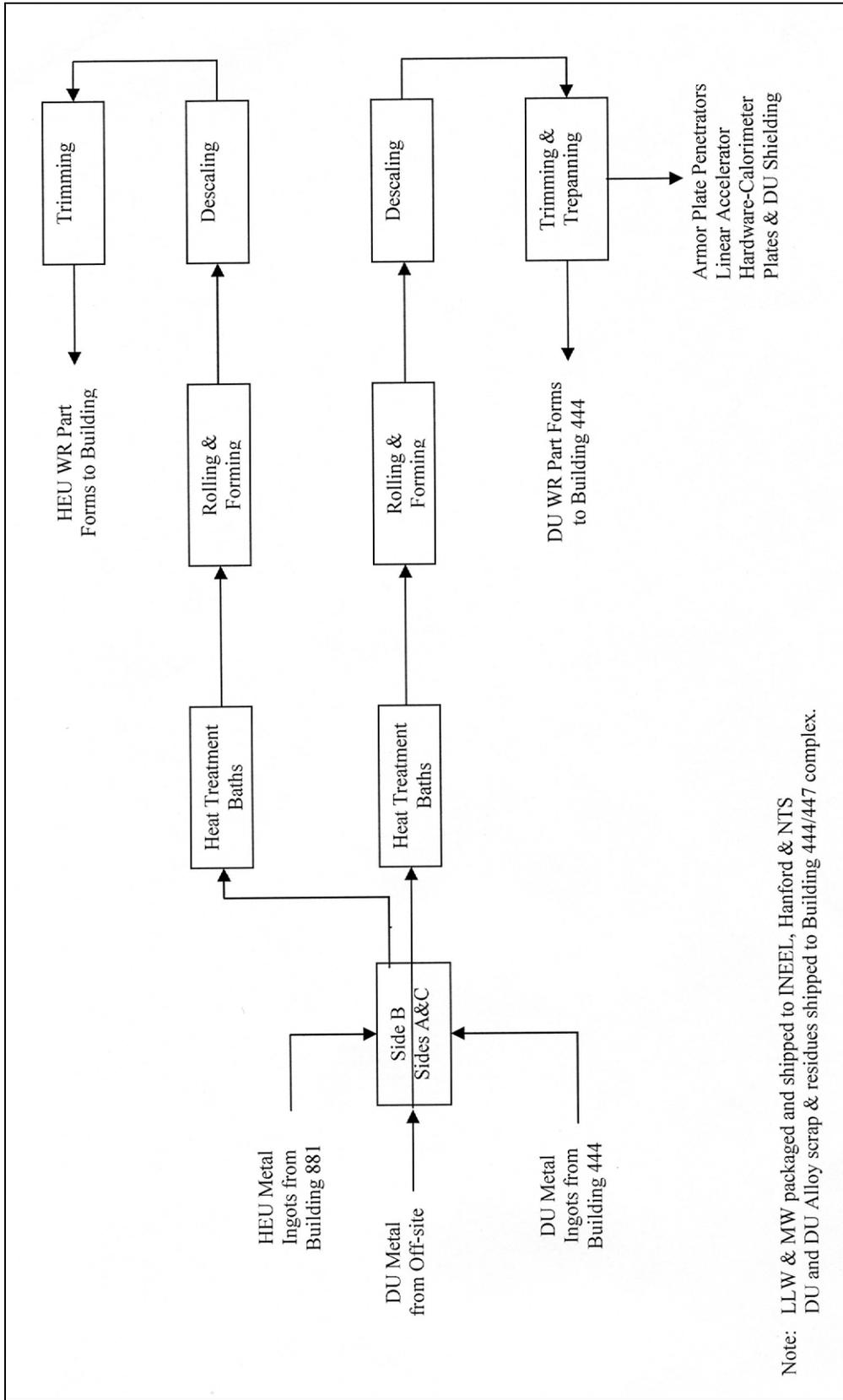


Figure 4-9. Fabrication processes—RFP Building 883 (RF-P105).

Note: All operations illustrated on Figure 4-9 may not be specific to the 1954 to 1970 timeframe, but are identified for completion. Operations known to be outside of the specified time are those specific to Side C of Building 883. Side C was not constructed until 1983, and operations within this side included pilot and full-scale manufacturing of armor plate for the M1A1 Tanks. In addition, hardware-calorimeter manufacturing did not take place until 1977.

The machining process in Building 883 was the same as the process used in Building 881. Spent lathe coolant was collected in drums and shipped to Building 774 for solidification and/or went to the burning pit based upon uranium concentration. One of the large presses contained oil contaminated with PCBs that was drained and taken to PCB storage (RF-P084). The PCB contaminated liquids were all stored at RFP until 1967, when a solidification process was established (RF-C058). Cleaning operations involved nitric acid pickling, degreasing, and grit blasting. Spent cleaning solutions were drummed and stored and/or shipped to Building 774 for solidification (RF-P105). Sheet trimmings and other depleted uranium residues were shipped to Building 444/447 for recasting and/or for conversion to an oxide form (roaster oxide) for disposal. Combustible waste was sent back to Building 881 for incineration and uranium recovery from the ash. Materials too low in uranium-235 to recover were packaged for shipment off-site to INEEL and Hanford. Documentation identifying annual waste generation is unavailable (RF-P084, RF-P015, RF-U115).

4.14.1 Physical Waste Matrices

A total of 3,854 waste containers (57,933 ft³) was generated from activities in Building 883 according to records in WasteOScope (RF-U169). A summary of the Building 883 waste by the seven waste types is provided in Table 4-39.

Table 4-39. Waste volumes shipped to INEEL designated 883 (RF-U169).

Building 883 Beryllium and Uranium Machining			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	1,524	22,326
I & V	Combustibles & non-combustibles	0	0.00
II	Filter paper	12	611
III	Filters	12	374
IV	Inorganic sludges	94	648
V	Non-combustibles	2,147	33,496
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	65	478
Total		3,854	57,933

It is assumed that the debris wastes were composed of uranium- and beryllium-contaminated gloves, wipes, and other common combustible waste forms; filters and filter paper from routine change out of ventilation systems; and non-combustible wastes generated during manufacturing and other operations conducted in the building. Waste was also generated from routine and non-routine decontamination activities. It is further assumed that the debris waste would also be contaminated with chemical constituents as listed below.

A limited amount of information is provided in WasteOScope. Specifics on the amount of CPR present in waste containers are not provided. As a conservative measure however, it may be assumed that the Type I combustible and Type II filter paper wastes are predominately CPR, and that some of the Type III filter waste was generated prior to the Building 771 fire and is combustible (RF-D001).

4.14.2 Chemical Constituents

Building 883 used a variety of chemical constituents in its waste generating processes. The chemicals and corresponding process or use are presented in Table 4-40.

Table 4-40. Expected chemical contaminants used in Building 883.

Constituent	Process/Use (if known)
F-Listed Organic Solvents	
Trichloroethylene	Cleaning, degreasing (RF-P084)
Tetrachloroethylene, perchlorethylene	Cleaning, degreasing (RF-P084)
Freon	Unknown (RF-P084)
Potentially Ignitable, Reactive, Corrosive	
Nitric acid	Cleaning, degreasing (RF-P084)
Other Chemical Constituents	
Beryllium	Metal component in fabrication process (RF-P084)

4.14.3 Radionuclides

The radioisotopes that may be present in wastes generated from Building 883 processes are listed in Table 4-41. Radioisotopic content for individual wastes or specific to RFP buildings cannot be determined. However, radioisotopic content for all RFP waste is discussed in detail in Section 6.

Table 4-41. Radionuclides expected to be present in Building 883 waste.

Radionuclides	Additional Radionuclides
U-232	Th-228 (trace)
U-233	Am-241*
U-234	Pu-239*
U-235	Pu-240*
U-236	Pu-242*
U-238	

* Source is from contamination

4.15 Building 886

Building 886 was constructed in 1965 to house the Critical Mass Laboratory. The primary purpose of the laboratory was to conduct nuclear criticality experiments on liquid, powder, and solid forms of fissionable materials. The experiments were essential to validate computer models used to establish nuclear criticality safety limits (RF-P025, RF-P060). In 1969, the critical mass program at Lawrence Radiation Laboratories was shut down, and studies still considered necessary for their purposes were performed at Rocky Flats. Process flow diagrams are not provided for Building 886 waste generating activities because the processes were associated with laboratory experimentation and not a linear progression of activities characteristic of other RFP processes.

Criticality experiments were conducted in a test cell area of the laboratory and included the use of materials such as plutonium, enriched uranium, and solutions of uranyl nitrate in dilute nitric acid. Uranyl nitrate solutions were held in storage tanks located in radioactive materials storage areas of Building 886. The storage tanks contained borosilicate-glass Raschig rings to absorb neutrons present in the uranyl

nitrate solution and prevent criticality events. As experiments were conducted, the solution was transferred from the tank to the test cell. At the conclusion of the testing, the solution was returned to the storage tank for reuse in future tests (RF-P025, RF-P085).

Approximately half of the 1,600 criticality experiments conducted in Building 886 actually achieved controlled criticality. The experiments were conducted in a manner that controlled the level of fissioning. A very few waste fission products were produced; these decayed rapidly and were contained until stable (RF-P085).

Building 886 also housed offices and a small electronics and machine shop (RF-P025, RF-P085).

4.15.1 Physical Waste Matrices Generated

A total of 243 containers (2,231 ft³) of debris that were sent to the INEEL for disposal are identified in WasteOScope. These wastes were generated from activities conducted in Building 886 (RF-U169). These numbers were compiled from WasteOScope (RF-U169) and grouped into the seven waste types as described in Section 5 and presented in Table 4-42. A more detailed presentation of the original waste type assignments entered into WasteOScope and the delineation into the seven final waste types are presented in Appendix B.

Table 4-42. Waste volumes shipped to INEEL designated 886 (RF-U169).

Building 886 Nuclear Safety			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	110	1,041
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	0	0
III	Filters	10	61
IV	Inorganic sludges	0	0
V	Non-combustibles	123	1,129
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	0	0
Total		243	2,231

4.15.2 Chemical Constituents

A small number of chemical constituents were used in Building 886, any of which may be present in the wastes (Table 4-43).

Table 4-43. Chemical constituents used in Building 886.

Constituent	Process/Use (if known)
Organic Compounds	
Tetrachloroethylene	Cleaning and degreasing metal parts
Other Chemicals/Constituents	
Uranyl nitrate solution (acid and enriched uranium)	Criticality testing

4.15.3 Radionuclides

The radioisotopes that may be present in wastes generated in Building 886 processes include:

Table 4-44. Radionuclides expected to be present in Building 886 waste.

Radionuclides	
Am-241	Pu-238
U-234	Pu-239
U-235	Pu-240
U-236	Pu-241
U-238	Pu-242

Radioisotopic content for individual wastes or specific to RFP buildings cannot be determined. However, radioisotopic content for all RFP waste is discussed in detail in Section 6.

4.16 Building 889

Building 889 was constructed in 1966 to provide decontamination and waste reduction operations for DU and HEU contaminated wastes originating outside the RFP protected area. Steam cleaning was used to decontaminate surplus equipment prior to reuse onsite or sale offsite. A significant amount of Oralloid contaminated equipment identified as surplus was packaged in crates and shipped to the INEEL (RF-P025, RF-U115).

4.16.1 Physical Waste Matrices

A total of 158 containers (6,474 ft³) of debris that were sent to the INEEL for disposal are identified in WasteOScope. These wastes were generated from activities conducted in Building 889 as recorded in WasteOScope (RF-U169). These numbers were compiled from WasteOScope (RF-U169) and grouped into the seven waste types as described in Section 5 and presented in Table 4-45. A more detailed presentation of the original waste type assignments entered into WasteOScope and the delineation into the seven final waste types are presented in Appendix B.

Table 4-45. Waste volumes shipped to INEEL designated 889 (RF-U169).

Building 889 Contaminated Equipment Decontamination			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	57	2,601
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	3	343
III	Filters	0	0
IV	Inorganic sludges	8	59
V	Non-combustibles	90	3,471
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	0	0
Total		158	6,474

4.16.2 Chemical Constituents

It is assumed that wastes generated from Building 889 are contaminated with any of the chemicals and metals used in the buildings outside the protected area. These chemical constituents are those listed for the entire site in Section 5.

4.16.3 Radionuclides

The major radioisotopes that may be present in wastes generated in Building 889 processes are assumed to be those associated with decontamination and waste reduction operations for DU and HEU contaminated wastes (Table 4-46). Radioisotopic content for individual wastes or specific to RFP buildings cannot be determined. However, radioisotopic content for all RFP waste is discussed in detail in Section 6.

Table 4-46. List of radionuclides for the RFP site as potential contaminants – Building 889.

Radionuclides	
U-233	U-236
U-234	U-238
U-235	

4.17 Building 991

Building 991 was the first of four original buildings to be completed at RFP. The building constructed between 1951 and 1952 was originally designated as the “D-Plant.” It was used for shipping and receiving, and for final assembly of weapon components received from onsite fabrication operations in Buildings 444, 881, and 771, and from Oak Ridge and Hanford. Assembled components were inspected and tested, then placed in storage prior to off-site shipment (RF-P085, RF-P041, RF-P084).

Final pit assembly of early design concept weapon components was reportedly a relatively simple operation. A new Part IV weapon design was introduced in the late 1950s. Under the Part IV design, final assembly became more involved, requiring additional machining and handling of the weapon materials. Building 777 was constructed to accommodate the more complex design IV requirements, and the final pit assembly process was relocated from Building 991 in 1957. It is believed that assembly of stockpiled older components continued in Building 991 until approximately 1960. After 1957, the mission of Building 991 became increasingly one of a shipping, receiving, and storage facility (RF-P084, RF-P085).

Building 991 served as the shipping and receiving facility for RFP from its inception. Incoming and outgoing special nuclear materials and products were contained in drums and were processed through or stored in Building 991. The drums were checked for radioactive contamination when received and prior to shipment, and were cleaned if radiation levels exceeded the established threshold limit (RF-P084). The threshold limit value(s) were not indicated in the AK source document and has not as yet been identified from any of the other source documents reviewed.

Other activities and special projects were performed or housed in Building 991 at various times throughout its history (RF-P084) and included:

- Nondestructive testing operations, a metallography laboratory, and production control operations
- Large fish tanks for radiation studies occupied a portion of the building in the 1960s and early 1970s

- A small beryllium coating process operated between July 1964 and September 1976
- An explosives forming project occupied the building between 1966 and 1974.

Most special project and development operations were moved out of the building by 1976.

Building 991 also served RFP's administrative functions until Building 111 was completed. A laundry facility in Building 991 was discontinued in 1958 when Building 778 became the laundry facility for all plutonium-related buildings (RF-P084, RF-P085).

4.17.1 Physical Waste Matrices Generated

A total of 2,806 containers (26,759 ft³) of debris was shipped to the INEEL for disposal. These wastes were generated from activities conducted in Building 991 as recorded in WasteOScope (RF-U169). These numbers were compiled from WasteOScope (RF-U169) and grouped into the seven waste types as described in Section 5 and presented in Table 4-47. A more detailed presentation of the original waste type assignments entered into WasteOScope and the delineation into the seven final waste types are presented in Appendix B.

Table 4-47. Waste volumes shipped to INEEL designated 991 (RF-U169).

Building 991 D-Plant, Final Assembly			
Waste Type	Waste Description	Container Count	Volume (ft ³)
I	Combustibles	2,205	16,922
I & V	Combustibles & non-combustibles	0	0
II	Filter paper	0	0
III	Filters	1	122
IV	Inorganic sludges	1	7
V	Non-combustibles	567	9,474
VI	Organic wastes	0	0
VII (Be)	Beryllium-contaminated debris	32	234
Total		2,806	26,759

4.17.2 Chemical Constituents

A variety of chemicals were used in Building 991 that might be present in the wastes. These chemical contaminants are listed in Table 4-48.

Table 4-48. Chemical contaminants used in Building 991 (RF-P084, RF-P085).

Constituent	Process/Use (if known)
Organic Compounds	
Trichloroethylene	Final assembly
Acetone	Final assembly
Metals	
Plutonium	Final assembly
Highly enriched uranium	Final assembly

Table 4-48. (continued).

Constituent	Process/Use (if known)
Depleted uranium	Final assembly
Beryllium	Final assembly
Lead	Lead-based paints
Other Chemicals/Constituents	
Triple C Cleaner	Unknown
Glue	Unknown
Paint	Unknown
Lubribrand A	Unknown
Sodium Bicarbonate	Unknown
Ultrasonic coupling gel	Nondestructive testing
Developer solutions and cleaner	Nondestructive testing
Photographic fixer	Nondestructive testing
Film	Nondestructive testing
Dye penetrant	Nondestructive testing
Dye penetrant cleaner	Nondestructive testing

4.17.3 Radionuclides

The radioisotopes that may be present in wastes generated in Building 991 processes are listed in Table 4-49. Radioisotopic content for individual wastes or specific to RFP buildings cannot be determined. However, radioisotopic content for all RFP waste is discussed in detail in Section 6.

Table 4-49. Radionuclides expected to be present in Building 991 Waste (RF-P041).

Radionuclides	
Am-241	Pu-242
Pu-238	U-235
Pu-239	U-238
Pu-240	U-234
Pu-241	U-236

4.18 OTHER RFP WASTES

Four additional generator designators (870, 871, 872, and 892) were used on load lists and entered accordingly in WasteOScope. The waste containers identified for these generator designations are shown in Table 4-50. No RFP buildings for the 1954 through 1970 time frame were identified for these numbers. However, the waste associated with these designations was identified as 'oil waste' from the descriptions included in WasteOScope for the entries. All of these waste containers were shipped to the INEEL on either June 13 or June 27, 1962.

Table 4-50. Waste containers identified for the additional generator designators (870, 871, 872, and 892).

Waste Type	Waste Description	870 Oil Waste		871 Oil Waste	
		Container Count	Volume (ft ³)	Container Count	Volume (ft ³)

I	Combustibles	0	0	0	0
I & V	Combustibles & non-combustibles	0	0	0	0
II	Filter paper	0	0	0	0
III	Filters	0	0	0	0
IV	Inorganic sludges	0	0	0	0
V	Non-combustibles	56	412	0	0
VI	Organic wastes	1	7	1	7
VII (Be)	Beryllium-contaminated debris	0	0	0	0
Total		57	419	1	7

Waste Type	Waste Description	872 Oil Waste		892 Oil Waste	
		Container Count	Volume (ft ³)	Container Count	Volume (ft ³)
I	Combustibles	0	0	12	88
I & V	Combustibles & non-combustibles	0	0	0	0
II	Filter paper	0	0	0	0
III	Filters	0	0	0	0
IV	Inorganic sludges	0	0	0	0
V	Non-combustibles	0	0	0	0
VI	Organic wastes	1	7	0	0
VII (Be)	Beryllium-contaminated debris	0	0	0	0
Total		1	7	12	88

4.19 Off-Site Wastes Trans-shipped to the INEEL by Rocky Flats Plant

In June 1957, the Rocky Flats AEC Office granted permission to the DOW Chemical Company to accept wastes generated by local off-site institutions and government agencies (e.g., universities, private industry, and defense agencies). Over the period from 1957 through 1970, off-site wastes were received at RFP and trans-shipped to the INEEL (RF-U029, RF-P085) from the industries and agencies listed in Table 4-51.

Table 4-51. Other off-site generators and the acronyms used on shipping documents (RF-U169).

Acronym	Off-Site Waste Generators
BOR	U.S. Bureau of Reclamation
CPC	Coors Porcelain Company
CUM	University of Colorado Medical Center
DOI	U.S. Department of the Interior
DOW	DOW Construction
DRI	Denver Research Institute
GE	GE Sandia
LAFB	Lowry Air Force Base
LRL	Lawrence Radiation Lab
Martin	Martin Aircraft

Table 4-51. (continued).

Acronym	Off-Site Waste Generators
SOM	Colorado School of Mines
SUN	Sunstrand Manufacturing
TOSCO	The Oil Shale Corporation
USGS	US Geological Survey
VA	Veterans Administration Hospital

Information about the types and amounts of wastes received at RFP from off-site waste generators is limited except for the Coors Porcelain Company wastes. Most of the information presented in this section for these wastes was taken from the Chem Risk Final Draft Report, dated August 1992 (RF-P085).

4.20 Coors Porcelain Company of Golden Colorado

The Coors Porcelain Company (CPC) of Golden, Colorado contracted with AEC in 1960 to manufacture beryllium and beryllium-uranium fuel elements and processed about 225 kg of uranium-235 in making unfueled beryllium and fueled beryllium-uranium elements for a Lawrence Livermore Laboratory designed reactor (Pluto Program). Agreements were reached with the AEC to allow CPC to dispose of Pluto liquid program wastes at RFP, and to use RFP as an intermediate stopping point for solid wastes destined for federally approved radioactive waste burial grounds. Solid wastes with low-level uranium contamination from CPC were received at RFP for shipment to INEEL. Records indicate that twenty-six 55-gal drums of low-level uranium contaminated waste, and some enriched uranium contaminated government-furnished "excessed" equipment associated with the Pluto Program, were shipped to Idaho for ultimate disposal from 1964 to 1970 (RF-P085, RF-C062, RF-U169). Eleven of the drums contained beryllium oxide extruder or fired scrap and the other 15 drums contained HEU contaminated combustible and non-combustible wastes. These drums contained a total of approximately 5 g of HEU. The total volume of CPC waste trans-shipped to the INEEL at that time was estimated to be 521.85 ft³. Additional contaminants identified in one drum of extruder scrap and the drums of debris are Methocel 400 (methylcellulose or cellulose methylether), butyl stearate, and water. It was assumed that the CPC waste drums were lined with one (1) plastic drum liner or bag (RF-C062, RF-P055). Thirty-two 55-gal drums and one carton of wastes received at the RFP in 1969 from off-site generators were attributed to a combination of generators: DOW Construction, USGS, U.S. Department of Interior, VA Hospital, TOSCO, Rocky Mountain Arsenal, and CPC. No descriptions of the waste contained in these containers or any other information were found (RF-P085, RF-C245).

The Lawrence Livermore CPC contract was terminated in 1964 and the fuel element fabrication project was abandoned; however, an additional forty-four 55-gal waste drums from CPC were reported received at RFP in 1970. These containers were not included in WasteOScope and it is assumed that if they were trans-shipped to the INEEL, they were put in retrievable storage at the RWMC and are not included as part of this report (RF-U115, RF-U0169, RF-P085).

4.21 Colorado School of Mines

Wastes were trans-shipped by RFP for the Colorado School of Mines Research Institute (SOM) to the INEEL from 1960 through 1964. These wastes were generated from research projects conducted for either American Metal Climax, Inc of Denver Colorado, or for the Atomic Energy Commission, Division of Isotopes Development. Research for the American Metal Climax, Inc. involved the development of rapid analytical techniques for trace elements in ore samples. One set of environmental (rock) samples

and molybdenite concentrates were sent to the Argonne National Reactor in Argonne, Illinois for neutron activation and analyzed for trace elements. Waste from this project may contain small quantities of chemicals used in analysis such as nitric, sulfuric, and hydrochloric acids, and toluene, 1,4-bis-2,5-phenyl oxazolyl benzene, p-terphenyls, and other scintillation solutes. Complete information concerning materials used in isotopic separations and solvent extractions were not available.

Research conducted for the AEC was concerned with evaluating large volume beta and gamma detection systems for process stream analysis and automation. Waste from these projects included the radioisotope sources (cobalt-60, cesium-137), and general laboratory waste (e.g., paper, glassware). The wastes may be contaminated with scintillation solutes, or toluene. A second aspect of the research conducted for the AEC was the evaluation of various radioisotope tags in aqueous and organic fluids, and in slurries typical of those encountered in the mining, chemical, and metallurgical industries. Waste from this project generally consisted of irradiated pipe inserts, paper wipes, and broken glassware. The contaminated slurries used in the experiments were disposed of on-site at the SOM. It is believed that no chemical waste from this aspect of the research was part of the radioactive waste sent to the INEEL.

During 1963 and 1964, the SOM conducted classified research for the Defense Atomic Support Agency, of Tonopah, Nevada. The purpose of the research was to determine the distribution of special nuclear materials in various soil size fractions due to a high explosive detonation. Four 55-gal steel drums of plutonium-contaminated wastes from this project were packaged and sent to the RFP for disposal (RF-C065). Dry waste, such as unused portions of 25 soil samples, contaminated paper, and glassware, and potentially an unknown number of Vycor beakers, was packaged in two drums. Each Vycor beaker may have contained up to 350 ml of 4M HCl acid. The other two drums contained wet wastes from decontamination of sampling equipment. The decontamination solutions consisted of a mixture of water, Alconox™, and acetone. Liquids were treated with an unknown flocculant (RF-C065).

The AK source document information and the shipping records as detailed in WasteOScope do not agree. Based on attachments provided with the Clements correspondence dated January 22, 1980 (RF-C065), two 55-gal waste drums were shipped from the SOM to RFP and trans-shipped to the INEEL. These drums were received and buried in November 1962. It is assumed that this shipment was radioactively contaminated waste generated from the research conducted for the AEC and contained the Cs-137 and Co-60 sources and general laboratory wastes. This shipment is not included in WasteOScope. The three shipments documented in WasteOScope from the SOM included five 55-gal drums; two drums shipped in April 1964, two drums shipped in June 1964, and one drum shipped in March 1965. The three shipments totaled 36 ft³ of waste. It is assumed that the four 55-gal drums of plutonium-contaminated wastes generated for the Defense Atomic Support Agency are those that were in the April and June 1964 shipments to the INEEL. The fifth drum of waste shipped in March 1965 was identified in WasteOScope as containing Type I combustible wastes and is assumed to also have been generated during this research project.

4.22 University of Colorado Medical Center

Minimal information was found in the AK record for the other off-site generators identified. A March 29, 1962 letter (RF-C100) regarding University of Colorado Medical School (CUM) advised that RFP would accept radioactively-contaminated solid wastes. The letter included instructions that dead animal carcasses preserved with formaldehyde should be wrapped air-tight in polyethylene to keep the odor 'nuisance' to a minimum and that other wastes should be packaged in open head 55-gal drums. Only one 55-gal drum is identified in WasteOScope for this generator that was shipped in 1964. However, wastes were received by RFP from the CUM in 1962 and 1964. The first contaminated wastes were received on July 5, 1962, and three additional 55-gal drums were received at RFP in 1964 (RF-U115, RF-P085). The radionuclide contaminants were not identified in any of these documents. It is assumed for

this report that radioisotopes were used as tracers in animal studies performed at the CUM. Common tracers used in medical research are carbon-14, tritium, and potassium-40. Additional nuclides that may also have been researched at that time are some of the actinides; plutonium-239, uranium-235, americium-241, and neptunium-237 based on radioisotopic constituents in biomedical wastes shipped from the Lawrence Livermore Laboratory to the INEEL WGS (RF-C246).

4.23 Denver Research Institute

The Denver Research Institute (DRI), a laboratory affiliated with the University of Denver, sent very small amounts of radioactive waste material to RFP. The radioactive materials were used in chemistry classes in the 1950s. There are 39 debris waste containers attributed to DRI in WasteOScope. There is no additional information in the AK record that indicates the contaminants of this waste. A 1971 letter sent to the DRI (RF-C150) from RFP outlined waste acceptance criteria for five 55-gal drums of beryllium-oxide-contaminated solid waste and does not apply to the wastes addressed by this report. The beryllium-oxide-contaminated solid wastes were generated after the date that INEEL stopped accepting LLW or wastes from generators other than RFP. The USGS operated a small nuclear reactor beginning in 1969 at the Denver Federal Center that may have generated radioactive wastes that were trans-shipped to the INEEL by RFP (RF-C105). The WasteOScope data includes 25 debris waste containers for the USGS during the 1954 through 1970 timeframe (RF-U169).

4.24 DOW Construction (U.S. Food and Drug Administration, U.S. Department of Interior, The Oil Shale Corporation, and VA Hospital)

Additional off-site generators identified in AK source documents but not identified in WasteOScope include the U.S. Food and Drug Administration, the U.S. Department of Interior, The Oil Shale Corporation (TOSCO), and the VA Hospital. The wastes from these generators are assumed to have been included in the data under the DOW Construction generator acronym since additional generating facilities were identified with the DOW acronym for some of the waste shipped to the INEEL in several of the AK source documents. For example, in 1961, RFP accepted a radioactively contaminated steel chest containing an assortment of filters and crucibles, a lead sheet, paper, and other miscellaneous debris items from the U.S. Food and Drug Administration. The chest and debris waste contained approximately 0.1 mg of radium-226. Disposal of the chest and contents were to be disposed of as part of RFP's normal waste to be sent to the 'Reactor Test Site in Idaho' (INEEL) for burial (RF-C101). In 1966, one 30-gal drum of beryllium-contaminated waste was attributed to the Bureau of Land Management. In 1970, twenty-five 55-gal drums of oil shale residue were received and buried in Pit 11. This waste was identified as Type I and Type V debris. It is assumed that this waste was generated by TOSCO (RF-C064). Based on these references, it is assumed that the radioactively contaminated chest, the beryllium-contaminated waste, and the oil shale residue waste were included in the WasteOScope waste volume for the DOW generator acronym.

The materials trans-shipped by RFP for off-site generators were shipped in a variety of containers (i.e., 15-, 20-, 30-, and 55-gal drums, CWS filters in cartons, cartons of debris, and wooden boxes of equipment; RF-P085, RF-U115, RF-U169). It is assumed based on the AEC agreement to allow RFP to aid these facilities/institutions in the disposal of their radioactive and/or hazardous wastes that the wastes were hazardous, low-level radioactive, mixed-low level radioactive, and TRU wastes. A summary of the WasteOScope entries for the wastes from off-site generators trans-shipped by RFP is presented in Table 4-52.

Table 4-52. Summary of the WasteOScope entries for the off-site generators waste trans-shipped by RFP.

Waste Type	Waste Description	Bureau of Reclamation		Coors Porcelain	
		Container Count	Volume (ft ³)	Container Count	Volume (ft ³)
I	Combustibles	0	0	0	0
I & V	Combustibles & non-combustibles	0	0	0	0
II	Filter paper	0	0	0	0
III	Filters	0	0	0	0
IV	Inorganic sludges	0	0	0	0
V	Non-combustibles	2	21	0	0
VI	Organic wastes	0	0	0	0
VII (Be)	Beryllium-contaminated debris	0	0	26	191
Total		2	21	26	191

Waste Type	Waste Description	Colorado University School of Medicine		DOW Construction	
		Container Count	Volume (ft ³)	Container Count	Volume (ft ³)
I	Combustibles	1	7	849	11,598
I & V	Combustibles & non-combustibles	0	0	18	132
II	Filter paper	0	0	5	26
III	Filters	0	0	3,903	18,435
IV	Inorganic sludges	0	0	891	6,942
V	Non-combustibles	0	0	1,314	22,494
VI	Organic wastes	0	0	0	0
VII (Be)	Beryllium-contaminated debris	0	0	16	185
Total		1	7	6,996	59,812

Waste Type	Waste Description	Denver Research Institute		Lowry AFB	
		Container Count	Volume (ft ³)	Container Count	Volume (ft ³)
I	Combustibles	13	92	92	133
I & V	Combustibles & non-combustibles	0	0.00	0	0
II	Filter paper	0	0.00	0	0
III	Filters	2	25	0	0
IV	Inorganic sludges	0	0	0	0
V	Non-combustibles	11	77	6	19
VI	Organic wastes	0	0	0	0
VII (Be)	Beryllium-contaminated debris	4	22	0	0
Total		30	216	98	152

Table 4-52. (continued).

Waste Type	Waste Description	Lawrence Research Lab		Colorado School of Mines	
		Container Count	Volume (ft ³)	Container Count	Volume (ft ³)
I	Combustibles	42	309	4	29
I & V	Combustibles & non-combustibles	0	0	0	0
II	Filter paper	0	0	0	0
III	Filters	0	0	0	0
IV	Inorganic sSludges	0	0	0	0
V	Non-combustibles	0	0	1	7
VI	Organic wastes	0	0	0	0
VII (Be)	Beryllium-contaminated debris	0	0	0	0
Total		42	309	5	36

5. SUMMARY OF “AS-DISPOSED” WASTE TYPES AND VOLUMES DISPOSED AT THE INEEL

When disposal at the INEEL RWMC SDA began over 50 years ago, requirements and practices did not include the current waste characterization requirements, so complete information about the waste was not supplied by the generators prior to disposal. The SDA burial ground was designed with two types of burial; trenches and pits that were excavated periodically as required for waste disposal.

Trenches were dug in a straight line about 5 ft wide and approximately 5 to 20 ft deep (i.e., down to the basalt). At first drums were stacked neatly, and wooden spacers were used to keep the sides of the trenches from caving in as drums were placed in the trench. When the spacer was filled, it was removed, and soil was backfilled around the drums. Eventually, drums and other containers (e.g., cardboard and wood boxes) were dumped into the trenches without stacking or use of spacers. As the trenches were filled, excavation either elongated or widened the trench as needed. As an example, the final dimensions of Trench 10 are 415 ft long on one side; 420 ft long on the opposing side with ends measuring approximately 60 and 70 ft. Trenches were dug in the high clay content areas. Wastes with high radioactivity (determined by external dose rate) were preferentially placed in trenches (RF-C078).

Pits were dug in more sandy areas of the burial ground on the order of 30 × 30 ft down to the basalt (approximately 5 to 20 ft deep). Pits were used for materials with relatively low radioactivity based on external dose (RF-C078).

A review of the waste type designations used in this report is presented in the following subsections. The results of the tabulation of the as-disposed container counts and waste volumes for each of these waste types are summarized in Table 5-1 for each of the pits and trenches. A correlation of the waste type designators used in shipping records and trailer load lists as entered in WasteOScope and the final waste types described in this report was previously provided in Table 3-4. This correlation is also provided in Appendix A in Tables A-2, A-3, A-4, and A-5, which are the results of summarizing the WasteOScope data for each building, off-site generator, pit, and trench, respectively.

5.1 Debris Waste

Debris waste is comprised of combustible and non-combustible waste items. The different categories of debris waste are Waste Types I, II, III, V, and VII as described in more detail in Section 3.4. It is assumed that the containers for each of the five types of debris wastes sent to the INEEL contained 50% or greater by volume debris waste. For those containers identified as containing both Types I and V waste, it is assumed that the volume of the two types would be equal for the identified containers. A summary of all container counts and waste volumes in cubic feet from WasteOScope is presented for each pit and each trench for each of the waste type designations in Tables 5-1 and 5-2 respectively. This includes all of the waste sent from RFP including the off-site generator wastes.

5.1.1 Waste Type I

Waste Type I was used to identify combustible debris wastes such as paper, rags, wood, etc. In some of the AK source documents, individual containers of combustible wastes were also defined as housekeeping wastes (RF-C028) or identified by other types of designators (such as alpha characters D&W) on the shipping records and in WasteOScope (RF-U169).

WasteOScope has a total of 94,148 containers with a gross volume of 1,062,219 ft³ of Type I waste shipped to the INEEL from RFP. The breakdown of volume for the wastes, as buried in the SDA, is 1,006,138 ft³ in the pits and 56,082 ft³ buried in the trenches (see Tables 5-1 and 5-2; RF-U169).

5.1.2 Waste Type II

Waste Type II consists of filter paper, including fiber/fibrous pads (containing asbestos), and non-HEPA filters. Filter paper waste was also identified with an alpha category, “A,” for filter paper generated from Building 444. In the 1960s, machine coolants and other process liquids were filtered using filter paper, but the use of filter paper declined in the 1960s, and as a result, significantly reduced the volume of this type of waste (RF-C026, RF-C032, RF-C045, RF-C124, RF-C140, RF-D001, RF-U095, RF-U115, RF-U169).

WasteOScope has a total of 2,092 containers with a gross volume of 21,562 ft³ of Type II waste shipped to the INEEL from RFP. The breakdown of volume for the wastes as buried in the SDA is 12,749 ft³ in the pits and 8,813 ft³ buried in the trenches (see Tables 5-1 and 5-2; RF-U169).

5.1.3 Waste Type III

Waste Type III consists of filters and filter media, including CWS and HEPA filters from glove boxes and facility ventilation systems. The CWS filters were eventually replaced by HEPA filters (RF-U115). The majority of filter wastes were identified in the database under Waste Type III, but process waste filters generated from Building 444 were also identified with an alpha category “K” and are included under the Waste Type III designation.

WasteOScope has a total of 13,354 containers with a gross volume of 144,118 ft³ of Type III waste shipped to the INEEL from RFP. The breakdown of volume for the wastes as buried in the SDA is 10,564 ft³ in the pits and 127,815 ft³ buried in the trenches (see Tables 5-1 and 5-2; RF-U169).

5.1.4 Waste Type V

Waste Type V consists of non-combustibles, such as glass, scrap metal, firebrick, spent equipment, wire, electric motors, piping, sheet metal, glove boxes, glove box material, tantalum molds, and roaster oxide (P047, U115). The following wastes are also identified as Waste Type V:

- Noncombustible debris; glass, scrap metal, brick, equipment, metal based objects, wire, electric motors, piping, sheet metal, graphite molds, DU, steel, aluminum, ion-exchange resins, glove boxes, glove box parts
- Five thousand three hundred and five (5,305) empty drums, identified in WasteOScope with generator codes of 774 or 746, and a waste type V designation.
- Cemented cyanide or cyanide cement from Building 444 (database designations ‘M’, ‘CC’, and ‘CM’) were identified as Type V waste, therefore it was assumed that this waste consists of pieces of cyanide cement produced (man-made) in Building 444 processes (RF-U115).
- Concreted (cemented) raffinate (database designation ‘CR’); the majority of the raffinate (liquid waste) was sent to Building 774 for inclusion in first stage processing. The Type V cemented raffinate consists of small quantities of cemented raffinate packaged in small containers.

- Miscellaneous noncombustible solid wastes from Building 444 (database designation ‘N’) and identified as a Type V.
- Slag heel (database designation ‘SH’); slag heels were the solid material (dross) scraped or removed from crucibles or molds after plutonium button removal (RF-U115).
- Metal or cemented firebrick (database designation ‘C’)
- Roaster oxide, identified in WasteOScope as RO, or mixed with organics (oils) as ‘L’; this waste consists of DU sheet trimmings and other residues, e.g., DU metal or alloy pieces oxidized by calcining or roasting (RF-U115).
- 1957 and 1969 fire wastes in the form of process equipment and other large items (RF-P047).

WasteOScope has a total of 71,194 containers with a gross volume of 1,122,351 ft³ of Type V waste shipped to the INEEL from RFP. The breakdown of volume for the wastes, as buried in the SDA, is 1,074,877 ft³ in the pits and 47,474 ft³ buried in the trenches (see Tables 5-1 and 5-2; RF-U169).

5.1.5 Combined Waste Types I and V

In WasteOScope, containers were identified as both Waste Types I and V for entries designated on the load lists and in the database with waste designations of F, FW, G (Building 771), graphite, LGW (line-generated waste), or U233. The description of container contents indicates both Type I (combustible debris) and Type V (non-combustible debris) waste are present in the containers. These waste type descriptors were also described in AK source documents as pertaining to both combustible and non-combustible wastes (RF-D001). Brief descriptions for the alpha designations for the combination Type I and V wastes are as follows:

- Graphite, Building 771 designation G, Building 444 designation F: includes HEU (Oralloy) graphite, Graphite molds, crucibles and combustibles (Building 881), mixed with combustibles.
- FW: Boxes of fire waste from the 1969 fire.
- U233: uranium contaminated debris may contain Type I Waste, Type V Waste, or a combination of the two.
- LGW: Line generated waste may contain Type I Waste, Type V Waste, or a combination of the two.

WasteOScope has a total of 7,054 containers with a gross volume of 60,238 ft³ for the combined Type I and Type V wastes shipped to the INEEL from RFP. The total volume for the Type I & V combination wastes are buried in the SDA pits (see Tables 5-1 and 5-2; RF-U169).

5.1.6 Waste Type VII

Use of the Roman numeral designation, VII, to denote beryllium-contaminated waste is unique to this report. The Type VII containers are beryllium-contaminated debris wastes identified in WasteOScope as Be, Be(I), Be(II), Be(V), etc. Beryllium wastes were often commingled with DU and other radioactive materials shipped to the INEEL.

The majority (93%) of the Type VII waste containers identified were generated from Building 444 (2,412 containers; 19,224 ft³), with containers of Type VII waste also generated from Buildings 331, 441, 771, 881, 883, and from Building 774. Additionally, there were debris wastes identified with a 742 (sludge) or a 746 (empty container) generator designation and a Be waste type in WasteOScope. Beryllium-contaminated wastes were also generated by off-site generators, but in minor amounts. The total volume or mass of beryllium or beryllium oxide shipped to the INEEL is unknown. However, it was estimated that during production, the casting process might have generated 3 to 7 kg/day of waste beryllium or beryllium oxide in the form of skulls (casting residues). In addition to skulls, impure or damaged castings that could not be salvaged were periodically included in the waste drums (RF-P047). All of the beryllium-contaminated waste is assumed to be low-level radioactive waste and was buried in the pits (RF-U169).

The WasteOScope database has a total of 2,592 containers with a gross volume of 20,784 ft³ with a waste type designation of Be shipped to the INEEL from RFP. All of these waste containers were buried in the SDA pits. Beryllium-contaminated debris waste as compiled for this report under the Waste Type VII designation, as recorded in WasteOScope, makes up less than 1% of the total volume of debris waste shipped by RFP to the INEEL from 1954 through 1970 as calculated below (RF-U169):

$$\% \text{ of total volume of debris waste (Type VII)} = \text{total Type VII (20,784 ft}^3\text{) / Total debris volume (2,431,272 ft}^3\text{)} \times 100 = 0.85\%$$

Where:

$$\text{Total volume debris wastes} = 1,062,219 \text{ (Type I)} + 60,238 \text{ (Types I \& V)} + 21,562 \text{ (Type II)} + 144,118 \text{ (Type III)} + 1,122,351 \text{ (Type V)} + 20,784 \text{ (Type VII)} = 2,431,272$$

5.2 Homogeneous Solid Waste

RFP homogeneous solid wastes consist of inorganic and organic sludges. The sludges were typically contaminated with long-lived alpha emitting radionuclides and other radioisotopes and chemical constituents (RF-C-132).

5.2.1 Waste Type IV

The Waste Type IV sludge wastes refer mainly to the series of inorganic sludges produced by the Liquid Waste Treatment Plant (Building 774). Type IV sludge waste includes the co-precipitation treatment sludge, and MUD (i.e., solids from filtration of the resulting solution from nitric acid leaching of impure materials contaminated with HEU; RF-U115).

Inorganic sludges were also identified on load lists (shipping records) as 74 series sludges and carry generator designations that identify the specific sludge; 741 for First Stage Sludge, 742 for Second Stage Sludge, 744 for Solidified off-specification aqueous liquids, and 745 for Evaporator Salts. The inorganic sludges and the stages associated with each type of sludge are described briefly below (RF-C114, RF-U115). The wastes and the generating processes are described in greater detail in Sections 3.4.2 and 4.10, respectively.

- **741 Sludge:** The first stage sludge was generated during the first stage of a two-stage ferric hydroxide carrier precipitation process for removal of radioactive constituent.

- **742 Sludge:** The first stage effluent was collected as feed along with liquid wastes from the other building generators for the second stage of the precipitation process. The resulting solids from the second precipitation processes were drummed as second stage sludge.
- **744 Sludge:** Other aqueous waste solutions processed in Building 774 that did not meet the feed specifications for first and second stage treatment were processed directly and identified as 744 sludge.
- **745 Sludge:** Concentrated salt liquids from the evaporator located in Building 774 were designated as 745 sludge.

WasteOScope has a total of 33,936 containers with a gross volume of 245,925 ft³ of Type IV waste shipped to the INEEL from RFP. The volume breakdown for the wastes, as buried in the SDA, is 209,704 ft³ in the pits and 47,474 ft³ buried in the trenches (see Tables 5-1 and 5-2; RF-U169).

5.2.2 Waste Type VI

Waste Type VI consists of containers of oil and organic liquid wastes, as well as treated organic liquid wastes. The organic wastes include coolant still bottoms, perchloroethylene still bottoms generated in Building 444 (Building 444 designation G), contaminated waste oil, and organic sludge generated from Building 774 liquid waste treatment activities, identified as 743 sludge. For this report, all of the wastes identified as being organic wastes have been tabulated under this designation.

WasteOScope has a total of 9,605 containers with a gross volume of 69,494 ft³ of Type VI waste shipped to the INEEL from RFP. The volume breakdown for the wastes, as buried in the SDA, is 62,711 ft³ in the pits and 69,494 ft³ buried in the trenches (see Tables 5-1 and 5-2; RF-U169).

Table 5-1. Breakdown of the as-disposed waste containers and waste volumes (ft³) presented for each waste type for each pit.

Waste ID	Pit 1		Pit 2		Pit 3		Pit 4	
	Container Count	Volume (ft ³)						
I	11,099	85,398	12,946	98,571	3,222	23,762	19,530	152,589
I and V	406	2,573	155	1,136	0	0	610	4,598
II	278	1,592	117	1,030	12	396	82	601
III	3,032	13,199	2,281	11,368	32	235	2,617	24,455
IV	2,979	21,918	3,883	28,552	805	5,945	5,829	44,257
V	5,287	53,746	7,277	79,624	1,392	16,481	11,091	136,576
VI	115	615	0	0	0	0	3,471	25,509
VII (Be)	88	652	532	3,987	155	1,154	719	5,608

Table 5-1. (continued).

Waste ID	Pit 5		Pit 6		Pit 7		Pit 8	
	Container Count	Volume (ft ³)						
I	11,148	104,738	6,322	76,469	0	0	0	0
I and V	271	1,988	143	1,053	0	0	9	66
II	29	210	14	103	0	0	0	0
III	1,007	21,782	276	4,690	0	0	0	0
IV	2,929	21,618	3,768	27,703	0	0	0	0
V	7,386	155,346	9,670	149,886	3	22	0	0
VI	28	206	2,509	18,450	0	0	0	0
VII (Be)	720	6,304	85	624	0	0	0	0

Waste ID	Pit 9		Pit 10		Pit 11		Pit 12	
	Container Count	Volume (ft ³)						
I	3,330	86,554	18,276	361,928	90	10,080	54	6,048
I and V	149	1,095	5,321	47,802	0	0	0	0
II	0	0.00	224	4,786	0	0	36	4,032
III	109	4,955	551	42,014	641	3,101	18	2,016
IV	839	6,439	7,607	52,037	4	29	16	118
V	3,624	78,682	18,810	387,675	90	10,080	62	7,280
VI	1,171	8,609	1,258	9,248	0	0	0	0
VII (Be)	5	37	288	2,117	0	0	0	0

Waste ID	Pit 13		Total Waste in Pits	
	Container Count	Volume (ft ³)	Container Count	Volume (ft ³)
I	0	0	86,017	1,006,138
I and V	0	0	7,054	60,238
II	0	0	792	12,749
III	0	0	10,564	127,815
IV	0	0	28,807	209,704
V	76	558	64,620	1,074,877
VI	0	0	8,562	62,711
VII (Be)	0	0	2,592	20,784

Table 5-2. Breakdown of the as-disposed waste containers and waste volumes (ft³) presented for each waste type for each trench.

Waste ID	Trench 1		Trench 2		Trench 3		Trench 4	
	Container Count	Volume (ft ³)						
I	1,068	4,919	474	3,249	660	4,844	866	6,255
I and V	118	516	0	0	75	551	0	0
II	0	0	0	0	58	426	751	5,516
III	0	0	0	0	1,005	5,502	830	6,087
IV	839	4,366	99	728	292	2,148	1,257	9,236
V	819	3,956	471	3,288	295	2,121	1,812	12,920
VI	0	0	0	0	0	0	0	0
VII (Be)	0	0	0	0	0	0	0	0

Waste ID	Trench 5		Trench 6		Trench 7		Trench 8	
	Container Count	Volume (ft ³)						
I	1,079	7,230	1,107	7,485	656	4,811	703	4,435
I and V	187	1,310	184	1,315	116	853	176	1,173
II	87	621	21	145	23	168	67	382
III	130	826	1	7	2	9	820	3,862
IV	474	3,417	561	4,122	431	3,167	377	4,256
V	645	4,661	541	3,928	333	2,454	478	66
VI	0	0	0	0	0	0	0	0
VII (Be)	0	0	0	0	0	0	0	0

Waste ID	Trench 9		Trench 10		Trench 19		Trench 32	
	Container Count	Volume (ft ³)						
I	929	6,741	255	2,294	26	1,539	308	2,278
I and V	187	1,066	0	0	0	0	0	0
II	82	331	211	1,223	0	0	0	0
III	2	9	0	0	0	0	0	0
IV	441	3,238	206	1,493	0	0	152	1,124
V	531	3,908	467	3,224	26	1,539	156	1,154
VI	0	0	0	0	0	0	0	0
VII (Be)	0	0	0	0	0	0	0	0

Table 5-3. (continued).

Waste ID	Trenches Totals		Totals for Pits and Trenches	
	Container Count	Volume (ft ³)	Container Count	Volume (ft ³)
I	8,131	56,082	94,148	1,062,219
I and V	0	0	7,054	60,238
II	1,300	8,813	2,092	21,562
III	2,790	16,303	13,354	144,118
IV	5,129	36,221	3,336	245,925
V	6,574	47,474	71,194	1,122,351
VI	1,043	6,783	9,605	69,494
VII (Be)	0	0	2,592	20,784

5.3 Correlation of Rocky Flats Plant Waste Streams

The AK information about the various wastes (debris and homogeneous waste types) generated from each building as described in the previous sub-sections is used in this section to provide a preliminary evaluation of its hazardous properties. This waste is also subject to the WIPP WAP. Any WIPP-specific requirements are also addressed.

5.3.1 Hazardous Determination

A preliminary hazardous waste determination based upon the AK, the RCRA regulations, and the WIPP permit, including the WIPP WAP, is presented in this section. Chemicals used and produced, waste generation processes, and waste stream information were incorporated into this preliminary determination. The hazardous waste determination will not be final until waste stream profiles are approved for shipment of the waste to WIPP. It will continue to be refined as more data about the waste becomes known.

The compilation of all chemical constituents identified as being used at RFP in processing and/or waste generation during 1954 through 1970 are presented in Table 5-3. This table is a listing of chemical compounds, products, and non-radioactive metals identified as being used in some manner at the RFP plant. Where applicable, RCRA hazardous waste numbers (HWNs) identify those constituents that are regulated under RCRA as either characteristic or listed. The wastes were shipped to the INEEL prior to RCRA, and under DOT regulations for radioactive waste that did not require chemical identification or other contaminants. The HWNs identified in Table 5-3 are based upon a comparison of RFP waste generation with current RCRA hazardous waste identification requirements. Association of a RCRA HWN with a particular constituent is the initial step in the process of determining what HWN will be assigned. Further refinement of the HWNs can be conducted based upon the AK, as described in this section. Final assignment of HWNs will occur through approval of waste streams for shipment to WIPP, and will be based upon additional characterization information. The waste generation processes and waste stream information considered in this section are described in further detail in subsequent sub-sections of this report.

Contaminants with RCRA HWNs are identified for each of the buildings or for each generator designation and are presented in Table 5-4. Specific chemicals used were not identified for some of the buildings (i.e., 122, 551, and 553), generators (i.e., 870, 871, 872, and 892), or for the off-site generators during the review of the AK source documents and other available information sources. Based on the

information compiled, HWNs were identified for the different waste types and are summarized in Table 5-5.

5.3.1.1 Ignitability. An ignitable characteristic waste is defined in the RCRA regulations (40 CFR 261.21) as follows:

A solid waste exhibits the characteristic of ignitability if a representative sample of the waste has any of the following properties:

1. It is a liquid, other than an aqueous solution containing less than 24 percent alcohol by volume and has a flash point less than 60°C (140°F), as determined by a Pensky-Martens Closed Cup Tester, using the test method specified in ASTM Standard D-93-79 or D-93-80 (incorporated by reference, see Sec. 260.11), or a Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D-3278-78 (incorporated by reference, see Sec. 260.11), or as determined by an equivalent test method approved by the Administrator under procedures set forth in Secs. 260.20 and 260.21.
2. It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard.
3. It is an ignitable compressed gas as defined in 49 CFR 173.300 and as determined by the test methods described in that regulation or equivalent test methods approved by the Administrator under Secs. 260.20 and 260.21.
4. It is an oxidizer as defined in 49 CFR 173.151.

With the exception of lithium perchlorate, the chemical products listed in Table 5-3 and identified with HWN D001 are ignitable only in their liquid form. The combustible debris, filter paper, filters and filter media, and non-combustible debris wastes and the sludge waste forms are not liquid wastes and will not ignite through friction, moisture adsorption, or chemical changes.

Therefore, HWN D001 is not identified for the debris waste. Sludge drums contain the products identified on Table 5-3 as HWN D001. Sludges identified as containing excess free liquids (>1% liquids) may have the ignitable characteristic.

In 1966, lithium perchlorate was used in Building 779 as part of a study of the kinetics of the reaction of plutonium with xenon trioxide in a perchlorate media. Lithium perchlorate was used to maintain a constant ionic strength (RF-U208). Lithium perchlorate is not expected to be found in any debris waste. Unused amounts of the reagent from the study may have been processed as part of the liquid waste stream sent from B779 to B774, and it would be present in the inorganic (741 and 742) sludges generated during that time. Lithium perchlorate is a potential ignitable agent when in its crystalline form in the presence of combustible materials. The sludges generated from B774 are not expected to contain combustible materials. Therefore, the HWN D001 is not identified for sludges from B774.

The AK indicates that nitrate salt wastes, potential DOT oxidizers, were generated as a residue from an evaporator used for aqueous waste containing high concentrations of nitrates. The evaporator commenced operation in Building 774 in 1967 (RF-C053). These salt wastes are identified as 745 sludge waste containing 60% sodium nitrate, 30% potassium nitrate, and 10% other (RF-P047). Containers in this series are identified with the HWN D001.

Table 5-4. Chemical products used at RFP in processing and waste generation.

CHARACTERISTIC FOR IGNITABILITY, CORROSIVITY, AND REACTIVITY			
CONSTITUENT	Potential EPA HWN	CONSTITUENT	Potential EPA HWN
Acetic acid	D002	Lithium perchlorate	D001
Alcohol	D001	Magnesium perchlorate/sulfuric acid	D002
Ammonia gas	D002	Malonic acid	D002
Ammonium hydroxide	D002	Nitric acid	D002
Anhydrous hydrogen fluoride ¹	U134	Oxalic acid	D002
Caustic soda	D002	Perchloric Acid	D001, D002
Chromic acid	D002, D007	Phosphoric acid	D002
Denatured alcohol	D001	Potassium hydroxide	D002
Dodecane	D001	Potassium nitrate	D001
Ethanol (ethyl alcohol)	D001	Salicylic acid	D002
Ethylene glycol	D001	Sani-Phene Disinfectant ²	D001
Formaldehyde	D001	Soda lime	D002
Hexane (cyclohexane)	D001	Sodium hydroxide	D002
Hydrochloric acid	D002	Sulfamic acid	D002
Hydrofluoric acid	D002	Sulfuric acid	D002
Hydroiodic acid	D002	Uranyl ntrate	D002
Isopropanol (isopropyl alcohol)	D001	Uranyl nitrate solution (acid and enriched uranium)	D002
Lithium	D003		
F-LISTED HAZARDOUS WASTES			
1,1,1-Trichloroethane	F001, F002	Methyl ethyl ketone	F005
1,1,1-Trichloroethane (1,1,1-TCA)	F001, F002	Methylene chloride	F001, F002
Acetone	F003	Tetrachloroethylene (PCE) ³	F001, F002, D039
Benzene	F005, D018	Toluene	F005
Carbon tetrachloride	F001, F002, D019	Trichloroethane	F001, F002
Chlorofluorohydrocarbon	F001	Trichloroethane-perchloroethylene mixture (Dowclene EC, CSM-320)	F001, F002
Freon (unspecified)	F001, F002	Trichloroethylene (TCE) ⁴	D040, F001, F002
Freon 113	F001, F002	Trichlorotrifluoroethane ⁵	F001, F002
Freon 12	F001, F002	Trichlorotrifluoroethane-ethylene glycol monobutyl ether mixture (Freon TB-1)	F001, F002
Freon TF	F001, F002	Xylene	D001, F003
Methanol	D001, F003		

CHARACTERISTIC FOR IGNITABILITY, CORROSIVITY, AND REACTIVITY			
CONSTITUENT	Potential EPA HWN	CONSTITUENT	Potential EPA HWN
METALS			
Aluminum	N/A	Lithium chloride (Kathene)	N/A
Aluminum nitrate	N/A	Lithium salts	N/A
Aluminum oxide	N/A	Magnesium	N/A
Arsenic	D004	Magnesium chloride	N/A
Beryllium	N/A	Magnesium oxide	N/A
Cadmium	D006	Mercury	D009
Cadmium oxide	D006	Mercury (nitrate)	D009
Cadmium salts	D006	Molybdenum	N/A
Calcium	N/A	Nickel	N/A
Calcium chloride	N/A	Nickel (nickel sulfate crystals)	N/A
Calcium fluoride	N/A	Nickel (powder, nickelous chloride, nitrate, oxide, sulfate)	N/A
Calcium hypochlorite	N/A	Nickel carbonyl	N/A
Calcium metal	N/A	Palladium (trace)	D003
Calcium-zinc alloy	N/A	Photographic fixer	D011
Chloroform	D022	Plutonium	N/A
Chromium	D007	Potassium chromate	D007
Chromium (includes chloride, nitrate, oxide, potassium sulfate, sulfate, trioxide)	D007	Potassium dichromate	D007
Copper sulfate	N/A	Silver	D011
Cupric Sulfate	N/A	Silver nitrate	D011
Developer solutions and cleaner	D011	Sodium dichromate	D007
Ferric nitrate	N/A	Strippable paint	PCB
Ferrous sulfamate	N/A	Thorium	N/A
Ferrous sulfate	N/A	Titanium	N/A
Film	D011	Tungstun	N/A
Lead	D008	Uranium	N/A
Lithium carbonate		Vanadium	N/A
OTHER WASTE CONSTITUENTS			
“Amercoat” paint ⁶ Lead, polyisocyanate adduct &/or butyl acetate	D008	Machining coolant, vacuum pump oils	N/A
2-ethyleneoxyethanol	N/A	Magnesia cement	N/A
Ammonium bifluoride	N/A	Magnesium zirconate	N/A
Ammonium chloride	N/A	Methyl Cellosolve	N/A
Ammonium nitrate	N/A	Nalco 2536 ⁷	N/A
Ammonium sulfate	N/A	Nalco 2826 ⁷	N/A
Ammonium thiocyanate	N/A	Nitradd ⁷	N/A

CHARACTERISTIC FOR IGNITABILITY, CORROSIVITY, AND REACTIVITY

CONSTITUENT	Potential EPA HWN	CONSTITUENT	Potential EPA HWN
Ammonium thiosulfate	N/A	Nitric/Nitradd	N/A
Anchorlube ⁶	N/A	Nitrous oxide	N/A
Asbestos	N/A	Oakite ⁷	N/A
Ascorbic acid	N/A	Oakite 160 ⁷	N/A
Bismuth nitrate	N/A	Oakite 162 ⁶	N/A
Boric acid	N/A	PCB	N/A
Carbon	N/A	Potassium bromide	N/A
Cesium chloride	N/A	Potassium carbonate	N/A
Cimcool ⁷	N/A	Potassium chloride	N/A
Citric acid	N/A	Potassium ferricyanide	N/A
Cyanide standards	N/A	Potassium iodate	N/A
Dibutyl carbitol	N/A	Potassium permanganate	N/A
Dicesium plutonium hexachloride	N/A	Potassium persulfate	N/A
Dimethylamine	N/A	Powdered magnesium	N/A
Dimethyldichlorosilane	N/A	Separan (a polyacrylamide) ⁷	N/A
Dye penetrant	N/A	Shell Vitrea cutting oil ⁶	N/A
Dye penetrant cleaner	N/A	Shell Vitrea oil ⁶	N/A
Epoxy Glues	N/A	Silicone Oil	N/A
Fluorinert liquids ⁶	N/A	Sodium 2, 4-dihydroxyazbene	N/A
Fluosilicic acid ⁶	D002/U134	Sodium bicarbonate	N/A
Formula 409 ⁶	N/A	Sodium carbonate	N/A
Glue	N/A	Sodium chloride	N/A
Glycerol	N/A	Sodium fluoride	N/A
Gold	N/A	Sodium nitrate	N/A
Graphite	N/A	Sodium peroxide	N/A
Gulf BT ⁷	N/A	Sodium thiosulfate	N/A
Helium	N/A	Sulfide standards	N/A
Hollingshead 333 Cocoon ⁷	N/A	Tetrabromoethylene	N/A
Hydrazine	N/A	Texaco CX ⁷	N/A
Hydrogen peroxide (35 & 50%)	N/A	Texaco Regal oil ⁷	N/A
Hydrogen peroxide (50 & 35%)	N/A	Texaco Soluble D ⁷	N/A
Hydrogen peroxide 30%	N/A	Transul Tex 210 ⁷	N/A
Hydroxylamine hydrochloride	N/A	Tributyl phosphate	N/A
Hydroxylamine nitrate	N/A	Trichloromethane	N/A
Hydroxylamine sulfate	N/A	Trim Rinse detergent ⁷	N/A
Iodine	N/A	Trim Sol ⁷	N/A
Kerosene	N/A	Triple C Cleaner ⁷	N/A
Lube Oil/Coolants ⁷	N/A	Turco 4215 ⁶	N/A

CHARACTERISTIC FOR IGNITABILITY, CORROSIVITY, AND REACTIVITY

CONSTITUENT	Potential EPA HWN	CONSTITUENT	Potential EPA HWN
Lubribrand A ⁷	N/A	Ultrasonic coupling gel	N/A
Mac Stop 9554 ⁷	N/A	Winterfene disinfectant	N/A
Machine cutting & vacuum pump oil	N/A	Xenon trioxide	N/A
		Yttrium oxide	N/A

- (1) Hydrofluoric acid is a U134 listed constituent when disposed of as a pure chemical or product. Hydrofluoric acid was used at RFP in the processing and only spent residues would be part of the wastes.
- (2) Sani-Phene disinfectant was composed of isopropyl alcohol 23.0%, vegetable oil, O-Benzyl P-chlorophenol, methyl salicylate.
- (3) Tetrachloroethylene is also known as: PCE, perchloroethylene, chlorothene, chlorothene NU, chlorothene VG, Tri-Ethane 314, Tri-Ethane 324
- (4) Trichloroethylene is also known as TCE and is a component of products: Neu-Tri, Blacosolv, Alk-Tri, Ex-Tri
- (5) Trichlorotrifluoroethane is also known as Genesolv D, Freon MF, Freon TF.
- (6) MSDSs in file.
- (7) No MSDS on file. Data Gap

5.3.1.2 Corrosivity. A corrosive characteristic waste is defined in RCRA (40 CFR 261.22) as follows:

“A solid waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties:

1. It is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter using Method 9040 in “Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,” EPA Publication SW-846, as incorporated by reference in Sec. 60.11 of this chapter.
2. It is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55°C (130°F) as determined by the test method specified in NACE (National Association of Corrosion Engineers) Standard TM-01-69 as standardized in “Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,” EPA Publication SW-846, as incorporated by reference in Sec. 260.11 of this chapter.”

This characteristic will not apply to the debris or the homogeneous solid final waste forms because the wastes are solid and will not exhibit either of the properties listed under 40 CFR 261.22 for the corrosivity characteristic when retrieved. The debris wastes are not aqueous and will not have a pH ≤ 2 or ≥ 12.5, nor will the wastes be corrosive to steel (SAE 1020) at a rate greater than 6.35 mm (0.250 in.)/year at a test temperature of 55°C (130°F).

Many of the chemicals that carry the corrosive characteristic were used in RFP processes in a manner that would have resulted in neutralization. Ammonium hydroxide was used in the HP Laboratory in Building 123 for analytical process, and would have been neutralized (RF-P181). Magnesium perchlorate/sulfuric acid was used in Building 771 to scrub laboratory off-gas. Acetic acid, perchloric acid, chromic acid, and phosphoric acid were used in plutonium metallurgical research and development in Building 771. Soda lime was used in chemistry technology in Building 779 (RF-P040). Sodium hydroxide, phosphoric acid, acetic acid, and nitric acid were used for Building 881 cleaning and would have been spent or neutralized after use (RF-C227).

Other chemicals were used or formed in plutonium recovery and purification operations in Building 771 and in HEU recovery operations in Building 881. Chemicals identified as used are sulfuric acid (RF-P085), sulfamic acid (RF-P264, RF-U057), hydrofluoric acid, anhydrous hydrofluoric acid used in fluorination, ammonium hydroxide, potassium hydroxide, hydrochloric acid, and hydroiodic acid. Ammonia gas, uranyl nitrate, and malonic acid are also identified, but for HEU recovery only. Fluosilicic acid was produced through anion exchange and would have been in the liquid waste.

Liquids used in recovery and purification were processed until sufficient plutonium or HEU had been removed and then sent to Building 774 for waste processing. The first step was pH adjustment, using caustic soda, sodium hydroxide, or potassium hydroxide (P047, U115). The liquids were then processed and solidified. Raffinates with hydrochloric acid were incompatible with the sludge treatment process and were solidified separately. This waste was called 741 or 742 sludge until 1967, after which it was called 744 sludge.

Sulfuric acid was used in research on joinings and coatings in Building 779. Any spent solution would have been processed through Building 774. Uranyl nitrate solution was also used in experiments of plutonium criticality. The uranyl nitrate solution was stored in a tank and returned to the tank after use (RF-P025, RF-P085). The process knowledge does not describe disposition of this solution when the need for it ended.

Any liquids that may be present in inner containers that are intact will be dealt with at the time of retrieval. Homogeneous solid waste forms will not carry the D002 characteristics unless excess free liquids (> 1% liquids) are present, in which case the liquids would need to be assessed.

Table 5-5. Preliminary Hazardous Waste Assessment.

Waste Type	Description	Preliminary HWNs
I	Combustibles	D004, D006, D007, D008, D009, D011, D022, F001, F002, F005
II	Filter paper	D004, D006, D007, D008, D009, D011, D022, F001, F002, F005
III	Filters and filter media	D004, D006, D007, D008, D009, D011, D022, F001, F002, F005
IV	Inorganic sludges	D004, D006, D007, D008, D009, D011, D022, F001, F002, F005
IV	745 sludge	D001, D004, D006, D007, D008, D009, D011, D022, F001, F002, F005
V	Non-combustibles	D004, D006, D007, D008, D009, D011, D022, F001, F002, F005
VI	Contaminated organics	D004, D006, D007, D008, D009, D011, D022, F001, F002, F005
VII	Beryllium waste	D004, D006, D007, D008, D009, D011, D022, F001, F002, F005

Table 5-6. Hazardous waste numbers identified for each waste generator.

Generator Designation	D001 Ignitability	D002 Corrosivity	D003 Reactivity	D004 Arsenic	D006 Cadmium	D007 Chromium	D008 Lead	D009 Mercury	D011 Silver	D018 Benzene	D019 Carbon tetrachloride	D022 Chloroform	D039 Tetrachloroethylene	D040 Trichloroethylene	F001	F002	F003	F005	F006, F007, F009 Cyanide	Beryllium	PCBs
122	◆																				
123	◆	◆						◆									◆			◆	
331								◆												◆	
441		◆					◆	◆	◆												◆
444	◆	◆			◆	◆	◆	◆	◆			◆			◆	◆			◆	◆	
447	◆	◆			◆	◆	◆	◆	◆			◆			◆	◆			◆	◆	
551																					
553																					
559	◆	◆				◆	◆	◆			◆	◆			◆	◆				◆	
771	◆	◆				◆			◆	◆	◆	◆			◆	◆				◆	
774	◆	◆			◆	◆	◆	◆	◆	◆	◆	◆			◆	◆			◆	◆	
741	◆	◆			◆	◆	◆	◆	◆	◆	◆	◆			◆	◆			◆	◆	
742	◆	◆			◆	◆	◆	◆	◆	◆	◆	◆			◆	◆			◆	◆	
743	◆	◆			◆	◆	◆	◆	◆	◆	◆	◆			◆	◆			◆	◆	
744	◆	◆			◆	◆	◆	◆	◆	◆	◆	◆			◆	◆			◆	◆	
745	◆	◆			◆	◆	◆	◆	◆	◆	◆	◆			◆	◆			◆	◆	
746	◆	◆			◆	◆	◆	◆	◆	◆	◆	◆			◆	◆			◆	◆	
776	◆	◆			◆	◆	◆	◆	◆	◆	◆	◆			◆	◆			◆	◆	◆
777	◆	◆			◆	◆	◆	◆	◆	◆	◆	◆			◆	◆			◆	◆	◆
779	◆	◆			◆	◆	◆	◆	◆	◆	◆	◆			◆	◆			◆	◆	◆

Generator Designation	D001 Ignitability	D002 Corrosivity	D003 Reactivity	D004 Arsenic	D006 Cadmium	D007 Chromium	D008 Lead	D009 Mercury	D011 Silver	D018 Benzene	D019 Carbon tetrachloride	D022 Chloroform	D039 Tetrachloroethylene	D040 Trichloroethylene	F001	F002	F003	F005	F006,F007,F009 Cyanide	Beryllium	PCBs
870																					
871																					
872																					
892																					
881	◆	◆	◆		◆	◆	◆		◆		◆	◆	◆	◆	◆	◆	◆		◆	◆	◆
883		◆		◆	◆								◆	◆							
886		◆											◆								
889	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆		◆	◆	◆
991							◆		◆												◆
BOR																					
CPC															◆						
CU																					
M																					
DO																					
W																					
DRI																					
LAF																					
B																					
LRL																					
SO																					
M		◆								◆											
MA																					
RTI																					
N																					
USG																					
S																					
SUN																					

5.3.1.3 Reactivity. The characteristic of reactivity is defined in RCRA (40 CFR 261.23) as follows:

“A solid waste exhibits the characteristic of reactivity if a representative sample of the waste has any of the following properties:

1. It is normally unstable and readily undergoes violent change without detonating.
2. It reacts violently with water.
3. It forms potentially explosive mixtures with water.
4. When mixed with water, it generates toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.
5. It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors, or fumes in a quantity sufficient to present a danger to human health or the environment.
6. It is capable of detonation or explosive reaction if it is subjected to a strong initiating source or if heated under confinement.
7. It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
8. It is a forbidden explosive as defined in 49 CFR 173.51, or a Class A explosive as defined in 49 CFR 173.53 or a Class B explosive as defined in 49 CFR 173.88.”

Lithium metal was fabricated at RFP beginning in the 1960s. It was first fabricated in a non-plutonium area and the chips were disposed of by burning in an open trench. When operations were moved to a plutonium-contaminated area, a study of disposal methods was made (RF-P114). Disposal of the scrap by reaction was recommended. Therefore, it is not anticipated that lithium metal in its unreacted form would be present in the waste.

The wastes do not contain sulfides and are not capable of detonation or explosive reaction. The wastes may contain trace quantities of cyanide derived from electrorefining wastes and from heat treating salt baths. However, the trace quantities of cyanide that may be present would be in a cemented form and would not contact pH conditions that would cause it to generate toxic gases. The waste may also contain trace quantities of palladium. Palladium was used in trace quantities for plutonium metallurgical research and development. It is most reactive in its powdered form. If it was used and reacted in research activities, it would not be present in the waste. Any remaining trace quantities would not be in sufficient quantity or form to meet the characteristic of reactivity.

The debris and homogeneous solid wastes do not meet the characteristic of reactivity (D003) as defined under 40 CFR 261.23. The waste materials are stable and will not react violently with water, form potentially explosive mixtures with water, or generate toxic gases, vapors, or fumes when mixed with water. The homogeneous solid waste forms will not carry the D003 characteristics unless excess free liquids (> 1% liquids) are present, in which case the liquids would need to be assessed.

5.3.1.2 Toxicity. The characteristic of toxicity is defined in RCRA (40 CFR 261.24) as follows:

“A solid waste (except manufactured gas plant waste) exhibits the characteristic of toxicity if, using the Toxicity Characteristic Leaching Procedure, test Method 1311 in “Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,” EPA Publication SW-846, as incorporated by reference in Section 260.11 of this chapter, the extract from a representative sample of the waste contains any of the contaminants listed in Table 1 at the concentration equal to or greater than the respective value given in that table. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering using the methodology outlined in Method 1311, is considered to be the extract for the purpose of this section.”

Acceptable knowledge indicates the potential presence of metals (arsenic, cadmium, chromium, lead, mercury, and silver) in the debris wastes. There are no data indicating the contamination levels of the toxicity characteristic metals in either the debris waste or in the homogeneous solids waste. As a conservative measure, the EPA toxicity characteristic HWNs (D004, D006, D007, D008, D009, and D011) associated with the tabulated metals will be assigned to both types of waste.

Spent halogenated organic compounds commonly used for their solvent properties for cleaning and degreasing were used in many of the processes that generated the debris wastes. Both the toxicity characteristic and appropriate F-listed HWNs for the halogenated solvents, carbon tetrachloride, tetrachloroethylene, and trichloroethylene, are presented in Table 5-4. It is assumed that these compounds will not be in the waste at toxicity characteristic regulatory levels, and the associated F-listed HWNs for these compounds will be applied to all debris waste as a conservative measure. The toxicity characteristic waste codes associated with these compounds will not be assigned.

Another chlorinated hydrocarbon, chloroform, was also identified as a potential waste constituent in many of the generating processes. Headspace gas sample data from the 3100 m³ Project did indicate chloroform was present in some containers of debris and homogeneous solid wastes (RF-P090). The associated toxicity characteristic HWN, D022 will be assigned as a conservative measure.

5.3.1.3 Listed Waste Constituents. Chlorinated hydrocarbon compounds, tetrachloroethylene, trichloroethylene, 1,1,1-trichloroethane, trichlorotrifluoroethane, unspecified chlorofluorohydrocarbons, several types of freon, and carbon tetrachloride were commonly used at RFP in the cleaning and degreasing of equipment, gloveboxes, and isotopic products (e.g., plutonium buttons, triggers, uranium metal components) during the 1954 through 1970 timeframe (Table 5-4). The F001 and F002 HWNs apply to the waste stream for these compounds. Methylene chloride was also identified as a common chlorinated chemical used at RFP. Its primary use was for paint removal, and as such, carries an F002 listed HWN (RF-C167, RF-C215, RF-C223, RF-P040, RF-P084, RF-P085, RF-P090).

Acetone, benzene, methyl ethyl ketone, methanol, toluene, and xylenes were used as solvents in laboratory operations and may be present in the RFP debris and homogeneous solid wastes (RF-C195, RF-P084, RF-C196, RF-U115, RF-C215, RF-U133, RF-U254). The F003 listed constituents (acetone, methanol, and xylenes) carry the HWN based on ignitability. It is assumed that because the procedures for the use and handling of these solvents did not change significantly over time, the F003 wastes were not mixed with any other listed (F001, F002, F004 or F005) waste streams at the point of generation (RF-C243, RF-P090). Because the debris wastes do not meet the definition for the ignitability characteristic, the resulting combined mixture of the solid debris and the F003 constituents qualifies for the exemption within 40 CFR 261.3(a)(2)(iii) and the F003 waste HWN does not apply.

The other non-halogenated constituents: benzene, methyl ethyl ketone, and toluene were identified for the Building 771 and Building 774 wastes. The potential presence of these constituents is supported

by headspace gas sample data collected during the 3,100 m³ Project from similar/related wastes. The F005 HWN should be assigned as a conservative measure.

Although the headspace gas samples used for the 3,100 m³ Project (RF-P090) were actually collected from containers of debris and homogeneous solid wastes generated at RFP after 1970, the processes that generated the wastes did not change significantly over time and the chemical constituents used remained relatively constant. The biggest change in chemical usage was in the actual reduction of the amount of chemical used during processing over time, and change from use of the non-halogenated solvents to the halogenated solvents due to the fire hazards.

Hydrofluoric acid (HF) was used in conjunction with nitric acid for plutonium oxide dissolution. If this material was discarded unused, the HWN U134 may apply. The WIPP WAP allows acceptance of waste with HWN U134, but no detectable liquid is allowed in containers with HWN U134. If liquids are encountered during retrieval, the presence of HF should be considered when the liquids are evaluated.

5.3.1.4 Other Waste Constituent Issues. The volume of beryllium-contaminated wastes or waste beryllium or beryllium oxide shipped to the INEEL is unknown. However, it was estimated that during production, the casting process might have generated 3 to 7 kg/day of waste beryllium or beryllium oxide in the form of sculls (casting residues). In addition to sculls, impure or damaged castings that could not be salvaged were periodically included in the waste drums. This waste is assumed to be included under the Type VII designation and may be further delineated by the building/generator in the load lists and WasteOScope (RF-P047).

The designation VII was used in this report to denote beryllium-contaminated wastes. This waste was given this designation to specifically identify beryllium wastes in response to requirements included in the WIPP CH-TRU WAC that set plutonium-239 fissile gram equivalent limits specific to CH TRU wastes with beryllium content greater than 1% (DOE/WIP-02-3122, Revision 1, Dated March 1, 2004).

Note: 55-gal drums containing greater than 100 kilograms of beryllium are prohibited from storage and disposal at the WIPP.

Beryllium-contaminated debris waste, as recorded in WasteOScope, makes up less than 1% of the total debris waste volume shipped from RFP in 1954-1970. The majority of the beryllium-contaminated waste is assumed to be low-level radioactive waste, and was buried in the pits (RF-U169).

Machining oils and degreasing agents (trichloroethane, etc.) contaminated with beryllium were processed through Building 774 and became part of the 743 sludge. Beryllium that may have entered the waste treatment process from foundry, metallurgical, and casting operations would have added minor amounts of beryllium contamination to other sludges generated in Building 774. It was estimated for wastes generated after 1970 that the total beryllium in the sludge waste is less than 1% by weight. However, there is a potential to have high concentrations of beryllium in some Type VII waste drums that were sent from the beryllium/uranium fabrication processes in Building 444.

5.3.1.5 PCBs. Polychlorinated biphenyls (PCBs) were identified as paint components that may have been part of the debris waste streams (RF-P093). PCB containing oils (hydraulic oils from equipment, capacitors, etc.) may be present in oil waste containers (Waste Type VI) or in equipment (Waste Type V) identified under the 870, 871, 872, and 892 generator designations. These waste containers were shipped to the INEEL in June 1962. The total number of waste containers shipped to the INEEL under these designations were:

- Twelve containers (88 ft³) Waste Type I combustible debris

- Three 55-gal drums (22 ft³) Waste Type VI organic sludge
- Fifty-six containers (412 ft³) Waste Type V non-combustible debris.

The WIPP WAP addresses PCBs. The list of prohibited items includes the limitation on PCBs (WAP, Section B-1c Waste Prohibited at the WIPP Facility):

- “wastes with polychlorinated biphenyl (PCB) concentrations equal to or greater than 50 parts per million.”

Table B-4, footnote d, of the WAP states:

- “Transformer oils containing PCBs have been identified in a limited number of waste streams included in the organic sludges waste matrix code. Therefore, only waste streams included in the solidified organics final waste form shall be analyzed for PCBs.”

PCBs were used for industrial purposes beginning in the 1930s and were not regulated until after the Toxic Substance Control Act was passed in 1976. In addition to debris containing low concentrations of PCB from paint, solidified PCB waste oil and motors and pumps containing PCBs (from the 1969 fire) were all sent to INEEL for disposal. It is also possible that PCB contaminated oil could have been processed with other liquid wastes and sent to INEEL. PCB containing oils such as transformer fluid were collected and stored with other oils until a treatment process became available in 1966. Up to 5,000 waste drums had been accumulated by that time. This waste was processed through the Grease Plant beginning in August 1966 and shipped to INEEL. Processing data collected from PCB wastes processed in later years indicate that the PCB wastes were combined with other wastes in the treatment process. Sampling and analysis data collected from 1979 through 1986 for Grease Plant sludge wastes showed a UCL₉₀ exceeding 50 ppm PCBs. The PCB contamination was attributed (at least in part) to the inclusion of mineral oils in the feed waste to the Grease Plant treatment process. It is assumed that PCB-contaminated oils were processed in Building 774 prior to 1970 and are therefore a constituent of the 743 sludge waste. One of the large metal presses in Building 883 was filled with oil containing PCBs, but it is not known whether oil from this machine was ever treated in the Grease Plant (RF-C058, RF-P047, RF-P084, RF-P090, RF-U115).

To assess the WAP requirements, the data was reviewed to determine whether a mean concentration of PCBs for waste disposed between 1954 and 1970 could be determined. By employing conservative assumptions about the PCB concentrations in the waste disposed at INEEL, it can be estimated that the mean concentration ranges between 38 ppm and 190 ppm. This indicates that further characterization will be necessary prior to shipment of these wastes to WIPP.

This range of mean concentrations of PCBs was calculated based upon the following assumptions:

- Waste Type I combustible debris would not contain significant PCB concentrations, as the sole source was from paint containing PCBs. Therefore, PCB concentrations for this waste are not estimated.
- Waste Type VI organic sludge wastes generated by the Grease Plant – 743 Sludge totaling 62,625 ft³ contained PCBs ranging from 100 to 500 ppm at the time of disposal. This is a conservative estimate of the 50 to 500 ppm range used by EPA to define PCB-contaminated oil.

- Waste Type V non-combustible waste containers listed above contained equipment such as motors and pumps that contained PCB oil (500 ppm PCB) of approximately 1 gal in volume per container. This would total an additional 8 ft³ of PCBs at the time of disposal.
- The PCB oil (500 ppm) volume percent that may have been mixed with all other aqueous liquid feed streams sent to the waste treatment facility would be equivalent to the volume percent of the organic waste sludges for the total sludge wastes (~20% or 20 ppm). The total volume for other aqueous sludges (774 IV sludge = 3,201 ft³; 741 IV sludge = 61,697 ft³; 742 sludge = 108,156 ft³; and 745 sludge = 41,764 ft³) was 214,818 ft³. Therefore, 20% of this total amount is assumed to be PCB oil.

5.3.1.6 Items of Concern. Prohibited items and other items of concern that have been reported in the AK record as having been included in RFP waste containers sent to the INEEL between 1954 and 1970 include:

- Unpunctured aerosol cans, unvented nickel carbonyl or other gas bottles, including spent carbon dioxide fire extinguishers, used during the 1957 fire in Building 771 and the 1969 fire in Building 776. At the time of their disposal, there was no prohibition concerning the disposal of these items (RF-P047).
- Expended mercury batteries. None of the documents reviewed for this report indicated specific quantities of mercury batteries that may have been put in waste containers during 1954 through 1970. However, RFP reported in 1971 that it collected used mercury metal and spent mercury batteries and sent it to an outside reprocessor for recycling (RF-C208). Therefore, a large quantity of spent mercury batteries is not expected.
- Expended lithium cell batteries. The potential that lithium batteries were included in sludges disposed at INEEL prior to 1970 has been identified (RF-P047). Lithium batteries were not widely used until the late 1960s, and it was determined during the 3,100 m³ Project that lithium batteries of the type described (lithium cell batteries) did not exist prior to 1970 when the sludge waste was generated (pre-1971; RF-P090). If any lithium batteries are present, they are spent and would not pose a concern of reactivity after 30 years.
- Electric motors that may contain PCB or other undrained oil. At the time of disposal, there was no prohibition against PCB disposal in this manner. Vacuum pump motors, lathes, and other equipment were packaged in boxes as fire waste after the 1969 fire (RF-P047).
- Small amounts of mercury in 0.5-L bottles (every 1 or 2 years; RF-C209, RF-P047).
- Prior to 1969, two 25-lb packs of sodium or potassium cyanide pellets were distributed in drums containing 742 sludge (RF-P047).
- Containerized and un-containerized unused chemicals (RF-P047). Process information on specific quantities and the types of unused chemicals that may have been put in waste containers was not identified during preparation of this document. However, as RFP was an operating industrial concern during the time period in question, the likelihood that unused chemicals were discarded is low. Processes changed little, and there would be minimal need to discard unused chemicals because they had no use.

- Toxic materials such as the suspect human carcinogenic hardening agent [4,4 –methylene-bis (2-chloroaniline), or “Moca,”] for resins. Approximately 10 to 20 gal of Moca was mixed with cement in ice cream cartons, double-bagged, and packaged with 744 sludge (RF-P047).
- Revolvers and ammunition. The most credible testimony identifies as many as four revolvers confiscated from guards by Health Physics during the 1969 fire in Building 776 (RF-P047).
- Radioactive sources. The following radioactive sources were shipped to the INEEL prior to October 1970, and were most likely buried in the SDA:
 - In 1965, eight radionuclide sources, 1 to 5 mCi radium/beryllium neutron sources, were included in sludge waste drums generated in Building 774. The sources were ‘radium/beryllium’ sources, wrapped in lead shielding prior to placing them in the drums, and had radiation levels of approximately 100mR/hr gamma at the surface (RF-C138).
 - Four lead-shielded cobalt-60 sources totaling approximately 80 mCi were shipped to the INEEL on January 3, 1968 (RF-C138).
 - Four radium/beryllium neutron and one radium-226 (60 mCi) sources packaged in individual lead containers were shipped to the INEEL on September 6, 1968 (RF-C138).
 - A 20- μ Ci cobalt-60 source and a 20 μ Ci cesium-137 source were sent to the INEEL in February 1970 (RF-C138).
 - Nine cobalt-60 and cesium-137 sources totaling 174 Ci and 214 Ci, respectively, were placed in individual lead containers and packaged in a red drum filled with concrete and shipped by railcar on June 18, 1970 (RF-C138).
 - Tritium sources totaling 360 mCi and a 100 mCi radium source were shipped to the INEEL in October 1970. Conservatively, it is assumed that these sources arrived before the burial of waste at the RWMC ceased (RF-C138).
- Depleted uranium, plutonium, or other pyrophoric metal wastes in the form of machining chips, turnings, or fines. The primary objectives of recovery operations for the accountable isotopes and the treatment of depleted uranium materials were to process the waste material until it could be safely and economically discarded. Economic discard limits were calculated based on the value of the material, the labor required to recover the material, and the efficiency of the recovery process. Limits were determined for plutonium, HEU, and other accountable isotopes, such as neptunium-237 and uranium-233. Depleted uranium chips, turning, and fines waste were treated by incineration to convert the pyrophoric metal to a stable oxide prior to INEEL shipment. The uranium waste treatment process may not preclude the possibility that pyrophoric metal could be present in the waste (RF-P047). On June 1, 1970, a container of RFP waste that originated in Building 444 was involved in a fire at the NRTS (INEEL) burial grounds. Analytical data from samples collected from the container after the fire indicated the presence of copper (plated on both sides with cadmium), copper cadmium alloys, plastics such as polystyrene and nylon in the form of rods and diced pieces loaded with uranium oxide, and high-fired uranium oxide, which indicated that the fire was caused from pyrophoresis of the depleted uranium (RF-P047, RF-P221). The subject drum had originated in Building 444, and was moved to a trench north of the 903 area and buried in November 1955. During the fall of 1968, the barrel was inadvertently uncovered and the lid removed by a grader. A new lid was installed and the drum was shipped to the INEEL in February 1970 (RF-C221).

- Three incidents of fires involving uranium chips had been reported in Building 444 between 1955 and 1962 (RF-P133, RF-U143). Information on uranium metal indicates that non-enriched uranium is combustible. Uranium in finely divided form is readily ignitable, and uranium scrap from machining operations is subject to spontaneous ignition. This reaction can usually be avoided by storage under dry (without moisture) oil. Grinding dust has been known to ignite even under water, and fires have occurred spontaneously in drums of coarser scrap after prolonged exposure to moist air. *Primer on Spontaneous Heating and Pyrophoricity*, DOE-HDBK-1081-94, December 1994.
- Flammable and/or explosive nitrated resins. Ion exchange resins used in plutonium recovery operations were exposed to nitric acid. Nitrated resins may become highly flammable and/or explosive if the resin is allowed to dry. Prior to 1970, resin waste was placed in plastic bags and packaged in 55-gal waste drums. It is not known if the resins were denitrified (rinsed with water) before bagging. Pre-1970 resin wastes may not have been completely denitrified. It is assumed that the buried resin drums and other wastes are not intact, and that any nitrate(s) remaining on the resins has been neutralized by other waste items or the soil environment over the time the resins have been buried (RF-P047).

6. RADIOISOTOPIC DISTRIBUTION SUMMARY

The purpose of this section is to provide baseline AK radionuclide content information of contact-handled TRU wastes generated or trans-shipped by RFP and buried in the INEEL SDA during the time period of 1954 through 1970. At a minimum, the major isotopes expected to be present are identified as well as other isotopes that are in the WIPP WAC list of specified radionuclides that are required to be reported and tracked, or that have the potential to be in measurable quantities in some wastes.

It has been estimated that approximately 95% of the radioactive waste volume generated at Rocky Flats was a result of processing plutonium. A majority of the remaining 5% was generated during the processing of depleted uranium or during R&D. After processing, approximately 70% of the waste volume shipped off the RFP site was low-level and 30% was TRU (RF-P271). The low-level waste (LLW) was shipped to the INEEL and the Nevada Test Site. Much of the TRU wastes were shipped to the INEEL (RF-P090). From 1954 through 1970, wastes received at the INEEL from RFP and other AEC facilities were buried in the RWMC burial ground. The two burial types used were trenches and pits that were excavated periodically as required for waste disposal. Wastes with high radioactivity were preferentially placed in trenches that were dug in the high clay content areas. Materials with relatively low radioactivity were buried in pits, which were dug in more sandy areas of the burial ground (RF-C078).

Much of the waste shipped during the 1954 through 1970 timeframe may contain TRU isotopes with less than 100 nCi/g activity range. Based on the shipping records as entered into WasteOScope, 77.74% of the waste volume shipped to INEEL was generated in RFP plutonium processing and production facilities, and is assumed to be TRU contaminated at activity levels greater than 10 nCi/g; 19.78% of the waste volume were generated from depleted uranium/beryllium processing and production facilities and are assumed to be low level and mixed low level contaminated wastes; and the remaining 2.24% are low level and mixed low level wastes generated by the off-site generators and trans-shipped to the INEEL by RFP (RF-U169).

The principal radionuclides contained in RFP waste are those identified in weapons-grade plutonium (e.g., ^{238}Pu , ^{239}Pu , ^{240}Pu , ^{241}Pu , and ^{242}Pu), HEU, and DU. Due to ^{241}Pu decay and ingrowth of ^{241}Am , this radioisotope is expected in any RFP wastes containing plutonium. In wastes containing chemically separated materials from the purification of plutonium, the ^{241}Am can be at considerably higher relative activities than would be expected from ingrowth alone (RF-P090).

Other radionuclides may also be found in some RF wastes generated from R&D, analytical processing, tracer studies, and special order work, such as ^{244}Cm , ^{232}Th , ^{236}U , ^{233}U , ^{137}Cs , and ^{237}Np . Processing of these "special" radioisotopes was performed until the early- to mid-1970s (RF-P090). Radioisotopes were not identified for several of the RFP building/generators (i.e., 122, 444, 447, 551, 553, 870, 871, 872, 892) or for some of the off-site generators. The isotopes that were identified for at least one of the wastes generated during the 1954 through 1970 timeframe in AK source documents reviewed for this report are listed in Table 6-1. The correlation between the radioisotopes and each building-generator as described in the Section 4 sub-sections is presented in Table 6-2.

Fission products, including ^{137}Cs and ^{90}Sr , were not expected to be present in detectable quantities or at levels that would require reporting (e.g., contributing to 95% of the radioactive hazard) in any of the RFP TRU waste streams analyzed during the 3,100 m³ Project. The absence of ^{137}Cs was verified for that project during radioassay at the INEEL using the 661 keV line. Detecting the presence of ^{90}Sr was predicated on observing the presence of ^{137}Cs (as a correlated fission product), therefore, it was never reported for any of the RFP wastes analyzed during the 3100 m³ Project (RF-P090).

Table 6-1. Isotopes (and their acronyms) identified for at least one of the wastes generated from 1954 through 1970.

Radionuclides	
Americium-241 (Am-241)	Plutonium-240 (Pu-240)
Barium-133 (Ba-133)	Plutonium-241 (Pu-241)
Californium-250 (Cf-250)	Plutonium-242 (Pu-242)
Cerium-134 tracer (Ce-134)	Strontium-90 (Sr-90)
Cesium-137 (Cs-137)	Thorium-228 (Th-228)
Cobalt-60 (Co-60)	Thorium-232 (Th-232)
Curium-244 (Cu-244)	Tritium (H-3)
Gadolinium-148 (Gd-148)	Uranium-232 (U-232)
Lead-209 (Pb-209)	Uranium-233 (U-233)
Neptunium-237 (Np-237)	Uranium-234 (U-234)
Nickel-63 (Ni-63)	Uranium-235 (U-235)
Plutonium-238 (Pu-238)	Uranium-236 (U-236)
Plutonium-239 (Pu-239)	Uranium-238 (U-238)

872	Am-241	Ba-133	CF-250	Ce-134	Cm-244	Co-60	Cs-137	Gd-148	H-3	Np-237	Ni-63	Pb-210	Pu-238	Pu-239	Pu-240	Pu-241	Pu-242	Sr-90	Th-228	Th-232	U-233	U-234	U-235	U-236	U-238	LLW ¹
	◆			◆		◆			◆				◆			◆		◆			◆			◆		◆
881				◆		◆			◆				◆			◆		◆			◆			◆		
883	◆								◆				◆			◆		◆			◆			◆		◆
886	◆												◆			◆		◆			◆			◆		◆
889																										
991	◆						◆						◆			◆		◆			◆			◆		◆
BOR																										◆
CPC																										◆
CUM	◆			◆		◆			◆				◆			◆		◆			◆			◆		◆
DOW																										◆
DRI																										◆
LAFB																										◆
LRL ²	◆					◆			◆				◆			◆		◆			◆			◆		◆
SOM ²	◆					◆							◆			◆		◆			◆			◆		◆
MARTIN																										◆
USGS ³	◆						◆						◆			◆		◆			◆			◆		◆
SUN																										◆

1. The majority of the waste from these buildings/generators was assumed to be LLW (low level waste).
2. The Colorado School of Mines (contracted with Lawrence Livermore Laboratories) was analyzing soil samples from NTS detonation area.
3. The USGS had a small reactor at this time. The waste sent to the INEEL was assumed to be related.

6.1 Radioisotopic Content

The isotopic compositions for weapons grade plutonium, HEU, and DU reported for waste shipped from RFP to INEEL are shown in Table 6-3 by the time ranges in which the wastes were buried in the SDA (RF-U169). A summary of the isotopic content is presented in Table 6-4. The data are minima and maxima, in weight percent, for the time ranges for which data were reported. In the cases of ^{238}Pu and ^{242}Pu , the maxima are “less than” values. These were used because values as high as this could not be excluded by the data, and therefore could at least theoretically be observed by improved assay sensitivity. Quantities of plutonium disposed of during the 1954 to 1959, 1960 to 1968, and 1969 periods were 17.4, 282.6, and 40.6 kilograms of plutonium, respectively (RF-C240).

Table 6-3. Rocky Flats Weapons-Grade Plutonium, Enriched Uranium, and Depleted Uranium Isotopic Levels 1954-1971 (Stream Averages – Wt%) (RF-C144, RF-C240, RF-U115, RF-U135).

Calendar Year(s)	Weapons Grade PU ¹					EU ²				DU ²	
	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu	^{234}U (U115)	^{235}U (U115)	^{236}U (U115)	^{238}U (U115)	^{238}U (C240)	^{235}U (C240)
1954–1959 (C240)	0.009	93.762	5.858	0.355	0.016	1.02	93.17	0.44	5.37	99.85	0.15
1960–1968 (C240)	0.009	93.670	5.853	0.452	0.016	1.02	93.17	0.44	5.37	99.96	0.04
1969 (C144, C240, U135)	0.009	93.750	5.857	0.368	0.016	Not given	Not given	Not given	Not given	99.84	0.16
1959–1960 (U115)	<0.05	93.714	5.593	0.5932	<0.05	Not given					
1961–1962 (U115)	<0.05	93.817	5.486	0.5979	<0.05	Not given					
1963–1964 (U115)	<0.05	94.398	4.854	0.6482	<0.05	Not given					
1965–1966 (U115)	<0.05	93.586	5.823	0.5610	<0.05	Not given					
1967–1968 (U115)	<0.05	93.451	5.953	0.5670	<0.05	Not given					
1969 (U115)	<0.05	93.538	5.953	0.4790	<0.05	Not given					
1970 (U115)	<0.05	93.450	5.965	0.4850	<0.05	Not given					
1971 (U115)	<0.05	93.533	5.929	0.4380	<0.05	Not given					

1. The sources for the isotopic data in each row for plutonium are shown in the “Calendar Year(s)” column.

2. The sources for the isotopic data for uranium are shown in the column headers for the respective isotope.

Table 6-4. Summary of Reported Nominal Isotopic Content of Radionuclides in Wastes Shipped by RFP.

	Year of Shipments For Data	Minimum (Wgt%)	Maximum (Wgt%)
WG-Pu			
²³⁸ Pu	1954–71	0.009%	<0.05%
²³⁹ Pu	1954–71	93.45%	94.398%
²⁴⁰ Pu	1954–71	4.845%	5.965%
²⁴¹ Pu	1954–71	0.355%	0.648%
²⁴² Pu	1954–71	0.016%	<0.05%
Enriched Uranium			
²³⁴ U	1954–68	1.02%	1.02%
²³⁵ U	1954–68	93.17%	93.17%
²³⁶ U	1954–68	0.44%	0.44%
²³⁸ U	1954–68	5.37%	5.37%
Depleted Uranium			
²³⁸ U	1954–69	99.840%	99.960%
²³⁵ U	1954–69	0.040%	0.160%

The nominal isotopic compositions of RF weapons-grade plutonium, HEU, and DU for waste generated after 1970 are listed in Table 6-5 (RF-P090). A comparison of the two tables indicates that the isotopic content in the pre-1971 waste is for the most part within the ranges reported for the post 1970 wastes. Only the composition of the HEU was noticeably higher for wastes generated in 1968 and earlier, and the post 1971 wastes. HEU processing was curtailed in 1964 and clean-up of the HEU processing facilities ended in 1968.

Table 6-5. Nominal compositions of radionuclide mixtures at RFP in weight percent (RF-P090).

Weapons-Grade Plutonium (WG Pu)		Enriched Uranium (HEU)		Depleted Uranium (DU)	
²³⁸ Pu	0.01 – 0.05%	²³¹ Th	negligible	²³¹ Th	negligible
²³⁹ Pu	92.8 – 94.4%	²³⁴ Th	negligible	²³⁴ Th	negligible
²⁴⁰ Pu	4.85 – 6.5%	²³⁴ U	~ 0.1%	²³⁴ U	~ 0.0006%
²⁴¹ Pu ¹	0.3 – 1.0%	²³⁵ U	~ 90 – 93%	²³⁵ U	~ 0.2%
²⁴² Pu	0.005 – 0.60%	²³⁶ U	~ 0.4%	²³⁸ U	~ 99.8%
		²³⁸ U	~ 5.3%		

1. Includes ²⁴¹Am daughter product.

6.1.1 Recommended Default Mass Fraction Values

At the INEEL, NDA systems are used to determine the quantity of radioactive material entrained in waste forms as described in EDF-3374, "Radioassay Data Collected During the 3100 Cubic Meter Project." A Passive-Active Neutron (PAN) assay system was used to directly measure ^{239}Pu or ^{235}U in its active mode and ^{240}Pu in its passive mode. To provide plutonium isotopic information, gamma spectroscopy systems was used to supplement the PAN measurements by providing the relative mass ratios of $^{238}\text{Pu}/^{239}\text{Pu}$, $^{240}\text{Pu}/^{239}\text{Pu}$, $^{241}\text{Pu}/^{239}\text{Pu}$, $^{241}\text{Am}/^{239}\text{Pu}$, $^{241}\text{Am}/^{235}\text{U}$, $^{235}\text{U}/^{239}\text{Pu}$, $^{235}\text{U}/^{239}\text{Pu}$ and $^{235}\text{U}/^{238}\text{U}$. The gamma spectrometry systems also detected and directly measured the mass concentrations of ^{241}Am , ^{238}Pu , ^{239}Pu , ^{240}Pu , ^{241}Pu , ^{233}U , ^{235}U , ^{238}U , ^{137}Cs , and other gamma emitting radionuclides (RF-P267). These measured values were used to confirm AK based mass fraction values.

The recommended default mass fraction values of the plutonium isotopes to be used as the AK based values and confirmed during NDA are listed in Table 6-6. These default mass fractions were calculated based on AK and measured values (RF-P269).

Table 6-6. Recommended values for the default mass fractions of the plutonium isotopes.

Isotope	Mass Fraction	Standard Deviation
^{238}Pu	1.05E-04	4.1E-05
^{239}Pu	9.406E-01	4.9E-03
^{240}Pu	5.72E-02	4.8E-03
^{241}Pu	1.73E-03	3.2E-04
^{242}Pu	4.3E-04	2.2E-04

The mass fraction values for ^{241}Am , ^{234}U , ^{235}U , and ^{238}U previously determined for RF wastes at the INEEL were based on individual gamma spectrometric measurements. The ^{234}U activity was calculated using scaling factors based on ratios with detected uranium isotopes (RF-P268). The criteria used for selection and the formulas for determining the ^{234}U mass are presented in Table 6-7 (RF-P268). The determination of the appropriate ratio and isotopic mix was based on various scenarios postulating the presence of HEU only, DU only, or a mixture of DU and HEU in the waste.

Table 6-7. Criteria and formulas to be used in the determination of U-234 Mass.

^{235}U Condition	^{238}U Condition	Determination of M_{234}
$^{235}\text{U} > 0$	$^{238}\text{U} > 0$	$M_{234} = [(9.971\text{E}-04)(M_{235}) + (3.080\text{E}-06)(M_{238})] / 0.9275$
$^{235}\text{U} > 0$	$^{238}\text{U} = \text{ND}$	$M_{234} = [(9.971\text{E}-04)(M_{235})] / 0.9275$
$^{235}\text{U} = \text{ND}$	$^{238}\text{U} > 0$	$M_{234} = [(3.080\text{E}-06)(M_{238})] / 0.9275$
$^{235}\text{U} = \text{ND}$	$^{238}\text{U} = \text{ND}$	$M_{234} = 0$

$M_{234} = ^{234}\text{U}$ Mass; $M_{235} = ^{235}\text{U}$ Mass; $M_{238} = ^{238}\text{U}$ Mass (M_{238} may be determined from either its ratio to ^{235}U or from its ratio to ^{239}Pu)

ND = Not Determined

MR = mass ratio

6.1.2 Waste Stream Specific Information

Matrices and other physical parameters from the waste generating processes that could affect quantitative and/or confirmatory radioassay data should be determined for each of the proposed as-retrieved RFP wastes. These data are required to calibrate and set operating parameters for NDA systems to be used for assaying the packaged waste. The range of isotopic content/activities or ratios in RFP waste has changed over time relative to those existing at the generation date of the waste due to radioactive decay and ingrowth. Calculation of activities for those isotopes scaled from measured values such as ingrowth of ²⁴¹Am, should be based on the earliest disposal date of 1954.

The HEU metal required for the weapons program (used in Building 881 and 883 from 1953 through 1967) was obtained from ORNL. The HEU did not have recycle contaminants because of the processing steps used to perform the enrichment at ORNL and the recycle contaminants were considered *de minimis*. Mass balance and assay data for the HEU shipments and receipts were classified and were not provided. However, a small quantity of HEU material (~200 kg) that was derived from recycle in the form of uranyl nitrate was received at RFP from Idaho. The contaminant data for this material is 0.007 ppb plutonium, 2.5 ppb neptunium, and 9.12 ppb technetium (RF-P105).

To illustrate the amounts of plutonium that could be present in some waste forms, the economic discard limits for plutonium that were used from 1967 through 1969 for various wastes and the quantities of plutonium in the solid wastes generated for each year are presented in Table 6-8.

Table 6-8. Plutonium economic discard limits for various residues, FY-67 to FY-69 (RF-U172).

Code No.	Residue Description	Economic Discard Limit	Plutonium FY-67 (g)	Plutonium FY-68 (g)	Plutonium FY-69 (g)
110	Sweepings	0.007 g/g	18,147	15,882	8,852
111	Sludge	“	3,779	3,307	1,843
112	MgO Sand	“	2,599	2,275	1,268
113	Ion Exchange Resin	“	754	660	368
116	Incinerator Ash	“	1,657	1,450	808
123	Sweepings Heel	“	10,153	8,886	4,952
114	Glass & Ceramics	0.0005 g/g	680	595	332
121	Scarfed Molds	0.00035 g/g	5,248	4,593	2,560
125	Graphite Float Residues	“	33	33	18
122	CWS Filters	24.0 g/filter	4,180	3,653	2,089
126	Drybox Filters	3.0 g/filter	91	80	44
128	Washables	0.0006 g/g	7,495	6,560	3,656
129	Combustibles	0.0005 g/g	1,730	1,514	844
130	Misc. Scrap Metal	0.0003 g/g	7,146	6,254	3,485
-	Non-Routine (Equipment)	NA	393	589	4
-	Fire (Solids & Solutions)	NA	—	—	282
		FY TOTALS	64,090	56,336	31,355

A summary of all DU waste shipments to INEEL is provided in Table 6-9. The table includes shipments of DU contaminated waste generated after processing operations in Building 441 ceased in

1966. These wastes were generated from DU processing conducted in other RFP buildings (RF-U043, RF-U169, RF-U115).

Table 6-9. Summary of depleted uranium waste containers shipped to the INEEL by calendar year (RF-U115).

Calendar Year	55-Gal. Drums	40-Gal. Drums	30-Gal. Drums	Boxes ¹	C.W.S Filters ²	Tanks	Total Volume (ft ³)	Gross Wt (lb)	U-238 ³ (kg)
1954	1,217 ⁴								738
1955	1,564		115				12,248	390,104	979
1956	1,795					2	12,347	315,727	1,174
1957	1,882		300		460		22,176	863,800	2,147
1958	818	37	220		327		8,055	283,938	4,209
1959	692		97	4			5,323	200,380	3,753
1960	839		28	17			6,866	230,913	4,123
1961	1,030		37	29	333		10,236	268,708	4,311
1962	839		4	24			6,775	208,882	4,674
1963	1,510		3	24	92		12,629	286,966	1,672
1964	2,058			42	93		19,381	386,931	1,339
1965	1,479			41			15,742	326,797	4,269
1966	1,488			31			14,509	420,113	53,452
1967	1,473			64			18,434	498,914	53,176
1968	1,491			44			16,216	390,470	33,373
1969	1,087			40			13,028	326,098	22,721
1970	567			63			11,252	172,383	7,084
TOTALS	21,829	37	804	423	1,305	2	205,217	5,571,124	203,194

1. The standard size waste box was 4' x 4' x 7'. Some boxes of slightly different sizes were also shipped as described in Section 3.2.3.
2. C.W.S Filters was the terminology used for what are now HEPA filters. Most were 2' x 2' x 1' in size, shipped to INEEL in boxes in the early years and later packaged in drums for shipment and disposal.
3. Data on total weight of U-238 shipped were not related to individual containers.
4. The 1954 data were not broken out as to drum size, volume, or weight.

Based on the data presented in this summary, except for a few waste types, plutonium and uranium isotopes should be routinely expected in the RFP waste buried in the SDA. Plutonium isotopes should occur in relatively predictable ratios corresponding to weapons grade plutonium. The isotope ²⁴¹Am will occur in all wastes of this age containing weapons grade plutonium. Relative quantities of this isotope will be bounded on the low end by the radioactive decay of ²⁴¹Pu. The upper end of the ²⁴¹Am activity range will be determined by the presence of wastes enhanced in ²⁴¹Am by chemical separation to purify plutonium, and will not be easily predictable based on activities of other isotopes. Containers with high americium content are expected to have been generated in Building 771 from the americium recovery line and packaged predominantly in lead-lined containers. It will be necessary to identify the americium

containing wastes for segregation from the CH TRU wastes as RH TRU wastes to be addressed separately under another project and related documentation.

Isotopes of uranium should be assignable to DU or HEU and should also be in relatively predictable ratios, unless there was significant commingling within a given waste type or with other waste types.

A wide variety of other isotopes are expected to be sporadically encountered in the waste. Many of these will be encountered as contamination due to their use as tracers, standards, or in special order projects. In addition, discrete sources were disposed of over this time period. Depending on form, condition, and stability, these may be present as discrete sources, or may represent locally high activity ranges. In either case, though expected in some waste containers, they should not be encountered on a routine basis.

Appendix A
WasteOScope

Appendix A

WasteOScope

Assumptions and discrepancies identified:

1. Some entries do not include weight and/or volume estimates. Other entries were not consistent regarding the volume of the waste containers. We estimated volume for our calculations of total waste volume for each pit or trench based on the assumption that the container (e.g., carton or box) was the largest used during that time period or used the largest volume associated with the container in the database. The volumes used in our estimates for each container type are included in Table A-1.

Table A-1. Volume estimates for each container type.

Type of Container	Volume (ft ³)
Carton	18
Wooden box	121
Metal Container (CM)	21
15-gal drum	2
20-gal drum	3
30-gal drum	4
40-gal drum	6
55-gal drum	7.35

2. Volume for waste was the maximum volume for the container the waste was shipped in (100% utilization). This is a conservative estimate of the waste volume disposed.
3. Uncertainty: To bound the volume of the waste by type, two assumptions were made: for the lower bound it is assumed that only 50% of the container was utilized, and for the upper bound, 100% of the container was utilized.
4. Due to the usage of several additional waste type designators in WasteOScope, it is necessary to revise the RF-D001 discrepancy resolution to add in the additional designators as well as revise or amend previous entries in the resolution to clarify their use.
5. The number of containers assigned to waste types added up to a number greater than the number of containers shipped for some of the shipments because when a number of containers were attributed to a combination of two debris types (e.g., Types I and V), the total number of containers shipped were entered for both waste types. We have assumed that the number in the container count column is correct for that waste type.
6. The generator designators used in WasteOScope refer to either the RF building where the waste was generated or in other cases refer to a drum prefix, such as for the identification of sludges. In some cases, a building number has also been used as a drum prefix and are not exclusive. That is to say, the drum prefix on some drums does not reflect the building of the same number.
7. Use of the Roman numeral VII for beryllium-contaminated wastes is unique to this report. However, there is a report that this numeral was used in WasteOScope to identify off-site (non-

RFP) waste, and in other instances, it identified unknowns or empty drums. During the review of the WasteOScope download, the VII waste code was not found.

Summaries of the waste by waste type designations as disposed of in the RWMC trenches and pits are presented in Table A-2 and Table A-3, respectively. The first column is how the designator entered in the database was re-assigned for the as-disposed of totals for this report based on the discrepancy resolution, RF-D001 (Appendix B).

Table A-2

Final Waste Form	WasteOScope Waste ID	Building 122		Building 123		Building 331		Building 441	
		Container Count	Volume (cu ft)						
I	D	0	0	0	0	0	0	0	0
I	W	0	0	0	0	0	0	0	0
I	I	4	29	30	217	105	771	22	192
I or V	F	0	0	0	0	0	0	0	0
I or V	FW	0	0	0	0	0	0	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	0	0	0	0	0	0	0	0
I or V	LGW	0	0	0	0	0	0	0	0
I or V	U233	0	0	0	0	0	0	0	0
II	A	0	0	0	0	0	0	0	0
II	II	0	0	0	0	0	0	0	0
III	K	0	0	0	0	0	0	0	0
III	III	0	0	0	0	0	0	0	0
IV	IV	0	0	0	0	1	7	3	17
V	C	0	0	0	0	0	0	0	0
V	CC	0	0	0	0	0	0	0	0
V	CM	0	0	0	0	0	0	0	0
V	CR	0	0	0	0	0	0	0	0
V	Empty	0	0	1	12	0	0	0	0
V	M	0	0	0	0	0	0	0	0
V	N	0	0	0	0	0	0	0	0
V	RO	0	0	0	0	0	0	0	0
V	SH	0	0	0	0	0	0	0	0
V	V	0	0	52	378	53	568	115	833
VI	B	0	0	0	0	0	0	0	0
VI	G (444)	0	0	0	0	0	0	0	0
VI	VI	0	0	0	0	0	0	0	0
VII	VII (BE)	0	0	0	0	2	197	1	7
TOTALS		4	29	83	608	161	1544	141	1049

Final Waste Form	WasteOScope Waste ID	Building 444		Building 447		Building 551		Building 553	
		Container Count	Volume (cu ft)						
I	D	26	219	0	0	0	0	0	0
I	W	0	0	0	0	0	0	0	0
I	I	5848	60680	0	0	9	920	1	112
I or V	F	164	1202	0	0	0	0	0	0
I or V	FW	0	0	0	0	0	0	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	436	2794	0	0	0	0	0	0
I or V	LGW	0	0	0	0	0	0	0	0
I or V	U233	0	0	0	0	0	0	0	0
II	A	123	748	0	0	0	0	0	0
II	II	738	4452	0	0	0	0	0	0
III	K	60	438	0	0	0	0	0	0
III	III	1007	6329	0	0	0	0	0	0
IV	IV	165	1176	0	0	0	0	0	0
V	C	1438	10209	0	0	0	0	0	0
V	CC	19	140	0	0	0	0	0	0
V	CM	4	28	0	0	0	0	0	0
V	CR	0	0	0	0	0	0	0	0
V	Empty	2	25	0	0	0	0	0	0
V	M	5	35	0	0	0	0	0	0
V	N	27	199	0	0	0	0	0	0
V	RO	668	4910	0	0	0	0	0	0
V	SH	0	0	0	0	0	0	0	0
V	V	10800	113663	1	215	9	920	1	112
VI	B	2	15	0	0	0	0	0	0
VI	G (444)	1053	6857	0	0	0	0	0	0
VI	VI	57	195	0	0	0	0	0	0
VII	VII (BE)	2412	19224	0	0	0	0	0	0
TOTALS		25054	233539	1	215	18	1840	2	224

Final Waste Form	WasteOScope Waste ID	Building 559		741 Sludge		742 Sludge		743 Sludge	
		Container Count	Volume (cu ft)						
I	D	0	0	0	0	0	0	0	0
I	W	0	0	0	0	0	0	0	0
I	I	491	3269	675	4788	765	5652	2	15
I or V	F	0	0	0	0	0	0	0	0
I or V	FW	0	0	0	0	0	0	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	1	7	0	0	0	0	0	0
I or V	LGW	3	12	1	4	0	0	0	0
I or V	U233	0	0	0	0	3	22	0	0
II	A	0	0	0	0	0	0	0	0
II	II	0	0	0	0	0	0	0	0
III	K	0	0	0	0	0	0	0	0
III	III	1	7	4	15	29	328	0	0
IV	IV	0	0	8861	61697	14713	108156	8437	62022
V	C	0	0	77	415	0	0	0	0
V	CC	0	0	0	0	0	0	0	0
V	CM	0	0	5	36	20	146	0	0
V	CR	0	0	0	0	0	0	0	0
V	Empty	0	0	1	7	0	0	0	0
V	M	0	0	0	0	0	0	0	0
V	N	0	0	0	0	0	0	0	0
V	RO	0	0	0	0	0	0	0	0
V	SH	0	0	0	0	0	0	0	0
V	V	486	6301	154	956	403	4079	0	0
VI	B	0	0	0	0	0	0	0	0
VI	G (444)	0	0	0	0	0	0	0	0
VI	VI	0	0	0	0	0	0	0	0
VII	VII (BE)	0	0	0	0	8	59	0	0
TOTALS		982	9596	9778	67919	15941	118442	8439	62037

Final Waste Designation	WasteOScope Waste ID	Building 774		Building 776		Building 777		Building 779	
		Container Count	Volume (cu ft)						
I	D	0	0	0	0	0	0	0	0
I	W	0	0	2	15	0	0	0	0
I	I	20	2183	15529	222101	8158	107410	495	4427
I or V	F	0	0	0	0	0	0	0	0
I or V	FW	3	336	22	1941	37	2792	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	0	0	112	823	0	0	0	0
I or V	LGW	0	0	544	4104	0	0	0	0
I or V	U233	0	0	0	0	0	0	0	0
II	A	0	0	0	0	0	0	0	0
II	II	0	0	42	4080	5	351	1	7
III	K	0	0	0	0	0	0	0	0
III	III	13	842	960	19889	144	6887	33	355
IV	IV	689	3201	69	505	5	37	11	81
V	C	0	0	0	0	0	0	0	0
V	CC	0	0	0	0	0	0	0	0
V	CM	0	0	0	0	0	0	0	0
V	CR	935	6856	0	0	0	0	0	0
V	Empty	0	0	107	997	0	0	0	0
V	M	0	0	0	0	0	0	0	0
V	N	0	0	0	0	0	0	0	0
V	RO	0	0	0	0	0	0	0	0
V	SH	0	0	0	0	0	0	0	0
V	V	34	4305	9917	222877	3347	90160	408	3802
VI	B	0	0	0	0	0	0	0	0
VI	G (444)	0	0	0	0	0	0	0	0
VI	VI	0	0	13	95	0	0	0	0
VII	VII (BE)	0	0	0	0	0	0	1	4
TOTALS		1694	17723	27317	477427	11696	207636	949	8677

Final Waste Designation	WasteOScope Waste ID	870 Oil Waste		871 Oil Waste		872 Oil Waste		892 Oil Waste	
		Container Count	Volume (cu ft)						
I	D	0	0	0	0	0	0	0	0
I	W	0	0	0	0	0	0	0	0
I	I	0	0	0	0	0	0	0	0
I or V	F	0	0	0	0	0	0	0	0
I or V	FW	0	0	0	0	0	0	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	0	0	0	0	0	0	0	0
I or V	LGW	0	0	0	0	0	0	0	0
I or V	U233	0	0	0	0	0	0	0	0
II	A	0	0	0	0	0	0	0	0
II	II	0	0	0	0	0	0	0	0
III	K	0	0	0	0	0	0	0	0
III	III	0	0	0	0	0	0	0	0
IV	IV	1	7	1	7	1	7	12	88
V	C	0	0	0	0	0	0	0	0
V	CC	0	0	0	0	0	0	0	0
V	CM	0	0	0	0	0	0	0	0
V	CR	0	0	0	0	0	0	0	0
V	Empty	0	0	0	0	0	0	0	0
V	M	0	0	0	0	0	0	0	0
V	N	0	0	0	0	0	0	0	0
V	RO	0	0	0	0	0	0	0	0
V	SH	0	0	0	0	0	0	0	0
V	V	56	412	0	0	0	0	0	0
VI	B	0	0	0	0	0	0	0	0
VI	G(444)	0	0	0	0	0	0	0	0
VI	VI	0	0	0	0	0	0	0	0
VII	VII (BE)	0	0	0	0	0	0	0	0
TOTALS		57	419	1	7	1	7	12	88

Final Waste Designation	WasteOScope Waste ID	Building 881		Building 883		Building 886		Building 889	
		Container Count	Volume (cu ft)						
I	D	0	0	0	0	0	0	0	0
I	W	0	0	0	0	0	0	0	0
I	I	2842	88858	1524	22326	110	1041	57	2601
I or V	F	0	0	0	0	0	0	0	0
I or V	FW	0	0	0	0	0	0	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	0	0	0	0	0	0	0	0
I or V	LGW	0	0	0	0	0	0	0	0
I or V	U233	66	485	0	0	0	0	0	0
II	A	0	0	0	0	0	0	0	0
II	II	11	183	12	611	0	0	3	343
III	K	0	0	0	0	0	0	0	0
III	III	2934	17058	12	374	10	61	0	0
IV	IV	376	2775	94	648	0	0	8	59
V	C	1	7	0	0	0	0	0	0
V	CC	0	0	0	0	0	0	0	0
V	CM	0	0	0	0	0	0	0	0
V	CR	0	0	0	0	0	0	0	0
V	Empty	2	15	0	0	0	0	0	0
V	M	0	0	0	0	0	0	0	0
V	N	0	0	0	0	0	0	0	0
V	RO	0	0	2	8	0	0	0	0
V	SH	0	0	0	0	0	0	0	0
V	V	5684	138030	2145	33488	123	1129	90	3471
VI	B	0	0	0	0	0	0	0	0
VI	G(444)	0	0	0	0	0	0	0	0
VI	VI	37	266	0	0	0	0	0	0
VII	VII (BE)	15	110	65	478	0	0	0	0
TOTALS		11968	247786	3854	57933	243	2231	158	6474

Final Waste Designation	WasteOScope Waste ID	Building 991		RFP Generator TOTALS	
		Container Count	Volume (cu ft)	Container Count	Volume (cu ft)
I	D	0	0	26	219
I	W	0	0	112	821
I	I	2205	16922	92998	1048933
I or V	F	0	0	164	1202
I or V	FW	0	0	4573	42720
I or V	G	0	0	0	0
I or V	Graphite	0	0	1349	9154
I or V	LGW	0	0	872	6458
I or V	U233	0	0	78	572
II	A	0	0	123	748
II	II	0	0	1964	20788
III	K	0	0	60	438
III	III	1	122	9389	125220
IV	IV	1	7	41524	301310
V	C	0	0	1586	11146
V	CC	0	0	19	140
V	CM	0	0	29	210
V	CR	0	0	935	6856
V	Empty	0	0	4150	47825
V	M	0	0	6	42
V	N	0	0	27	199
V	RO	0	0	683	5014
V	SH	0	0	1	7
V	V	567	9474	62319	1027534
VI	B	0	0	2	15
VI	G (444)	0	0	1053	6857
VI	VI	0	0	113	600
VII	VII (BE)	32	234	2546	20386
TOTALS		2806	26759	226701	2685415

Table A-3

Final Waste Designation	WasteOScope Waste ID	Bureau of Reclamation		Coors Porcelain Company		University of Colorado School of Medicine		DOW Construction		Denver Research Institute		Lawry Air Force Base	
		Container Count	Volume (cu ft)	Container Count	Volume (cu ft)	Container Count	Volume (cu ft)	Container Count	Volume (cu ft)	Container Count	Volume (cu ft)	Container Count	Volume (cu ft)
I	W							3	22	0	0	0	0
I	I			1	7.35			846	11574.95	13	92	92	132,707.5
I or V	LGW							18	132	0	0	0	0
II	II							5	26.35	0	0	0	0
III	III							3903	18435.3	2	25	25	0
IV	IV							891	6941.9	0	0	0	0
V	Empty							90	858	0	0	0	0
V	V	2	21					1224	21636.2	11	77	77	18.5
VII	VII (BE)				191.1			16	185	4	22	22	0
TOTALS		2	21	1	7.35			6996	59811.7	30	216	216	151,207.5
Final Waste Form	WasteOScope Waste ID	Lawrence Livermore Laboratories		Martin Aircraft		Colorado School of Mines		Sunstrand		U.S. Geological Survey		Off-Site Generators Totals	
		Container Count	Volume (cu ft)	Container Count	Volume (cu ft)	Container Count	Volume (cu ft)	Container Count	Volume (cu ft)	Container Count	Volume (cu ft)	Container Count	Volume (cu ft)
I	W											3	22
I	I	42	308.7			4	29			11	79.75	1009	12224.46
I or V	LGW									0	0	18	132
II	II									0	0	5	26.35
III	III									0	0	3905	18460.3
IV	IV									0	0	891	6941.9
V	Empty									0	0	90	858
V	V			9	65.75	1	7	40	286.35	14	101.75	1307	22213.55
VII	VII (BE)											46	398.1
TOTALS		42	308.7	9	65.75	5	36	40	286.35	25	181.5	7274	61276.66

Table A-4.

Final Waste Designation	WasteOScope Waste ID	Pit 1		Pit 2		Pit 3		Pit 4	
		Container Count	Volume (cu ft)						
I	D	0	0	24	204	2	15	0	0
I	W	0	0	0	0	0	0	0	0
I	I	11099	85398	12922	98367	3220	23747	19530	152589
I or V	F	9	66	155	1136	0	0	0	0
I or V	FW	0	0	0	0	0	0	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	397	2507	0	0	0	0	384	2822
I or V	LGW	0	0	0	0	0	0	218	1717
I or V	U233	0	0	0	0	0	0	0	0
II	A	7	51	98	565	0	0	18	132
II	II	271	1541	19	465	12	396	64	469
III	K	0	0	56	409	0	0	4	29
III	III	3032	13199	2225	10959	32	235	2613	24426
IV	IV	2979	21918	3883	28552	805	5945	9300	69766
V	C	205	1352	1063	8136	0	0	6	44
V	CC	0	0	0	0	0	0	0	0
V	CM	28	203	0	0	0	0	0	0
V	CR	0	0	0	0	0	0	0	0
V	Empty	0	0	11	85	0	0	567	5614
V	M	0	0	5	35	0	0	0	0
V	N	0	0	27	199	0	0	0	0
V	RO	0	0	0	0	0	0	243	1788
V	SH	0	0	0	0	0	0	0	0
V	V	5054	52191	6171	71168	1392	16481	10275	129140
VI	B	2	15	0	0	0	0	0	0
VI	G (444)	0	0	0	0	0	0	8	59
VI	VI	113	600	0	0	0	0	0	0
VII	VII (BE)	88	652	532	3987	155	1154	719	5608
TOTALS		23284	179693	27191	224269	5618	47973	43949	394203

Final Waste Designation	WasteOScope Waste ID	Pit 5		Pit 6		Pit 7		Pit 8	
		Container Count	Volume (cu ft)						
I	D	0	0	0	0	0	0	0	0
I	W	95	696	0	0	0	0	0	0
I	I	11053	104042	6322	76469	0	0	0	0
I or V	F	0	0	0	0	0	0	0	0
I or V	FW	0	0	0	0	0	0	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	187	1373	0	0	0	0	0	0
I or V	LGW	8	58	139	1023	0	0	9	66
I or V	U233	76	557	2	15	0	0	0	0
II	A	0	0	0	0	0	0	0	0
II	II	29	210	14	103	0	0	0	0
III	K	0	0	0	0	0	0	0	0
III	III	1007	21782	276	4690	0	0	0	0
IV	IV	2957	21824	6285	46210	0	0	0	0
V	C	0	0	0	0	0	0	0	0
V	CC	0	0	0	0	0	0	0	0
V	CM	0	0	0	0	0	0	0	0
V	CR	0	0	0	0	0	0	0	0
V	Empty	0	0	3181	37433	0	0	0	0
V	M	1	7	0	0	0	0	0	0
V	N	0	0	0	0	0	0	0	0
V	RO	98	721	147	1072	0	0	0	0
V	SH	1	7	0	0	0	0	0	0
V	V	7286	154611	6334	111323	3	22	0	0
VI	B	0	0	0	0	0	0	0	0
VI	G(444)	0	0	2	15	0	0	0	0
VI	VI	0	0	0	0	0	0	0	0
VII	VII (BE)	720	6604	85	624	0	0	0	0
TOTALS		23518	312491	22787	278977	3	22	9	66

Final Waste Designation	WasteOScope Waste ID	Pit 9		Pit 10		Pit 11		Pit 12	
		Container Count	Volume (cu ft)						
I	D	0	0	0	0	0	0	0	0
I	W	0	0	20	147	0	0	0	0
I	I	3330	86554	18256	361782	90	10080	54	6048
I or V	F	0	0	0	0	0	0	0	0
I or V	FW	0	0	4573	42720	0	0	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	0	0	381	2452	0	0	0	0
I or V	LGW	149	1095	367	2631	0	0	0	0
I or V	U233	0	0	0	0	0	0	0	0
II	A	0	0	0	0	0	0	0	0
II	II	0	0	224	4786	0	0	36	4032
III	K	0	0	0	0	0	0	0	0
III	III	109	4955	551	42014	641	3101	18	2016
IV	IV	2159	16143	8898	61526	4	29	16	118
V	C	0	0	70	515	0	0	0	0
V	CC	0	0	0	0	0	0	0	0
V	CM	0	0	0	0	0	0	0	0
V	CR	0	0	0	0	0	0	0	0
V	Empty	0	0	405	4993	0	0	0	0
V	M	0	0	0	0	0	0	0	0
V	N	0	0	0	0	0	0	0	0
V	RO	8	59	187	1375	0	0	0	0
V	SH	0	0	0	0	0	0	0	0
V	V	3467	77528	18115	380551	90	10080	62	7280
VI	B	0	0	0	0	0	0	0	0
VI	G(444)	0	0	0	0	0	0	0	0
VI	VI	0	0	0	0	0	0	0	0
VII	VII (BE)	5	37	288	2117	0	0	0	0
TOTALS		9227	186371	52335	907608	825	23290	186	19494

Final Waste Designation	WasteOScope Waste ID	Pit 13		Waste Totals for SDA Pits	
		Container Count	Volume (cu ft)	Container Count	Volume (cu ft)
I	D	0	0	26	219
I	W	0	0	115	843
I	I	0	0	85876	1005076
I or V	F	0	0	164	1202
I or V	FW	0	0	4573	42720
I or V	G	0	0	0	0
I or V	Graphite	0	0	1349	9154
I or V	LGW	0	0	890	6590
I or V	U233	0	0	78	572
II	A	0	0	123	748
II	II	0	0	669	12001
III	K	0	0	60	438
III	III	0	0	10504	127377
IV	IV	0	0	37286	272031
V	C	0	0	1344	10048
V	CC	0	0	0	0
V	CM	0	0	28	203
V	CR	0	0	0	0
V	Empty	76	558	4240	48683
V	M	0	0	6	42
V	N	0	0	27	199
V	RO	0	0	683	5014
V	SH	0	0	1	7
V	V	0	0	58249	1010376
VI	B	0	0	2	15
VI	G(444)	0	0	10	74
VI	VI	0	0	113	600
VII	VII (BE)	0	0	2592	20784
TOTALS		76	558	609008	2575015

Table A-5.

Final Waste Designation	WasteOScope Waste ID	Trench 1		Trench 2		Trench 3		Trench 4	
		Container Count	Volume (cu ft)						
I	D	0	0	0	0	0	0	0	0
I	W	0	0	0	0	0	0	0	0
I	I	1068	4919	474	3249	660	4844	866	6255
I or V	F	0	0	0	0	0	0	0	0
I or V	FW	0	0	0	0	0	0	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	0	0	0	0	0	0	0	0
I or V	LGW	0	0	0	0	0	0	0	0
I or V	U233	0	0	0	0	0	0	0	0
II	A	0	0	0	0	0	0	0	0
II	II	0	0	0	0	58	426	751	5516
III	K	0	0	0	0	0	0	0	0
III	III	0	0	0	0	1005	5502	830	6087
IV	IV	839	4366	99	728	292	2148	1257	9236
V	C	203	812	0	0	27	198	0	0
V	CC	0	0	0	0	19	140	0	0
V	CM	0	0	0	0	0	0	0	0
V	CR	150	1103	75	551	104	764	0	0
V	Empty	0	0	0	0	0	0	0	0
V	M	0	0	0	0	0	0	0	0
V	N	0	0	0	0	0	0	0	0
V	RO	0	0	0	0	0	0	0	0
V	SH	0	0	0	0	0	0	0	0
V	V	466	2042	396	2736	145	1019	1812	12920
VI	B	0	0	0	0	0	0	0	0
VI	G(444)	118	516	0	0	75	551	0	0
VI	VI	0	0	0	0	0	0	0	0
VII	VII (BE)	0	0	0	0	0	0	0	0
TOTALS		2844	13757	1044	7265	2385	15593	5516	40015

Final Waste Designation	WasteOScope Waste ID	Trench 5		Trench 6		Trench 7		Trench 8	
		Container Count	Volume (cu ft)						
I	D	0	0	0	0	0	0	0	0
I	W	0	0	0	0	0	0	0	0
I	I	1079	7230	1107	7485	656	4811	703	4435
I or V	F	0	0	0	0	0	0	0	0
I or V	FW	0	0	0	0	0	0	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	0	0	0	0	0	0	0	0
I or V	LGW	0	0	0	0	0	0	0	0
I or V	U233	0	0	0	0	0	0	0	0
II	A	0	0	0	0	0	0	0	0
II	II	87	621	21	145	23	168	67	382
III	K	0	0	0	0	0	0	0	0
III	III	130	826	1	7	2	9	820	3862
IV	IV	474	3417	561	4122	431	3167	377	3182
V	C	0	0	4	29	0	0	8	59
V	CC	0	0	0	0	0	0	0	0
V	CM	0	0	0	0	0	0	1	7
V	CR	405	2962	185	1360	16	116	0	0
V	Empty	0	0	0	0	0	0	0	0
V	M	0	0	0	0	0	0	0	0
V	N	0	0	0	0	0	0	0	0
V	RO	0	0	0	0	0	0	0	0
V	SH	0	0	0	0	0	0	0	0
V	V	240	1699	352	2539	317	2338	469	4256
VI	B	0	0	0	0	0	0	0	0
VI	G(444)	187	1310	184	1315	116	853	176	1173
VI	VI	0	0	0	0	0	0	0	0
VII	VII (BE)	0	0	0	0	0	0	0	0
TOTALS		2602	18066	2415	17002	1561	11462	2621	17355

Final Waste Designation	WasteOScope Waste ID	Trench 9		Trench 10		Trench 19		Trench 32	
		Container Count	Volume (cu ft)						
I	D	0	0	0	0	0	0	0	0
I	W	0	0	0	0	0	0	0	0
I	I	929	6741	255	2294	26	1539	308	2278
I or V	F	0	0	0	0	0	0	0	0
I or V	FW	0	0	0	0	0	0	0	0
I or V	G	0	0	0	0	0	0	0	0
I or V	Graphite	0	0	0	0	0	0	0	0
I or V	LGW	0	0	0	0	0	0	0	0
I or V	U233	0	0	0	0	0	0	0	0
II	A	0	0	0	0	0	0	0	0
II	II	82	331	211	1223	0	0	0	0
III	K	0	0	0	0	0	0	0	0
III	III	2	9	0	0	0	0	0	0
IV	IV	441	3238	206	1493	0	0	152	1124
V	C	0	0	0	0	0	0	0	0
V	CC	0	0	0	0	0	0	0	0
V	CM	0	0	0	0	0	0	0	0
V	CR	0	0	0	0	0	0	0	0
V	Empty	0	0	0	0	0	0	0	0
V	M	0	0	0	0	0	0	0	0
V	N	0	0	0	0	0	0	0	0
V	RO	0	0	0	0	0	0	0	0
V	SH	0	0	0	0	0	0	0	0
V	V	531	3908	467	3224	26	1539	156	1154
VI	B	0	0	0	0	0	0	0	0
VI	G(444)	187	1066	0	0	0	0	0	0
VI	VI	0	0	0	0	0	0	0	0
VII	VII (BE)	0	0	0	0	0	0	0	0
TOTALS		2172	15294	1139	8234	52	3078	616	4556

Final Waste Designation	WasteOScope Waste ID	Waste Totals for SDA		Waste Totals for SDA Pits	
		Container Count	Volume (cu ft)	Container Count	Volume (cu ft)
I	D	0	0	26	219
I	W	0	0	115	843
I	I	8131	56082	94007	1061158
I or V	F	0	0	164	1202
I or V	FW	0	0	4573	42720
I or V	G	0	0	0	0
I or V	Graphite	0	0	1349	9154
I or V	LGW	0	0	890	6590
I or V	U233	0	0	78	572
II	A	0	0	123	748
II	II	1300	8813	1969	20814
III	K	0	0	60	438
III	III	2790	16303	13294	143680
IV	IV	5129	36221	42415	308252
V	C	242	1099	1586	11146
V	CC	19	140	19	140
V	CM	1	7	29	210
V	CR	935	6856	935	6856
V	Empty	0	0	4240	48683
V	M	0	0	6	42
V	N	0	0	27	199
V	RO	0	0	683	5014
V	SH	0	0	1	7
V	V	5377	39372	63626	1049748
VI	B	0	0	2	15
VI	G(444)	1043	6783	1053	6857
VI	VI	0	0	113	600
VII	VII (BE)	0	0	2592	20784
TOTALS		24967	171676	233975	2746691

Appendix B
RF-D001 Discrepancy Resolution

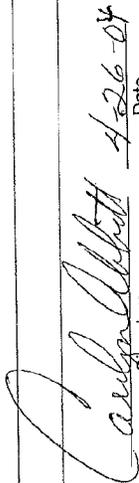
**ACCEPTABLE KNOWLEDGE
SOURCE DOCUMENT DISCREPANCY RESOLUTION**

Waste Generator: Rocky Flats							
Associated Source Document Tracking Number	Source Document Tracking Number: RF-D001	Revision: 4-26-04 cka	Source Document Title	Document No./Rev. No.	Author	Date	Page No.
RF-C028			Memo to Paul Sentier re: pre 1970 RFP waste	NA / NA	Ed Vejvoda	11/7/2002	2
RF-C032			Letter to K. J. Holdren re: EPA Region 10 Requests	NA / NA	Ed Vejvoda (LATA)	2/12/2002	2
RF-C105			Letter to Rod Thomas re: Rocky Flats Waste Information	NA / NA	Ed Vejvoda, LATA	7/17/2000	38
RF-C110			Letter from Ed Vejvoda (LATA) to Rod Thomas (BBW!) re: Responses to Faxes of 6/28/00 and 7/10/00	NA / NA	Ed Vejvoda	8/23/2000	2
RF-C124			Memo from L. C. Farrrell re: Waste Shipments	NA / NA	L. C. Farrrell	9/18/1957	2
RF-U095			Study of Disposal of Radioactive Waste: Rocky Flat Colorado.	NA / NA	N/A	N/A	1
RF-C045			Rod Thomas' notes on telephone conversations with Ed Vejvoda, LATA	NA / NA	Rod Thomas	6/20/2001	106, 140
RF-U132			Letter to F.H. Langell, Dow Chemical, re: off site solid waste disposal	NA / NA	Gilbert C. Hoover	12/17/1963	4
RF-U026			Rocky Flats to INEEL Shipping and Loading Record Search for the 960's and Early 970's.	NA / Interim	E. Vejvoda	12/11/1998	5
RF-U169			WasteOScope Database Download: RFP Pre-71 Disposals.pdf	NA / NA	NA	1/15/2004	CD

Nature of Discrepancy:
Different definitions or descriptions of waste types I, II, III, IV, V, and VI generated at RF pre-1970. Also some differences in how wastes were defined by different RF facilities were identified in some of the source documents.

Resolution:
Seven Roman numeral designations will be used by this project to identify waste forms identified in AK source documents as shown in the attached Discrepancy Resolution RF-D001 document.

Discrepancy Resolved: Yes No

AK Personnel: Carolyn Abbott  Date: 4-26-04

Print Name _____

**ACCEPTABLE KNOWLEDGE
SOURCE DOCUMENT DISCREPANCY RESOLUTION**

Nature of Discrepancy: Different definitions or descriptions of waste types I, II, III, IV, V, and VI generated at RF pre-1970. Also some differences in how wastes were defined by different RF facilities were identified in some of the source documents. Examples of discrepancies identified include: A definition of Type II as glass and ceramics and not filter paper (RF-U026 and RF-C045); sludge wastes other than those identified in the brief description without a waste type assignment (e.g., Drum prefixes used to indicate the type of sludge generated from building 774 (i.e., 741 for first stage sludge; 742 for second stage sludge; 743 for grease plant (organic based) sludge; 744 for solidified liquid (bottle process); 745 for evaporator (mainly nitrate) salts; and 7412 a combination of first and second stage sludges). The attached table includes indications of additional discrepancies and the appropriate assignment of waste type designators for this project.

Resolution: Seven Roman numeral designations will be used by this project to identify waste forms identified in AK source documents as shown in the attached table. The following is the initial waste type descriptions and the basis for the final descriptions presented in the attached table.

The I through VI designators used in most of the AK documents (RF-C028, RF-C032, RF-C124, RF-C140, RF-U115) reviewed are briefly described below:

- Type I = combustibles, such as paper, rags, wood, etc. also defined as housekeeping wastes in some documents (RF-C028) and for building 444 waste an alpha category, D, was also used for this designation;
- Type II = filter paper, including fiber/fibrous pads (containing asbestos), and non-HEPA filters. Building 444 filter paper waste was identified with an alpha category, A;
- Type III = Filters and filter media, defined as including Chemical Warfare System (C.W.S.) and HEPA filters such as from glove boxes;
- Type IV = Sludges and MUD, including co-precipitation treatment sludge, Building 444 perchloroethylene still bottoms (Building 444 designation G);
- Type V = Non-combustibles, such as glass, scrap metal, firebrick, spent equipment, wire, electric motors, piping, sheet metal, also including glove box material, tantalum molds, Building 444 Type V waste, metal fire brick, graphite, cyanide cement, and miscellaneous non-combustibles were designated alpha categories of C, F, M, and N respectively.
- Type VI = Organic wastes (this includes coolant still bottoms, and contaminated waste oil, and Building 444 perchloroethylene still bottoms (Building 444 designation G).

We also will be using additional Roman numerals as follows:

- Type VII = Beryllium contaminated waste (debris) identified in the WasteOScope database as Be, Be(I), Be(II), Be(V), etc. Many of the source documents and the WasteOScope database specify Be containers or waste. (This is to provide Be as a searchable item in the AK document database.)
- Other letter or numerical designators also were used in some cases during the pre-1970 time frame to identify waste or to signify radioisotope levels. Also in the early period of shipping, categories I (combustibles) and V (noncombustibles) were often mixed and are indicted as I & V on several load lists.

Additional confusion might result because the waste type was sometimes referred to as "Type" or as "Category." "Category" or "Group" was also used with a roman number in some cases in reference to ICC designations pertaining to radioactive material levels in the waste. Specifically, the letter G with the Roman numeral IV applied to waste in classified shipments designated fissile content over a certain limit (limit not specified), however with the initials R and B, indicated the color (red or blue) of the label indicating >15 g Pu or < 15 g Pu, respectively.

The attached table is provided to identify the relationship between different waste designators identified in the AK documents reviewed and the Roman numerals (I, II, III, IV, V, VI, and VII).

Discrepancy Resolved: Yes No

AK Personnel: Carolyn K. Abbott

Print

Sign

Date

Carolyn K. Abbott 4/26/04

ACCEPTABLE KNOWLEDGE
SOURCE DOCUMENT DISCREPANCY RESOLUTION

Roman Numeral Designator	Waste Form Description or definition for the designation used	Other designators identified in AK Source Document (Reference)	References**
Debris Waste Forms Type I	(I, II, III, V, VII)		2, 9, 8, 10, 11, 12
	Combustibles, paper, rags, wood, plastics, cloth, etc.		9
	Graphite -- considered a combustible in some cases		1, 6
	Housekeeping waste	Building (Drum prefix) 441 (41)	*9
	Graphite	Building (Drum prefix) 771 (71)	*9
	Wet and Dry combustibles, graphite	Building (Drum prefix) 881 (81)	*9
	Wet and Dry combustibles, HEU (Oralloy)graphite	Building (Drum prefix) 886 (86)	*9
	Operating, Housekeeping wastes	Building (Drum prefix) 889 (89)	*9
	Housekeeping wastes	Building (Drum prefix) 991 (91)	*9
	Operating, Housekeeping wastes	D	3, 11, 12
	Paper, wood	W	3
	Washed or wet plastics or other combustibles	G (Generator 71)	3
	Graphite	771-596	5, 3
	1969 Fire waste	Cat I or V	3
	PPE, gloves, blankets etc with asbestos	Type I	11
	Graphite molds, crucibles & combustibles from Bldg 881 and thorium fabrication combustibles		
	Bioassay & Medical Wastes (Radioactively contaminated)	Drum prefixes 121, 122, 123 combustibles	*9, 11
	Graphite	Graphite	12
	Plastics	Benelex	12
	Zero Power Plutonium Reactor wastes (debris)	ZPPR	3
	Uranium contaminated debris - single Type I or Type V or combination of them	U233	12
	Line generated waste - single Type I or Type V or combination of them	LGW	12
	Debris wastes - single Type I or Type V or combination of them	HITE	12
Combustibles	W	12	
Wet or Washed combustibles	Type I W	12	
Type II	Filter paper	Building (Drum prefix) 771 (71)	2, 6, 8, 10, 11, 12
	Filter pads		*9
	Filter pads	Building (Drum prefix) 881 (81)	*9
	Filter paper	Building 444 Type A	3, 11
	Fibrous pad - asbestos fibers. Non-HEPA (machining filters)	Type II	3
Filter paper	A	12	

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Roman Numeral Designator	Waste Form Description or definition for the designation used	Other designators identified in AK Source Document (Reference)	References**
Type III	Filters and insulation media		8, 12
	CWS type filters (Chemical Warfare System)		2, 6, 9, 10, 11
	Glovebox filters		3
	Plenum filters from 81 (in cartons)	Type III	3
	HEPA filters	Type III	11
	CWS filters	Bureau of Explosives permit number: 2060	11
	1969 Fire waste	771-596	5, 3
	Zero Power Plutonium Reactor wastes (debris)	ZPPR	3
	Process waste filter (should be type III)	K	11, 12
Type V	Noncombustibles; glass, scrap metal, brick, etc.		2, 5, 6, 3, 8, 10, 11, 12
	Maintenance waste		1
	Waste from the stripout of HEU equipment in the late 1960's and early 1970's were Type V noncombustibles.		11
	Metal based objects, wire, electric motors, piping, sheet metal, etc.		9
	Aluminum, steel, DU, Graphite	Building (Drum prefix) 441 (41)	*9
	DU, Steels, Aluminum, Graphite Molds	Building (Drum prefix) 444 (44)	*9
	Graphite, Ion-exchange resins, glass	Building (Drum prefix) 771 (71)	*9, 12
	Glass	Building (Drum prefix) 881 (81)	*9
	spent equipment, glove box material	Category V	3
	Roaster oxide - U ₃ O ₈ compound formed when depleted uranium chips were burned. (could contain up to 0.28 to 0.35% U-235). Listed as debris.	RO	3, 12
	RO mixed with organics	L	3
	Empty drums	MTD	3
	Empty containers	MTC, Empty, 'Y', VII	3, 12, 12
	Raschig rings -	Category II in some docs	3
	Metal Firebrick from Building 444	C	3, 11, 12
	Graphite (e.g. molds) from Building 444	F	3, 11, 12
	Misc. noncombustibles from Building 444	N	3, 11, 12
	MgO molds - ceramic	Type II - discrepant	3
	Tantalum Molds	Building 776 - metal	3
	1969 Fire waste	771-596	5, 3
	Silica type filters - acid resistant - ground up glass	Cat. V	3
	PPE, gloves, blankets etc with asbestos	Cat I or V	3

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Roman Numeral Designator	Waste Form Description or definition for the designation used	Other designators identified in AK Source Document (Reference)	References**
Type V cont'd	Filter media categorized w/furnace insulation	Cat V	3
	Cyanide cement from Building 444	M, CM	3, 11, 12
	Non combustible waste	N	12
	Magnesium oxide crucibles	Type V	11
	HEU equipment/waste	Type V	11
	Emission spectrographic graphite electrodes & spend lab equip	Noncombustibles	11
	Empty drums, cardboard cartons, wooden boxes	Empty	12
	Oxide	Oxide	12
	Cemented firebrick	C	3, 12
	Concreted raffinate	CR	3, 12
	Zero Power Plutonium Reactor wastes (debris)	ZPPR	3
	Firebrick	Firebrick	12
	Slag Heel	Slag heel, SH	12
	Roaster oxide contaminated noncombustibles	Type V RO	12
	Wet noncombustibles	Type V W	12
	Noncombustibles from Research & Development activities	Type V R&D	12
	Type VII	Beryllium contaminated waste; U/Be fabrication process waste; grinding wheels and motors w/Be and D38 contamination; foundry waste	Be
Beryllium		Building (Drum prefix) 441 (41)	*9
Beryllium		Building (Drum prefix) 444 (44)	*9
Beryllium		Building (Drum prefix) 776/777 (76/77)	*9
Be		Coors Be drums	3
DU and Be contaminated waste		Bldg. 444/447	11
Steel can cuttings from Be-forming processed (Bldg. 883A) - Be contaminated		Type V	11
Beryllium contaminated combustibles		Be(I)	12
Beryllium contaminated noncombustibles		Be(V)	12
Homogeneous solids/Sludges and solidified liquids (IV and VI)			
Type IV	Sludges from co-precipitation treatment, etc.		2, 3, 8, 10, 11
	Sludges and MUD: Impure materials contaminated with HEU ground to a fine powder for nitric acid leaching. The nitric acid solution was filtered and the solids collected from the process were called MUD. The MUD was dried, assayed, packaged into drums and shipped to the INEEL as Type IV sludge.		6, 11

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Roman Numeral Designator	Waste Form Description or definition for the designation used	Other designators identified in AK Source Document (Reference)	References**
Type IV	MUD from Bldg. 81 & 83	A (DU); B (HEU)	3
	First stage sludge	Generator or Drum prefix 741	3, 9, 12
	Second stage sludge	Generator or Drum prefix 742	3, 9, 12
	Solidified liquid (bottle process)	Generator or Drum prefix 744	3, 9
	Evaporator (mainly nitrate) salts	Generator or Drum prefix 745	3, 9
	Combination of first and second stage sludges	Drum prefix 7412	9
	Sludge	Generator 771, identified as Type IV in Ref 12	12
	Sludge from DOW could be organic (VI) or inorganic (IV)	Generator is DOW identified as Type IV in Ref 12	12
	Cemented cyanide (homogeneous solid?)	CC	12
	Molten salts (776 item - mixed into 741 sludge process)	741 sludge	3
	Spent salt baths w/Uranium oxide	Type IV	11
	Aqueous lathe coolants (D-38 machining) (2 nd stage sludge precipitation)	Type IV	3, 11
Type VI	Contaminated organics (55 gallon oil drums)	VI	6, 12
	Sludge	Generator 331; identified as Type IV in Ref 12	12
	Sludge	Generator 444 identified as Type IV in Ref 12	12
	Coolant still bottoms from Building 444	B (could be VI or IV)	3
	Perchlor still bottoms from Building 444	G	3, 11, 12
	Organic Sludge or oil - other generators identified in Ref 12 for oil waste (but id'd as Type IV) are 870, 871, 872, and 892.	Generator 771, identified as Type IV in Ref 12 but also oil/organic	12
	Assuming oil or organic sludge based on processes in building 776	Generator 776, identified as Type IV in Ref 12 but also oil/organic	12
	Assuming oil or organic sludge based on processes in building 776	Generator 881, identified as Type IV in Ref 12 but also oil/organic	12
	Organic sludge	Generator 776 identified as Type IV in Ref 12	12
	Sludge from DOW could be organic (VI) or inorganic (IV)	Generator DOW identified as Type IV in Ref 12	12

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Roman Numeral Designator	Waste Form Description or definition for the designation used	Other designators identified in AK Source Document (Reference)	References**
Type VI cont'd	Grease plant (organic based) sludge Degrasing solvents	Drum prefix 743 Building (Drum prefix) 776/777 (76/77)	3, 9 *9
	Degrasing solutions, Heat Treat Baths	Generator (Drum prefix) 881 (81) identified as Type IV in Ref 12	*9, 12
	Sludge	Generator (Drum prefix) 883 (83) identified as Type IV in Ref 12	12
	Coolant still bottoms from Building 444	B (could be VI or IV)	3, 11
	Waste oil from Building 444 (may not have been sent to Idaho)	E	3, 11
	Process waste filters (oil) from Building 444	K (IV) discrepancy	3, 11
	Organic Sludges	Building 776	3
	Machining coolant (Bldg 881) and spent degreasing solvents (e.g., TCE & PCE)	Bldg 774 (Grease Plant)	11
Other: When the following designations are identified without a corresponding waste, include an appropriate limitation statement and keyword(s).			
	1969 Fire waste (can be any of the debris waste forms)	771-596	5
	Special drums were often lead lined drums; sludge waste w/loading exceeding 200 mR/hr-contact radiation.	"Special" drums/LLD	3
	ICC label put on drums to indicate fissile material over certain limit	(Group) G IV	3
	Line generated waste -- type not specified	LGW	12
	Low specific activity -- type not specified	LSA	12
	Research & Development -- type not specified	R&D	12
	'Hot' waste -- Curie limit not specified/waste type not specified	Hot Waste	12
	Zero Power Physics Reactor wastes (can be any of the debris waste forms)	ZPPR	3
	Waste from off (RF) site generators and in some cases empty drums -- identified in WasteOScope. (Pit 1 shipping records shown this Roman numeral)	VII in WasteOScope-- not Be contaminated	12

*9 (Reference RF-U026): The 1950, 1960, and early 1970 drum identification numbers used a prefix indicative of the building the waste was generated and/or shipped from. The prefix can serve as an indicator of the constituents within a drum or waste box. The materials (waste forms) that may be in drums with the prefixes listed have been included.

**Reference numbers presented in the fourth column refer to source documents as follows:

Ref. Number	Source Doc No.	Ref. Number	Source Doc No.	Ref. Number	Source Doc No.
1	RF-C028	4	RF-C105	7	RF-C132
2	RF-C032	5	RF-C110	8	RF-C140
3	RF-C045	6	RF-C124	9	RF-U026
				10	RF-U095
				11	RF-U115
				12	RF-U169

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Source Document Tracking Number	Title	Document No.	Revision No(s).	Date(s)	Author(s)
RF-C001	Letter to Rod Thomas Re: Discrepancy List for 1954 Shipments - Waste Data Set	NA	NA	03/15/2001	Ed Vejevoda
RF-C002	Letter to Bruce Becker Re: Leaching Report - Charles Pelletier	NA	NA	7/12/2001	Ed Vejevoda
RF-C003	Letter to Rod Thomas Re: Your FAX 10/23/00 – Discrepancies – 1971-72 RFP Data Set	NA	NA	10/30/2000	Ed Vejevoda
RF-C004	Fax to Rod Thomas Re: Records included in our R.G. 326 series: "Radioactive Waste Disposal, 1953-1962"	NA	NA	10/12/2000	John Ferrell
RF-C005	Letter to Rod Thomas Re: Your Fax 10/30/00, Discrepancy list from check of 1978 RW MIS listing for shipments stored on Pad A	NA	NA	11/14/2000	Ed Vejevoda
RF-C006	Memo to J. G. Epp, R.R. Harrison, and L. A. Matheson Re: Coors Solid Waste Disposal	NA	NA	6/22/1961	Lloyd M. Joshel
RF-C007	Letter to Rod Thomas Re: Waste Shipments for CY 1966 and 1967	NA	NA	11/15/2000	Ed Vejevoda
RF-C008	Letter to Rod Thomas Re: Your FAX 11-14-2000 - Discrepancy list for 1973 Pad A shipments	NA	NA	12/12/2000	Ed Vejevoda

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RF-C009	Letter to Rod Thomas Re: Your FAX 10-27-2000 - Discrepancy list for 1972 data set for Shipments placed on Pad A	NA	NA	12/12/2000	Ed Vejvoda
RF-C010	Letter to Rod Thomas Re: Conference meeting regarding depleted uranium	NA	NA	12/11/2000	Ed Vejvoda
RF-C011	FAX to Ed Vejvoda Re: Material Balance Areas listed for Pad A	NA	NA	11/27/2000	Rod Thomas
RF-C012	Letter to Rod Thomas Re: Building 774 Feed Solutions	NA	NA	3/30/2001	Ed Vejvoda
RF-C013	Letter to Bruce Becker Re: Your FAX July 23, 2001	NA	NA	8/8/2001	Ed Vejvoda
RF-C014	Letter to Rod Thomas Re: Rocky Flats Retrieved Waste	NA	NA	9/12/2000	Ed Vejvoda
RF-C015	Letter to Rod Thomas Re: Previous Requests	NA	NA	6/20/2001	Ed Vejvoda
RF-C016	Letter to L. L. Zodtner Re: Packing Line-Generated Waste	NA	NA	11/17/1967	F.E. Adcock
RF-C017	Letter to Bruce Becker Re: Graphite Specifications	NA	NA	7/25/2001	Ed Vejvoda
RF-C018	Letter to Rod Thomas Re: Sludges from building 881 - Your FAX of 10-24-00	N/A	N/A	1/18/2001	Ed Vejvoda
RF-C019	Letter to Rod Thomas Re: Discrepancy List for 1954 Shipment- Waste Data Set	NA	NA	03/12/2001	Ed Vejvoda
RF-C021	Letter to Rod Thomas Re: Your Fax 03/02/01	NA	NA	04/24/2001	Ed Vejvoda

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RF-C022	Letter to Rod Thomas Re: Additional NDA System Information (1966-1977)	NA	NA	2/16/2001	Ed Vejvoda
RF-C023	Memorandum to K. V. Best Re: Drum Counter – Washables	NA	NA	5/31/1966	O.H. Willoughby
RF-C025	Letter to Rod Thomas Re: NDA Reports	NA	NA	2/12/2001	Ed Vejvoda
RF-C026	Letter to Rod Thomas Re: CY 1967 discrepancy corrections	NA	NA	2/10/1999	Ed Vejvoda
RF-C027	Letter to Rod Thomas Re: Your FAX 2/19/01, July 12, 1955 Shipment	NA	NA	3/23/2001	Ed Vejvoda
RF-C028	Memo to Paul Sentieri Re: Pre-1970 RFP waste	NA	NA	11/7/2002	Ed Vejvoda
RF-C029	Letter to Wendell Jolly Re: Videotape Cassette Review	NA	NA	3/4/2002	Ed Vejvoda
RF-C031	Nuclear Materials Safety Limits, Letter from Ed. Vejvoda to Ms. Marianne Little	NA	NA	3/11/2002	Ed Vejvoda
RF-C032	Letter to K.J. Holdren Re: EPA Region 10 Requests	NA	NA	2/12/2002	Ed Vejvoda (LATA)
RF-C033	Letter to Marianne Little Re: 1964 Rocky Flats Drum Counting Assays	NA	NA	2/12/2002	Ed Vejvoda
RF-C034	Letter to Marianne Little Re: 1964 Rocky Flats Drum Counter	NA	NA	1/28/2002	Ed Vejvoda
RF-C035	Letter to Bruce Becker Re: Nuclear Safety - Waste Management	NA	NA	9/26/2001	Ed Vejvoda

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RF-C036	Letter to Hazardous Materials Regulation Board Re: Request for DOT Special Permit	NA	NA	12/23/1968	William F. Romine
RF-C037	Rocky Flats Reports-Letter with attached report- To Ms. Marianne Little	EV- L01045- Marianne Little	NA	12/11/2001	Ed Vejevoda
RF-C038	Your Fax July 23, 2001-Letter-To Bruce Becker	EV- L01033- Bruce Becker	NA	08/16/2001	Ed Vejevoda
RF-C039	Uranium-233 Questions-Letter-To Bruce Becker	EV- L01030- Bruce Becker	NA	08/03/2001	ED-Vejevoda
RF-C040	Rocky Flats Waste Information-Letter- To Ms. Marianne Little	EV- L01044- Marianne Little	N/A	12/04/2001	Ed Vejevoda
RF-C041	HEPA Filter Information, letter to Bruce Becker	NA	NA	7/6/2001	Ed Vejevoda
RF-C042	WR Material List To Bruce Becker-Letter	EL- L01035- Bruce Becker	NA	09/05/2001	Ed Vejevoda
RF-C043	Waste Drum Components and Weight Limits- EV-L00030-Rod Thomas Fax of Correspondence both of which were To Rod Thomas	EV- L00030- Rod Thomas	NA	12/27/2000	Ed Vejevoda
RF-C044	Memo to Bruce Becker Re: Plutonium Estimates for Rocky Flats Waste Forms	N/A	N/A	8/29/2001	Ed Vejevoda

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RF-C045	Rod Thomas' notes on telephone conversations with Ed Vejvoda, LATA	NA	NA	6/20/2001	Rod Thomas
RF-C047	Rocky Flats Refractory Materials-Letter-To Mr. Ross Darnel	78-RF-2079	NA	10/31/1978	C. E. Wickland
RF-C048	Interoffice Correspondence to R. L. Bendetti Re: TSA Waste Content	CRDL-10-79	NA	10/29/1979	G. R. Darnell
RF-C050	Letter to Fred Weitch Re: Further Information on Filters	NA	NA	8/1/1991	G.R. Darnell
RF-C051	Memo of Conversation between T. G. Headahl and H. M. Batchelder, 06/29/81	NA	NA	6/29/1981	T. G. Headahl
RF-C052	Interoffice Correspondence to T. G. Hadahl Re: Estimate of Nitrate Salts in SDA	HMB-3-79	NA	10/24/1979	H.M Batchelder
RF-C053	Memorandum to J. D. McKinney Re: Nitrate Salts Estimate in SDA	NA	NA	8/26/1980	T.L. Clements
RF-C054	Memorandum - General Distribution Re: Minutes of Meeting on Gas Generation - RFP	NA	NA	7/28/1980	T.H. Smith
RF-C055	Updated Communication with J.L. De Rouchi Re: Sludge Packaging	NA	NA	N/A	Unknown
RF-C056	Interoffice Correspondence to W. W. Hickman Re: Alpha Contamination Pit 2	NA	NA	4/24/1974	W.B. Kerr

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RF-C057	Letter to Dr. J. A. Buckham Re: Rocky Flats Waste Shipped to NRTS	NA	NA	12/7/1971	C. Wayne Bills
RF-C058	Memo to K. B. McKinley Re: PCB Contaminated Waste at RWMC TLC-7-81	NA	NA	8/25/1980	T.L. Clements, JR
RF-C059	Letter to G. Wayne Bills Re: Results of Dividing RF Waste Drums 771-7959 and 771-7961	NA	NA	7/22/1971	George Wehmann
RF-C060	Interoffice Correspondence to J.D. McKinney Re: Buried Waste Characterization TLC47-80	RWMC-109-80	NA	8/25/1980	T.L. Clements, JR
RF-C062	Memo to J. D. McKinney Re: Nonradiological Hazards Study	TLC-35-80	N/A	6/16/1980	T. L. Clements
RF-C064	Memo to T. H. Smith Subject: Nonradioactive Hazardous Waste Data	Pass-98-79	N/A	11/14/1979	R.W. Passmore
RF-C065	Memo to J. D. McKinney Re: Non-Radiological Hazards Study	C065	N/A	1/22/1980	T. L. Clements, Jr.
RF-C066	Nonradiological Hazards Study from E.N. Fray to J.B. Whitsett	NA	NA	2/15/1980	E.N. Fray
RF-C067	Memo to File Re: Rocky Flats Waste	NA	NA	4/20/1954	G.V. Beard
RF-C068	Memo to G. V. Beard Re: Radioactive Waste From Rocky Flats Field Office	NA	NA	4/23/1954	P. Griffiths

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RF-C071	Letter to W. D. Wayne, Aerojet General Re: Solid Radioactive Waste Disposal	N/A	N/A	10/23/1962	W. A. Erickson
RF-C072	Letter to J.F. Lyon, Phillips Petroleum	NA	NA	10/20/1964	W.A. Erickson
RF-C073	Letter to Dr. J. D. Shreve, Jr. Re: Proposal for Research Foundation on safety tests at Stonewall Flat.	NA	NA	4/23/1963	Fred L. Smith
RF-C076	W.L. Ginkel Diary 9/10/69, Re: Transfer of material from Rocky Flats to NRTS	NA	NA	9/10/1969	W.L. Ginkel
RF-C077	Notes Titled: Background Information on Rocky Flats for the File	NA	NA	10/29/1969	J.R. Horan
RF-C078	Letter to Martin B. Biles Re: Radioactive Solid Waste Management at the National Reactor Testing Stations	N/A	N/A	11/10/1969	Ray D. Walton Jr., AEC
RF-C079	Letter to Lawrence C. Farrell, Jr., Dow Chemical	NA	NA	2/9/1959	John R. Horan
RF-C080	Letter to Rod Thomas transmitting information Re: Waste Shipments to Arco - 1959 - 1965	NA	NA	4/5/2000	Ed Vejvoda
RF-C081	Letter to FtI Langell Re: Disposal of Contaminated Solid Waste	NA	NA	4/4/1952	T.S. Chapman, DOW Chemical Co.
RF-C082	Letter to Rod Thomas Re: Monthly RA Shipments to INEEL 1970 - 1974	NA	NA	11/6/2000	Ed Vejvoda

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RF-C083	Untitled letter to John Epp, Dow Chemical	NA	NA	5/5/1954	G.V. Beard
RF-C084	Untitled letter to M.C. Waddell, Colorado Health Planning Council	NA	NA	12/22/1970	M.B. Biles
RF-C085	Memorandum to F.H. Langell Re: Liquid Waste Disposal at Rocky Flats Plant	NA	NA	6/13/1952	B.P. Shepherd
RF-C086	Memo to Director, Safety & Fire Protection Division Re: Disposal of Solid Radioactive Waste from Rocky Flats Plant	NA	NA	5/14/1954	Gilbert C. Hoover, RFFO
RF-C087	Memo to J.C. Okeson, INEEL, Subject: Graphite, Filter, and Potentially Pyrophoric Wastes in Pit 9 for OU 7-10 Extended Probe Hole Activities, RW T-02-00	NA	NA	06/08/2000	R.W. Thomas, INEEL
RF-C088	Memorandum to L. MI Jodel, DOW, regarding oil leakage in drum storage area	NA	NA	2/17/1970	F. E. Abbott, USAEC
RF-C093	Memo to R. R. Harrison Re: Disposition of D-38 Oxide	N/A	N/A	01/05/1955	L. R. Drake, DOW
RF-C098	Memo to A. N. Sampson Re: Waste Disposal	NA	NA	8/17/1962	Frank E. Butler
RF-C099	Letter to S. R. Woodruff, US AEC Re: Disposal of Mercury-Type Dry Cell Batteries	NA	NA	08/15/1960	F. H. Langell

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RF-C100	Letter to Dr. A. Feldman, Re: Disposal of Radioactive Contaminated Wastes from Univ of Colorado Medical Center	NA	NA	03/29/1962	Edward S. Ryan
RF-C101	Letter to T.S. Klayder, U.S. Food and Drug Administration	NA	NA	5/17/1961	T.S. Chapman
RF-C102	TWX to J. B. Mallocci Re: Disposition of Unclassified Scrap (Shipment of material to Rocky Flats for disposal at INEEL)	NA	NA	12/1/1960	H.C. Strauss
RF-C103	Memo to W. F. McKelvey Re: Nickel Carbonyl Detection Monitor	NA	NA	11/22/1960	R.A. Vandergriff
RF-C105	Letter to Rod Thomas Re: Rocky Flats Waste Information	NA	NA	7/17/2000	Ed Vejevoda, LATA
RF-C106	2 Memos: 1) to T. S. Chapman, DOW, Re: Classification of waste and 2) to Alan T. Morphey Re: Radioactive waste shipments to NRTS	NA	NA	03/24/1964	1) T.S. Chapman 2) L. M. Grow
RF-C108	Letter to Rod Thomas Re: RA Waste Generation	NA	NA	12/2/1999	Ed Vejevoda
RF-C110	Letter from Ed Vejevoda (LATA) to Rod Thomas (BBWI) Re: Responses to Faxes of 6/28/00 and 7/10/00	NA	NA	8/23/2000	Ed Vejevoda

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RF-C114	Letter to Rod Thomas Re: Waste Drum Generation from the 903 Pad and Mound Area	NA	NA	1/11/2001	Ed Vejvoda
RF-C117	Memo to Mr. Best Re: Attempted Pu Recovery from Lathe Coolant in Storage Area	NA	NA	12/13/1967	M. E. Maas
RF-C120	Rocky Flats Waste Information-Ion Exchange Information-Letter-To Rod Thomas-This letter covers two waste items (1) ion exchange resins and (2) waste generation information	ev-1-99019-thomas	N/A	11/29/1999	Ed Vejvoda
RF-C123	Letter to Rod Thomas Re: Meeting Notes	NA	NA	9/12/2000	Ed Vejvoda
RF-C124	Memo from L. C. Farrell Re: Waste Shipments	NA	NA	9/18/1957	L. C. Farrell
RF-C125	Comments on the Characterization and Categorization Study-Notegram-To J.R. Bishoff	N/A	N/A	06/05/1980	R.L. Benedetti
RF-C126	The Issue of Irradiated Fuel in Pit 9 - RWT-06-99-Letter-To D.E. Wilkins	RWT-06-99	N/A	09/14/1999	R.W. Thomas
RF-C127	Est. Quantity of Oxidizer Compounds in OU7-10 Stages/IIA Area in Pit 9-RWT-03-99-Letter-To DE Wilkins	RWT-03-99	N/A	06/01/1999	R.W. Thomas

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RF-C128	Sludge Drum Count in Pit 9 Based on Rocky Flats Waste Disposal Data Sheets -RWT-04-99-To J.J. Einerson-Letter	RWT-04-99	N/A	07/20/1999	J.J.Einerson
RF-C129	Depleted Uranium and Beryllium Waste in Pit 9-RWT-05-99, To DE Wilkings-Letter	RWT-05-99	N/A	08/26/1999	R.W. Thomas
RF-C130	Waste Contents Information Supporting Unreviewed Safety Question (USQ) For OU 7-10 Stage II Storage Facility RWT-02-99-Interdepartmental Communication-To AG Ramos	RWT-02-99	N/A	04/27/1999	R.W. Thomas
RF-C131	Waste Contents Associated With OU 7-10 Stages I/II Activities in PIT 9-RWT-01-99-Letter-To D.E.Wilkins	RWT-01-99	N/A	04/16/1999	R.W. Thomas
RF-C132	Letter to F. H. Langell, Dow Chemical, Re: Off site solid waste disposal	NA	NA	12/17/1953	Gilbert C. Hoover

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RF-C133	Preliminary Report On Methods Of Handling Building 81 Raffinates In The Waste Treatment Plant-To L.P.Ferris,II cc J.G.Epp, I.B.Venable	N/A	N/A	07/12/1954	J.A. Basinger
RF-C136	Letter to AK Record Re: Review of Historical Rocky Flats Waste Shipment Records	NA	NA	01/31/2003	Jeff Harrison
RF-C137	Letter to Rod Thomas Re: CY 1967 Discrepancy Corrections	NA	NA	02/10/1999	Ed Vevjoda
RF-C138	Letter to R. L. Benedetti/J.D. McKinney Re: TRU Waste Characterization	NA	NA	5/13/1980	G. R. Darnell/T. L. Clements, Jr.
RF-C139	CY 1967 Discrepancy List Rework-To Rod Thomas-cc Roger Mayes, LATA-IDO Letter	EV-L99013-Thomas	N/A	04/19/1999	Ed Vevjoda
RF-C140	Report of Meeting Held in Mr. Langell's Office December 5 Regarding Feasibility Study for General Project Waste Incinerator	NA	NA	12/5/1952	B. P. Shepherd

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RF-C141	Colorado Committee for Environmental Information, To General E. B. Giller, Letter in response to allegations made by the Colorado Committee for Environmental Information after the 1969 fire.	NA	NA	1/29/1970	Lloyd M. Joshel
RF-C142	903 Oil Drum Storage Area, To E. A. Putzier, Letter with a brief history of the disposal of oil drums from the 903 Area.	NA	NA	4/14/1970	K. J. Freiberg
RF-C143	Recovery of Pu Values from Measured Discard Streams. To K. V. Best, Concerns R&D, carbon tetrachloride contaminated oil storage, and electrorefining.	NA	NA	7/30/1964	C. J. Pinamont and A. K. Williams
RF-C144	Waste Information for ARCO letter to E. S. Ryan from Donald L. Ziegler	NA	NA	2/20/1970	Donald Ziegler
RF-C145	Plutonium Isotopic Analysis-Plutonium-contaminated Waste from Rocky Flates Plant. To George Wehman, Waste Management, Idaho Operations Office, confirmation of a telephone conversation.	NA	NA	3/3/1971	Lloyd M. Grow

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RF-C146	Letter concerning use of a new form for waste shipments to Arco. To Lawrence C. Fairrel, Jr., Rocky Flats Plant.	NA	NA	2/9/1959	John R. Horan
RF-C147	Carbon Tetrachloride Recovery System. To W. F. McKelvey	NA	NA	12/1/1959	R. A. Vandegriff
RF-C148	Request for Proposal to Ship Radioactive Waste to Richland. To F. E. Abbott, Request that Dow Chemical Company submit a proposal to ship low specific activity waste to Richland.	NA	NA	8/24/1971	J. F. Burke
RF-C149	Proposal to Ship LSA Wastes from Rocky Flats to Richland. To J. F. Burke, Assistant Manager for Operations, ALO. Dow Chemical Company's proposal to ship LSA wastes to Richland	NA	NA	9/30/1971	A. K. Williams
RF-C150	Waste Disposal, To William Boyd. Conditions for Rocky Flats to Accept Be oxide contaminated waste from the Denver Research Institute	na	na	6/16/1971	J. B. Owens

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RF-C151	Waste Disposal. To William L. Smith. Conditions for Rocky Flats to accept contaminated waste from USGS Nuclear Science Building 15	NA	NA	7/13/1971	J. B. Owens
RF-C152	Emission of Carbon Tetrachloride Vapor from Building 774. To W. C. Bright. This concerns processing of CCl ₄ -oil waste in a still in Building 774.	NA	NA	2/5/1971	B. L. Kelchner
RF-C153	Disposal Summary of Pu Contaminated Materials - Building 903 Storage Area. To K. V. Best	NA	NA	9/24/1968	M. E. Maas
RF-C154	Use of Paper Boxes for Radioactive Shipments. To R. D. Gaskins, J. A. Greer, L. F. Grill, M. E. Maas, J. B. Owen, C. D. Skoats. Concerning the discontinuance of using corrugated boxes for offsite disposal.	NA	NA	4/17/1970	E.S. Ryan
RF-C155	Limitation on Size of Wooden Crates for Waste Shipments. To C. A. Noble. Written to preclude the use of crates to large to fit in ATMX rail cars.	NA	NA	2/24/1970	E. A. Putzier

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RF-C156	Progress Report for the Month of December 1954, Waste Disposal Coordination Group. To L. C. Farrell. Monthly report	NA	NA	1/4/1955	E. S. Ryan
RF-C157	Plutonium-Contaminated Equipment. To Lloyd M. Joshel. Equipment contaminated by the plutonium fire in B71 in September, 1957.	NA	NA	3/25/1963	I. B. Venable and L. A. Matheson
RF-C158	Transportation of Combustible Waste. To Martin B. Biles. Contains information on waste packaging for LSA wastes.	NA	NA	9/4/1970	Wade C. McCluggage
RF-C159	Waste Handling Procedures at Rocky Flats - Leaky Drum at NRTS, Idaho. To Lloyd M. Joshel. Policy against shipping liquids.	NA	NA	3/3/1971	F. E. Abbott, Area Manager
RF-C160	Letter to File Re: Radioactive Waste Shipments to NRTS Burial Ground	NA	NA	01/09/1964	Alan T. Morphey
RF-C161	Letter to E. Jianetti Re: Health Physics Aspects - Proposal to Process Enriched Uranium in Building 31	NA	NA	01/22/1964	W. D. Kittinger

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RF-C162	Letter to General Manager, Rocky Flats, Re: Disposal of sample residues from Nevada Test Site	NA	NA	03/27/1964	Fred. L. Smith, Colorado School of Mines
RF-C163	Letter to E. S. Ryan Re: Handling of Classified Waste Material	NA	NA	04/17/1964	W. R. Cornelison
RF-C165	Letter to C. H. Barnes, et.al., regarding operations/processes	NA	NA	12/17/1965	J. L. Holst
RF-C166	Letter to J. N. Vance Re: Criticality Recommendation: Oil Drums	NA	NA	04/20/1966	H. W. King
RF-C167	Letter to J. G. Epps Re: Use of Acetone in Production of Dryboxes	NA	NA	10/18/1967	Sam H. Pitts
RF-C168	Equipment Removal under Authority #381046	881	N/A	12/12/1967	Barry M. Prentice
RF-C169	Letter to C. W. Piltingarud Re: Tritium	NA	NA	12/11/1964	AB
RF-C170	Telex to Major General E. B. Giller Re: Clean-up of Bldgs 776 and 777	NA	NA	05/14/1969	H. C. Donnelly
RF-C171	Criticality Recommendation: Liquid Handling From Clean-up To: H. E. Bowman-Letter	N/A	N/A	05/23/1969	J. D. McCarthy
RF-C172	Criticality Recommendations: Raschig Rings -Letter- To HE Bowman	N/A	N/A	05/23/1969	JD McCarthy

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RF-C173	Material Removal from 776-Letter-To H Johnson, BL Keichner, HW King, JB Owen, CH Partington, FJ Quinn, DK Thirstlewood, JF Willging, ER Young	N/A	N/A	06/09/1969	LF Grill
RF-C174	Criticality Recommendation: Removal Of Parts-Letter-To GG Turner	N/A	N/A	06/10/1969	JC McCarthy
RF-C175	Request to Enter Building 776-777 and Remove Active Material-Letter-Procedure-To HE Bowman	N/A	N/A	06/09/1969	RA Henn
RF-C176	Criticality Recommendation: Raschig Rings-Letter-JB Owen	N/A	N/A	09/11/1969	CL Schuske
RF-C177	Raschig Rings-Letter-To HE Bowman, LF Grill, WA Hauschildt, AR Konecny, WH Lee, CL Schutten, ER Young	N/A	N/A	12/29/1969	H.W. King
RF-C180	Memo to H. E. Bowman Re: Interim Capability - South Line	NA	NA	07/23/1969	A. R. Konecny
RF-C183	Telecom-message to General E. B. Giller, AEC, Re: Criticality program at RFP	NA	NA	01/27/1970	H. C. Donnelly, US AEC
RF-C184	Letter to Chet Holifield, US Congress, Re: Safety concerns at RFP	NA	NA	10/01/1969	Glen T. Seaborg, US AEC

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RF-C189	Memo to H. E. Bowman Re: Plan for the Decontamination of the Long Term Capability Area, Buildings 776 and 777	NA	NA	09/19/1969	J. B. Owen
RF-C191	Memo to All Area Decontamination-Shift Supervisors Re: Building 777 supplied air	NA	NA	09/19/1969	J. B. Owen
RF-C195	Memo to R. A. Larson Re: Perchloroethylene -- Building 76	NA	NA	05/23/1966	J. E. Hill
RF-C196	Memo to J. W. Lind Re: Trichloroethylene Vapors from Ultrasonic Cleaners	NA	NA	06/30/1996	S. E. Hammond
RF-C197	Waste Management, Packaging and Shipping of Wastes in Outside Storage. To T. C. Jones. Concerns the backlog of 1,738 55-gal drums containing plutonium-contaminated wastes in outside storage.	N/A	NA	10/20/1971	J. B. Owen
RF-C198	Telex from H. C. Donnelly to F. E. Abbott. Progress Report to General Manager, Radioactive Waste Management	N/A	NA	12/9/1969	H. C. Donnelly

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RF-C199	Plutonium Content of Drums for GAMAS. To T. C. Jones. 200 drums to be assayed by the Gulf Atomic Mobile Assay System (GAMAS)	N/A	NA	8/10/1971	J. B. Owen
RF-C200	Radioactive Waste Shipment Records. To C. M. Rogers, Chief Administrative Branch USAEC. Rocky Flats shipment of 3 cardboard boxes of shipping records to Idaho Operations Office.	N/A	NA	6/15/1971	J. B. Owen
RF-C201	Transfer of Rocky Flats Waste Records to NRTS. To H. C. Donnelly, Manager Albuquerque Operations Office	N/A	N/A	1/29/1971	W. L. Ginkel
RF-C202	Commercial Burial of Rocky Flats Radioactive Wastes. To H. C. Donnelly, Manager Albuquerque Operations Office	N/A	NA	9/19/1969	Martin B. Biles
RF-C203	Major Fire at Rocky Flats. To A. P. Beutel, H. D. Doan, H. H. Dow, L. Evans, J. H. Hanes, J. E. Johnson. 1969 fire in B776.	N/A	NA	5/15/1969	Lloyd M. Joshel

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RF-C204	Chlorinated Aromatic Transformer Oils. To J. F. Kesting. Hazardous Materials Committee guidance for chlorinated aromatic transformer oils.	N/A	NA	4/25/1969	A. K. Williams
RF-C205	Ammonium Thiocyanate Concentrations - Americium Glove Box Line. To J. E. Hill, K. W. Hugo, W. D. Kittinger. Chemical information concerning this process.	NA	NA	5/21/1970	L. F. Gill, Superintendent, Chemical Operations
RF-C206	Packaging Hot Dry Waste and line Generated Waste. To all groups shipping drummed material to Chemical Operations, Building 771. Use of drums for this waste.	NA	NA	10/27/1969	W. B. Campbell, Assistant Superintendent
RF-C207	Calculations for Carbon Tetrachloride Still. To B. P. Shepherd. Calculations used for the carbon tetrachloride still.	DJO 4561	N/A	3/31/1959	R. W. Hawley
RF-C208	Letter with attachment from J. F. Willging, Director Research and Ecology to F. E. Abbott, Manager RFAO, Mercury Usage Survey	N/A	N/A	8/3/1972	J F. Willging
RF-C209	Mercury Survey. C. W. Piltingsrud. Use of mercury at Rocky Flats.	N/A	N/A	9/15/1970	J. E. Hill

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RF-C210	Reactive Material Survey - Development Coating Facility in B777, Rms. 437, 463, and 464. To D. G. Williams. List of chemicals used in the operation.	N/A	N/a	12/21/1971	C. W. Barrick
RF-C211	Reactive Chemicals, Building 771. To C. W. Barrick. List of chemicals used in Building 771.	N/A	N/A	9/1/1971	R. D. Gaskins
RF-C212	Hazardous Materials Survey NDT Environmental Testing. To S. J. Hartz. Chemicals used in Building 777.	N/A	N/A	11/12/1971	C. W. Barrick
RF-C213	Formula A Paint Remover. To C. W. Ellis. Opinion on the use of Formula A paint remover.	N/A	N/A	12/2/1971	C. W. Barrick
RF-C214	Service Lab Use of Halogenated Solvents. To M. A. Thompson. Use of halogenated solvents in the labs in Buildings 559, 881, and 771.	N/A	N/A	12/5/1973	C. W. Barrick
RF-C215	Hazardous Materials Survey - Building 707 Manufacturing Assembly, et al.	N/A	N/A	9/7/1971	F.D. Hobbs, R.M. Saiki, R.R. Gunning, W.D. Scheuer

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RF-C216	Procedure for Labeling, Sealing and Reporting on Containers Used for Waste Removal. To E. Martella, M. Roberts. Instructions for labeling, sealing, and reporting of waste containers used in the clean-up and restoration work after the Building 776 fire.	NA	NA	6/6/1969	B. A. Bowman
RF-C218	Headspace Gas Analysis of 774 Building Drums. To S. Hamilton. Samples taken from 4 drums of paint thinner being used in Building 774.	N/A	N/A	3/29/1972	T. L. McFeeters
RF-C219	ZPPR Fast Recycle Residues. To O. J. Elgert, Director Chemical Processing Div., RLO. List of residues generated by ZPPR production that have been processed through recovery and are to be shipped to Hanford.	N/A	N/A	8/19/1969	Seth R. Woodruff, Jr.
RF-C220	ZPPR Residue Resume. To Frank E. Abbott, Manager, RFAO, USAEC. Description of the fabrication of the ZPPR fuel plates, the recovery of the residues, and corrective measures to prevent liquid in the drums sent to Hanford.	NA	NA	2/12/1970	J. F. Willging

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RF-C221	Waste Barrel Fire at Idaho Burial Ground. To F. E. Abbott, Manager, RFAO, USAEC. The preliminary Rocky Flats analysis of the contents of the waste drum involved in the fire at Idaho.	N/A	N/A	10/23/1970	Lloyd M. Joshel
RF-C222	Neptunium-Plutonium Content of ZPPR Residues. To H. E. Bowman. Explanation for the high neptunium content in the ZPPR residues sent to Hanford.	N/A	N/A	4/8/1970	K. W. Calkins
RF-C223	Contaminated Liquid Disposal Mechanical R&D Plutonium Shop, Bldg. 779A. To J. Ackelson, D. R. Ferguson, R. C. Johnson, J. R. Luckow, A. E. Rains, E. D. Reynolds. Procedures for draining the contaminated liquid systems in B779A.	N/A	N/A	12/4/1969	John H. Quella
RF-C224	List of Potentially Hazardous Substances. To F. E. Abbott, Manager, USAEC, RFAO. List of potentially hazardous substances in use at Rocky Flats.	N/A	N/A	12/8/1971	J. F. Willging

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RF-C225	Beryllium - Building 551. To J. F. Landolt. An industrial hygiene assessment for handling beryllium in Building 551.	N/A	N/A	4/28/1969	J. E. Hill
RF-C226	Hazardous Materials Survey. To W. L. Rooker. List of materials used in Building 881.	N/A	N/A	9/2/1971	F. D. Hobbs and D. M. Saiki
RF-C227	Reactive Materials Survey - Building 444 and 881 Metallurgical Operations. To W. H. Hauschildt. Chemicals used in the processes in Building 444 and 881 Metallurgical operations.	N/A	N/A	10/7/1971	F. D. Hobbs and D. M. Saiki
RF-C228	Training - Pest Control and Public Health. To L. M. Grow, RFAO, USAEC. Notice of the discontinuance of the use of Chlordane and Malathion.	N/A	N/A	2/10/1970	J. Seastone
RF-C229	Restrictions on Use of DDT and Establishment of a Committee on Pesticides within the President's Environmental Quality Council. To various USAEC Area Office Managers	N/A	N/A	1/12/1970	J. F. Burke, Director, Op. Safety Div., USAEC

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RF-C230	Copper-Beryllium Scrap. To D. Bainbridge. Discussion of the release of beryllium-copper scrap to the public.	N/A	N/A	4/25/1968	J. E. Hill
RF-C231	Purchase of Chemicals from Precision Chemical Company, Denver, Colorado. To P. A. Carleton. Discussion of the problems the Site had been having with chemicals purchased through the Precision Chemical Company.	N/A	N/A	4/10/1968	J. L. Holst
RF-C232	Hazardous Materials Evaluation - Buildings 776 & 707 Manufacturing Fabrication. To F. B. Evans. List of chemicals and materials used in manufacturing fabrication in Buildings 707 and 776.	N/A	N/A	11/3/1971	D. M. Saiki, F. D. Hobbs, E. F. Lombardi
RF-C234	Memo to L. C. Farrell Re: History Report - Waste Disposal - March, 1958	NA	NA	04/02/1958	E. E. Johnston
RF-C240	Miscellaneous correspondence concerning isotopic information for plutonium waste shipped to Idaho for burial.	N/A	N/A	10/10/1969	M. A. Thompson, C. A. Pelletier, & W.H Lee, et al.
RF-C241	Telecommunication-Information concerning 903 Pad including a chronology. To H. C. Donnelly.	N/A	N/A	2/17/1970	Lloyd M. Joshel

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RF-C242	Summary of Proposed Pest Control Practice - 1970	N/A	N/A	12/03/1969	F. E. Abbott to J. F. Burke
RF-C243	Interview of RFP former employee, Al Wilson, conducted by Scott Smith on 4/30/03 regarding historical Rocky Flats plutonium operations	NA	NA	04/30/2003	Scott Smith
RF-C244	Memorandum to J.M. Roberson, RFFO & J. M. Wilczynski, INEEL Re: Identification of Defense Waste Streams Generated at Rocky Flats Environmental Technology Site (RFETS)	NA	NA	05/20/1997	George E. Dials, DOE CBFO
RF-C245	Letter to Ed Ryan, Dow Re: Low Level Waste to be Shipped for Burial (Coors Waste)	NA	NA	11/20/1964	H. B. Dunkelberger, Coors
RF-C246	Interview of Andy Jacobs, BBWI, WGS Re: Bioassay radioisotopes	NA	NA	03/30/2004	Carolyn K. Abbott
RF-D001 r0	Resolution for the use of Waste Type Designators	NA	NA	1/20/2004	Carolyn K. Abbott
RF-D001 r1	Resolution for the use of Waste Type Designators	NA	01	04/26/2004	Carolyn K. Abbott
RF-D002	Resolution of Incorrect Entry in WasteOScope	N/A	N/A	03/22/2004	Carolyn Abbott

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RF-P001	Assessment for Retrievability and Exhumation of USDOE Stored and Buried Radioactive Waste, RFP 3243	RFP 3243	NA	6/1/1981	P.G. Hagan
RF-P002	Handling and Packaging of Plutonium-Contaminated Waste, Nuclear Technology, Vol. 24, December 1974	NA	NA	5/13/1974	J.B. Owen
RF-P005	Measurement of Plutonium in Process Materials and Contaminated Waste	RFP-1325	NA	4/28/1969	O. H. Willoughby & D. R. Cartwright
RF-P006	Standardization and Performance of the Building 707 Drum Counter	950442-101	NA	9/30/1971	R.N. Chanda, R.A. Harlan
RF-P007	Building 771 Interim Drum Counter	950442-103	NA	11/4/1971	R.A. Deal, R.N. Chanda
RF-P008	Operations Manual for Drum Counter (South) – 771-A	950442-109	NA	9/8/1972	R.A. Deal, L.A. Bidwell
RF-P009	Computer Control of Three Passive Assay Systems: Helix Counter, Can Counter II, and South Drum Counter	950442-114	NA	4/26/1973	J.L. Lawless, L.A. Bidwell
RF-P010	A Crate Counter for Normal Operating Loss	RFP-2642	NA	6/24/1977	R. A. Harlan
RF-P011	Drum Counter Verification Studies, Uranium in the Drum Counter	940232-101B	NA	12/2/1965	O.H. Willoughby, L. D. Delpierre

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RF-P012	Drum Counter Verification Studies, Plutonium/Graphite in the Drum Counter	94023-101C	NA	12/30/1965	O.H. Willoughby, L. D. Delpierre
RF-P013	Drum Counter Verification Studies, Plutonium/Graphite in the Drum Counter	940232-101D	NA	5/27/1966	O.H. Willoughby, G. J. Cunningham
RF-P014	Drum Counter Verification Studies, Dead-Time Counting Error Correction	940232-101E	NA	11/15/1966	O.H. Willoughby, J. L. Lawless
RF-P015	Drum Counter Verification Studies, Discarded Waste Evaluation Summary	940232-101F	NA	3/15/1967	O.H. Willoughby
RF-P016	Drum Counter Status Report	940232-101G	NA	2/14/1968	O.H. Willoughby, J. L. Lawless, J. L. Martinez
RF-P017	Americium in the Can and Drum Counters	940232-101H	NA	2/16/1968	J. L. Lawless, O.H. Willoughby
RF-P018	Drum and Can Counter Computer Program	940232-101I	NA	2/27/1968	J. L. Lawless, O.H. Willoughby
RF-P019	Special Permit No. 5948	NA	NA	4/8/1969	Department of Transportation
RF-P021	Evaluation of Filter Flammability and Filter Bank Fire Detection Systems-Evaluation Report	RFP-222	N/A	02/24/1961	P.D. Erickson, J.A. Geer, F. J. Linck
RF-P022	Absolute Air Filters Flammability and Fire Control Studies-Study	RFP-97	N/A	03/17/1958	P.D. Erickson, F.J. Linck, Jr

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RF-P025	Volumes I & II -- Appendices to the Historical Release Report for the Rocky Flats Plant (RF-P084)	NA	Draft	01/01/1992	US DOE, RFP
RF-P026	Filter Testing and Development for Prolonged Transuranic Service and Waste Reduction	RFP-02643	NA	3/1/1976	J.A. Geer, K. Terada, & R. W. Woodard
RF-P027	Filter Testing and Development for Prolonged Transuranic Service and Waste Reduction	RFP-2635	NA	2/1/1977	Geer, Buttedahl, Skaats, Terada, Soodard
RF-P028	Exhaust Filtration on Gloveboxes Used for Aqueous Process of Plutonium	RFP-2445	NA	8/1/1976	Woodard, Grossaint, McFeeters
RF-P029	Studies on Prolonging HEPA Filter Service in Chemical Applications	RFP-2766	NA		Woodard, Terada, Buttedahl
RF-P040	Reconnaissance Level Characterization Report for the 779 Cluster.	RF/RMRS-96-0071	0	12/17/1997	Rocky Mountain Remediation Services, LLC
RF-P041	Reconnaissance Level Characterization Report for Area 2, Group 2 Closure Project - 991, 991 Tunnels, 985, 996, 997, 998 & 999.	03-RF-00072	1	1/14/2003	RFETS
RF-P042	Reconnaissance Level Characterization Report, Group A Facilities	NA	2	6/14/2000	RFETS

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RF-P045	Stored TRU Waste Composition	TWTF-67	0	11/3/1981	D. R. Darnell
RF-P047	Waste Characterization of Rocky Flats Plant Waste Shipped to INEL 1954-1890	WS-F2-81-001	NA	3/1/1980	G. R. Darnell, T. L. Clements, Jr., R. R. Wright
RF-P049	Improvements to a 55-Gallon DOT 17C Shipping Container for Alpha-Emitting Transuranium Waste	CRDL 950703-001	0	12/29/1972	P. A. Patton, J. W. Lindsay
RF-P055	Final Operation Report of the Manufacture of Beryllia-Urania Fuel Elemental for The Tory II-C Reactor	NA	0	5/31/1963	Lawrence Radiation Laboratory
RF-P060	Reconnaissance Level Characterization Report for the 886 Cluster Decommissioning Project	RF/RMRS-97-124	1	12/24/1997	Rocky Mountain Remediation Services
RF-P061	Conceptual Process for Recovery of Plutonium from ZPPR Fuels	CRD83-015	0	3/15/1983	J. B. Knighton
RF-P064	Reconnaissance Level Characterization Report, 881 Cluster Closure Project	NA	0	11/06/2001	Kaiser Hill
RF-P065	Reconnaissance Level Characterization Report, Buildings 331FD and C331	03-DOE-00448,03	0	04/14/2003	Kaiser Hill
RF-P066	Addendum 1 of the RFP EWQA Manual	1-10000-EWQA	0	9/27/1993	EG&G RFP E&WM, Waste Programs
RF-P071	The Impurity Analysis of Americium Solutions	RFP-194	0	9/28/1960	A. J. Johnson & E. Vejvoda

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RF-P072	Investigation of Salts for Use in Uranium Metal Heat-Treating Baths	RFP-191	0	7/25/1960	S. R. Pocsik
RF-P073	Preparation of Pur Americium on a One to Ten Gram Scale	RFP-130	0	N/A	V. A. Ryan and J. W. Pringle
RF-P083	Inventory Analysis of Stored Transuranic (TRU) Waste at the Radioactive Waste Management Complex	INEL-96/0308	2	11/1/1996	K. M. Croft & V. S. Scown
RF-P084	Building Histories for Bldgs 371, 444, 447, 461, 707, 771, 776/777, 881, 883, and 991 Historical Release Rep	NA	NA	11/1/1994	EG&G Rocky Flats, Inc
RF-P085	Reconstruction of Historical Rocky Flats Operations and Identification of Release Points	N/A	0	8/1/1992	ChemRisk
RF-P088	A Comprehensive Inventory of Radiological and Nonradiological Contaminants in Waste Buried in SDA	INEL-95/0310	1	8/1/1995	Lockheed Idaho Technologies Company
RF-P089	A Comprehensive Inventory of Radiological and Nonradiological Contaminants in Waste Buried in SDA	INEL-95/0310	1	8/1/1995	Lockheed Idaho Technologies Co.
RF-P090	Acceptable Knowledge Document for INEEL Stored Transuranic Waste - Rocky Flats Plant Waste	INEL-96.0280	3	2/28/2003	INEEL Bechtel BWXT Idaho, LLC

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RF-P091	Facility History for Building 771 at the Rocky Flats Plant	N/A	N/A	4/1/1992	M.H. Chew & Associates, Inc.
RF-P092	Reconnaissance Level Characterization Report (RLCR), 334, T334B, T334D	N/A	0	10/11/2002	Kaiser-Hill
RF-P093	Type2 Reconnaissance Level Characterization Report (RLCR) and PDSR Bldg 441	N/A	1	2/11/2003	Kaiser-Hill
RF-P094	RLCR 559 Closure Project Bldg 559,561, and 528	N/A	0	1/25/2002	Kaiser-Hill
RF-P095	RLCR Bldg 705	N/A	0	4/23/2003	Kaiser-Hill
RF-P096	Type I RLCR Area 5 Group 16 Closure Projects (Building 952, T974A, 988, 988A, 990, 990A, and 995)	N/A	0	9/3/2003	Kaiser-Hill
RF-P097	"Hot" Liquid Waste Tamed.	RFP-876	N/A	7/1/1967	D. M. Anderson
RF-P098	Disposal of Contaminated Liquid Wastes at Rocky Flats, Colorado	RFP-378	N/A	4/6/1964	E. S. Ryan
RF-P099	Plutonium Recovery from Fibrous Insulation and Firebrick	RFP-832	N/A	1/22/1968	William V. Conner
RF-P100	Solvents for Degreasing and Machining Plutonium Metal	RFP-921	N/A	9/22/1967	Ray E. Giebel
RF-P101	Control of Personnel Exposures to External Radiations in a Plutonium Chemical Plant	RFP-1524	N/A	9/3/1969	J. B. Owen

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RF-P102	Use of Trichloroethane for Degreasing Beryllium, Plutonium, and Uranium	RFP-2231	N/A	8/8/1974	Larry E. Musgrave
RF-P103	Waste Reduction Studies	RFP-1676	N/A	3/18/1971	D. L. Ziegler
RF-P104	Evaluation of Methods to Recover Plutonium from Incinerator Ash	RFP-1723	N/A	8/16/1971	Ziegler, Lindsey and Fraser
RF-P105	Report on the Flow of Recycled Uranium at the Department of Energy's Rocky Flats Plant, 1953-1993	N/A	N/A	6/30/2000	Rocky Flats Environmental Technology Site
RF-P106	Evaluation and Compatibility of Process Materials Used at Rocky Flats Division (History) 7/64 - 5/69	N/A	N/A	05/27/1969	J. L. Holst
RF-P107	Incineration at Rocky Flats	N/A	N/A	2/12/1970	R. D. Gaskins and R. L. Martin
RF-P108	Report on Waste Control Study for Rocky Flats Plant	N/A	N/A	2/2/1970	D. L. Ziegler
RF-P109	The Molten Salt Extraction of Americium from Plutonium Metal	RFP-1356	N/A	8/26/1969	J. L. Long and C. C. Perry
RF-P110	Plutonium Handling Safety Analysis of the Rocky Flats Nuclear Safety Facility	RFP-977	N/A	11/8/1967	Douglas C. Hunt, Grover Tuck
RF-P111	Preparation of High Purity Americium Oxide	RFP-1857	N/A	2/10/1972	S. G. Proctor
RF-P112	Nuclear Safety Measurements on Systems Containing Boron and Enriched Uranium	RFP-246	N/A	10/24/1961	L. A. Matheson

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RF-P113	Electron Beam Welding Radioactive and Toxic Materials	RFP-837	N/A	4/29/1968	G. K. Hicken, W. B. Sample Jr.
RF-P114	Disposal of Contaminated Lithium-Metal Scrap-Report	RFP-1347	N/A	9/19/1969	Donald L. Ziegler
RF-P115	Immediate Action Directive, Policy Statement Regarding Solid Waste Burial	IAD 0511-21	N/A	3/20/1970	U.S. Atomic Energy Commission
RF-P116	Rocky Flats Information for the AEC Plutonium Storage and Plutonium Processing Task Force, Part I	N/A	N/A	2/10/1970	M. A. Thompson, K.W. Calkins, L. F. Grill
RF-P117	Flow of Recycled Uranium at the Rocky Flats Plant, 1952-1989	N/A	N/A	3/1/2000	N/A
RF-P118	Deuterided Lithium Wire	RFP-428	N/A	10/7/1964	J. L. Guyton and K. Terada
RF-P119	Request for a Directive for Renovation, Phase I, Building 774 at Rocky Flats	N/A	N/A	1/28/1970	N/A
RF-P121	Plutonium Electrorefining at Rocky Flats	RFP-871	N/A	N/A	Jack L. Long and Robert D. Schweikhardt
RF-P122	Dissolution of Plutonium Oxide	RFP-922	N/A	8/29/1967	Garrel F. Molen
RF-P123	Plutonium Anion Exchange System Preliminary Design Report	RFP-365	NA	12/20/1963	R. S. Foster and D. S. Irwin
RF-P124	Process Vessel Calibration, A Tool for Controlling Material Unaccounted For (MUF)	RFP-858	N/A	6/12/1967	L.W. Doher

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RF-P125	Reduction of Plutonium Compounds to Plutonium Metal	RFP-356	N/A	2/7/1964	W. V. Conner
RF-P126	Trifluoride Processing of Plutonium Metal Recycle	RFP-391	N/A	5/21/1964	J. M. Cleveland
RF-P127	Static Reactor Reduction of Plutonium Hexafluoride with Iodine and Hydrogen	RFP-993	N/A	9/6/1968	James D. Navratil, Ralph O. Wing, Garrel F. Molen,
RF-P128	Report on Investigation of Fire Building 776 - 777 Rocky Flats Plant	N/A	N/A	8/1/1969	U.S. Atomic Energy Commission
RF-P129	Grain Boundary Precipitation in Sheet Rolled from Beryllium Ingots	RFP-987	N/A	6/26/1967	F. J. Fraikor, V. K. Grotzky
RF-P130	Compilation of Water Analysis Reports for Buildings 771, 774, 779, 865, and 889. Reports are dated November 3, 1970, & January 8 and 13, 1971.	N/A	N/A	N/A	Reported by A.C. Ficklin and C.E. Caldwell
RF-P131	Building 774 Caustic Analysis Report	70-3267	N/A	12/28/1970	C. E. Caldwell to M. E. Maas & G. E. White
RF-P132	Mass Spec Laboratory Analysis Report	MSL 5923	N/A	09/27/1971	K. J. Grossaint
RF-P133	Report of Fire or Similar Incident	N/A	N/A	5/3/1962	W. F. McKilruy
RF-P134	Report of fire or Similar Incident - Building 444 Furnace Explosion	N/A	N/A	8/29/1961	D. A. Craig

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RF-P135	Metallographic Techniques for Vacuum-Cast Rolled Ingot Beryllium Sheet	RFP-962	N/A	8/7/1967	Arthur E. Calabra, Ross J. Jackson
RF-P136	Analysis of Alkali Metal-Plutonium Compounds Using Atomic Absorption Spectrophotometry	RFP-1202	N/A	8/15/1968	G. A. Shepherd and A. J. Johnson
RF-P137	Effect of Water Vapor, Reduced Oxygen Concentrations, and Solvent Vapors on Plutonium Ignition	RFP-1566	N/A	1/28/1971	Larry E. Musgrave
RF-P138	Performance of High Efficiency Particulate Air Filter for Fume from Burning Plutonium Metal	RFP-1680	N/A	2/1/1971	R. W. Woodard, H. N. Robinson, and H. M. Baker
RF-P139	Preferred Orientation in Cross-Rolled Uranium	RFP-216	N/A	2/13/1961	G. R. Mallet
RF-P140	E&S - Property Accountability and Control Property Removal Permits	ES 9-620	N/A	N/A	N/A
RF-P141	Measurements of Plutonium 238	RFP-954	N/A	6/30/1967	J. R. Mann, R. W. Bistline, & Valens P. Johnson
RF-P142	Effects of Acid Concentration and Feed-Particle Size on the Dissolution of Pu-Bearing Materials	RFP-890	N/A	2/29/1968	G. F. Molen
RF-P143	Disposal of Fluorine	RFP-1200	N/A	5/1/1968	James D. Navratil

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RF-P144	Radiolysis of Oil-Solvent Mixtures	RFP-1561	N/A	3/18/1971	Armen R. Kazanjian and David R. Horrell
RF-P145	The Reduction of Plutonium Hexafluoride to Plutonium Tetrafluoride by Thermal Decomposition	RFP-1357	N/A	8/13/1970	Ralph O. Wing and Robert S. Marshall
RF-P146	Empirical Analysis of Spherical and Hemispherical Assemblies of Enriched-Uranium Metal	RFP-939	N/A	6/9/1967	B. B. Ernst, C. L. Schuske & H. W. King
RF-P147	High Temperature X-Ray Investigation of Plutonium Oxidation	RFP-1247	N/A	10/4/1968	K. Terada, R. L. Meisel, and M. R. Dringman
RF-P148	Techniques for Thinning Plutonium for Transmission Electron Microscopy	RFP-899	N/A	5/3/1967	Arvel W. Brewer
RF-P149	Adsorption on Plutonium Part II: The Light-Weight Hydrocarbons	RFP-1457	N/A	5/25/1970	Larry E. Musgrave and Anthony DiGiallonardo
RF-P150	Optical Constants of Plutonium at 5461 Angstroms	NA	N/A	7/18/1967	D. T. Larson and D. L. Cash
RF-P151	Evaluation of Modified Solidification Tech. for Growth of Large Crystals of Pu-3.3 Atomic % Ga Alloy	RFP-991	N/A	7/17/1967	R. L. Moment

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RF-P152	Adsorption on Plutonium Part I: Nitrogen, Oxygen, Hydrogen, and Carbon Monoxide	RFP-1456	N/A	6/9/1971	Richard O. Adams and Anthony DiGiallonardo
RF-P153	Plutonium - A Challenge to Chemists	RFP-1313	N/A	12/15/1969	J. M. Cleveland
RF-P154	Ellipsometer Studies of Plutonium Oxidation	N/A	N/A	11/1/1968	D. T. Larson and D. L. Cash
RF-P155	Properties of Plutonium Oxide, Part II	RFP-927	N/A	7/12/1967	Garrel F. Molen and Robert D. White
RF-P156	The Effect of Surface Condition and Temperature on the Total Hemispherical Emittance of Plutonium	RFP-938	N/A	6/5/1967	W. N. Seery
RF-P157	Electron Microanalysis of Gallium and Iron in Plutonium-Gallium and Plutonium-Iron Alloys	RFP-946	N/A	5/29/1967	M. R. Harvey and D. H. Riefenberg
RF-P162	Recovery of Plutonium from Incinerator Ash	RFP-396	0	07/31/1964	F. E. Butler, J. D. Moseley, G. F. Molen
RF-P165	Revised Engineering Criteria for Additional Processing Facilities at Building 71	NA	Unk	04/27/1962	Engineering Dept, RF, Dow
RF-P167	Fabrication of Ingot-Sheet Beryllium	RFP-1262	NA	10/7/1968	D. R. Floyd
RF-P170	Summary of Available Information on Plutonium Nitrate Solution Instability	CRDL-93087-1	N/A	4/18/1963	F. J. Miner

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RF-P178	Evaluation and Treatment of an Acute Internal Exposure to Plutonium	RFP-446,SM-56/4	N/A	N/A	E. A. Putzier, et. al.
RF-P181	Reconnaissance Level Characterization Report for Building 123.	RF/RMRS-97-021	0	8/13/1997	RFETS
RF-P182	What is the Actual Resolution of Shadowed Replicas?	RFP-389	N/A	10/27/1964	C. W. Price
RF-P183	Calcium-Lead Alloy Analysis by Atomic Absorption and Emission Spectroscopy	RFP-978	N/A	8/9/1967	Harlan N. Barton, Andrew J. Johnson, and Glenn A.
RF-P184	Vacuum Coating of Boron Nitride	RFP-972	N/A	4/18/1969	Robert G. Kurtz and T. Van Vorous
RF-P185	Drybox Gloves: Evaluation and Procurement	RFP-1286	NA	6/23/1971	Ray E. Giebel and Robert L. Riegel
RF-P186	Controlled Electron Beam Evaporation of Beryllium	RFP-1222	N/A	12/3/1968	P. S. McLeod & C. W. Nordin
RF-P187	A Survey of Potential Solvents to Replace Carbon Tetrachloride for Degreasing Plutonium	PRD 940477-104	N/A	6/4/1970	F. D. Hobbs
RF-P188	Compaction of Radioactive Waste at Rocky Flats	NA	N/A	2/10/1970	D. M. Anderson and D. L. Ziegler

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RF-P189	Mass Spec Laboratory Analysis Report - Determine Hazardous Materials Ratings for Each Metal in Each Solvent	MSL 7965	N/A	2/11/1972	Reported by R.S. Cichorz
RF-P190	Santa Fe Operations Activity Report	N/A	N/A	12/27/1955	U.S. Atomic Energy Commission Santa Fe Operations
RF-P191	Extraction of Uranium from Incinerator Ash Leach Solutions	RFP-115	N/A	7/10/1958	J. C. Biery
RF-P192	Extraction of Uranium from Incinerator Ash Leach Slurries	RFP-117	N/A	7/30/1958	J. C. Biery
RF-P216	Joining Beryllium by Electron Beam Braze Welding Technique	RFP-908	NA	2/6/1967	G. K. Hicken and W. B. Sample, Jr.
RF-P217	Installation of a Flame Spectrometer for the Analysis of Radioactive Solutions	RFP-1344	NA	3/9/1970	Andrew J. Johnson and Glan A. Shepherd
RF-P218	The Rolling Texture of Some Plutonium-Gallium Alloys	RFP-1315	NA	5/12/1969	Joseph E. Schindler
RF-P219	Average Beta Energy of Plutonium-241 by Calorimetry	NA	NA	9/5/1967	F. L. Oetting
RF-P220	Factors Influencing the Ignition of Metallic Plutonium	RFP-912	NA	3/1/1968	Sam H. Pitts, Jr.

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RF-P221	The Effect of Fluoride Ion Complexing Agents on the Dissolution of Plutonium Tetrafluoride	RFP-1203	NA	9/6/1968	James D. Navratil
RF-P222	Colorimetric Determination of Iron in Plutonium Metal using a Nitrobenzene Extraction Technique	RFP-948	N/A	12/20/1967	C. E. Plock and C. E. Caldwell
RF-P223	Electron Beam Welding Radioactive and Toxic Materials	N/A	N/A	N/A	G. K. Hicken and W. B. Sample, Jr.
RF-P224	Criticality Recommendations for Chemistry - Metal Production, Building 81	RFP-382	NA	4/29/1964	D. R. Ferguson
RF-P225	Rocky Flats Division Quality Assurance Manual for Contaminated Waste Disposal	Q-2000	NA	4/27/1971	Approved by W. H. Lee and J. Epp
RF-P226	A Method for Predicting Subject Background for In Vivo Plutonium Measurements	RFP-893	NA	11/19/1968	Robert W. Bistline
RF-P227	Desorption from Plutonium Dioxide	RFP-1248	N/A	11/21/1968	Jerry L. Stakebake and Marston R. Dringman
RF-P228	Structure of Beryllium Films Deposited at High Rates	RFP 1309	N/A	5/12/1969	R. J. Pinkney and T. Van Vorous

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RF-P229	Industrial Criticality Measurements on Enriched Uranium and Plutonium, Part II	RFP-248	N/A	1/10/1962	C. L. Schuske, C. L. Bell, G. H. Biding, et al.
RF-P230	Adsorption of Oxygen on Sintered Plutonium Dioxide	RFP-915	NA	5/23/1967	J. L. Stakebake and M. R. Dringman
RF-P231	Treatment of Plutonium in Contaminated Wounds	RFP-381	N/A	4/3/1964	C. W. Piltingsrud
RF-P232	The Criticality of a Uranium-Solution Slab under Various Reflector Conditions, Nuclea Applications & Technology. Vol. 7, December 1969	N/A	NA	12/1/1969	Robert E. Rothe, C. L. Schuske, and E. E. Hicks
RF-P233	Critical Parameters of a Uranium Solution Slab-Cylinder System	RFP-1314	N/A	12/16/1970	Grover Tuck & Harold E. Clark
RF-P234	Characteristics of Uranium Oxides Produced by Thermal and Oxygen-ion Bombardment Reactions	RFP-863	NA	1/30/1967	Donelly T. Larson, Norman W. Taylor, Kazuji Terada
RF-P236	Reaction Gamma-Ray Interferences in the Passive Assay of Plutonium	RFP-1711	NA	6/30/1971	H. R. Martin and R. A. Deal
RF-P237	Neutron Interrogation of Plutonium Bearing Low Specific Activity Wastes with a Reactor	CRDL 950442-102	N/A	11/5/1971	R. A. Harlan, H. R. Lukens, and D. R. Cartwright

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RF-P238	Building 771 Interim Drum Counter	CRDL 950442-103	N/A	11/4/1971	R. A. Deal, R. N. Chandra, R. J. Nau, R. A. Harlan
RF-P239	Use of an Alpha Pulse-Height Analyzer in Environmental Monitoring.	RFP-163	N/A	9/15/1959	E. L. Ray and S. E. Hammond
RF-P240	Historic American Engineering Record Pocky Flats Plant, Non-Nuclear production Facility (Rocky flats Plant, Building 444) (Rocky Flats Plant, Plant A) (Rocky Flats Plant, Building 44)	HAER # CO-83-L	N/A	N/A	D. Jayne Aaron, Judith Berryman, Ph.D.
RF-P241	Use of Trichloroethylene at Rocky Flats	N/A	N/A	10/19/1973	J. F. Willging
RF-P243	Grain Boundary Precipitation in Sheet Rolled from Beryllium Ingots; Transactions of the Metallurgical Society of AIME, Vol. 239.	RFP-987	N/A	12/1/1967	F. J. Fraikor & V. K. Grotzky
RF-P244	Ingot-Sheet Beryllium Fabrication	RFP-910	NA	2/9/1968	Julius L. Frankeny and Dennis R. Floyd
RF-P245	A Physical Inventory of the Enriched Uranium in a Solution System	RFP-1324	NA	3/12/1969	Robert E. Rothe

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RF-P247	Recycled Uranium Project - Health Physics Safety and Exposure Data for Uranium Areas at the RFP DOE Complex	Appendix B	N/A	3/1/2000	Ken Freiberg
RF-P248	Explosive Nature of Uranium-Base Niobium Alloys after Immersion in Nitric Acid	RFP-1575	N/A	12/8/1970	Ross J. Jackson, Wilbur L. Johns
RF-P250	Simplified Metallographic Techniques for Uranium Alloys and other Metals	RFP-862	NA	1/20/1967	Ross J. Jackson, W. L. Johns, Arthur E. Calabra
RF-P251	Coating Beryllium with Electroless Nickel	RFP-478	NA	12/29/1964	W. H. Roberts
RF-P252	Cleaning an Ideal Beryllium Surface	RFP-879	N/A	2/14/1967	R. O. Adams
RF-P254	Tensile Properties of Gamma Quenched and Aged Uranium-Rich Niobium Alloys	RFP-933	NA	6/2/1967	Ross J. Jackson, Ronald P. Brugger, Delmar Miley
RF-P257	Gas-Metal Arc Braze Welding of Ingot-Sheet Beryllium	RFP-1333	NA	10/22/1969	Richard J. Merlini and Walter L. Bush
RF-P258	Microanalysis of Plutonium-Uranium Alloys	N/A	N/A	9/14/1971	D. H. Riefenberg, J. H. Doyle, M. R. Harvey

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RF-P259	Neutron Multiplication Measurements of Plutonium Ingots in Arrays	RFP-1242	N/A	12/15/1968	Donald R. Ferguson
RF-P260	Actinide Processing at Rocky Flats	N/A	N/A	07/01/1984	James D. Navratil and Friend John Miner
RF-P261	A Survey of the Rocky Flats Division Waste Streams	CRDL-950351-009	N/A	06/30/1972	C. E. Plock
RF-P262	Rocky Flats Plant Plutonium Recovery Reference Process (Including Historical References 1952 to 1991)	RT92-002	N/A	02/03/1992	L. R. Crisler
RF-P263	A History of the Rocky Flats Plutonium/Actinide Recovery Plant - 1952 to 1991	RT92-003	N/A	02/03/1992	L. R. Crisler
RF-P264	A Comprehensive History of the Rocky Flats Plutonium/Actinide Recovery Operations 1952 to 1991	N/A	NA	N/A	L. R. Crisler
RF-P265	The Past 30 Years at Rocky Flats Plant	HS 371	N/A	11/01/1982	Edward A. Putzier
RF-P266	TWTF Buried Waste Characterization; Allied Chemical Corp., Rocky Flats Trip Report from 1973	TWTF-46	NA	03/03/1981	G. R. Darnell; R. J. Thompson
RF-P267	Radioassay Data Collected During 3100 Cubic Meter Project-EDF	EDF-3374	Rev 0	02/26/2002	Cecilia Hoffman

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RF-P268	U-234 Activity with Respect to Total Alpha Activity, INEEL/INT-98-01268	EDF-RWMC-1045	Rev. 1	03/17/1999	Cecilia R. Hoffman
RF-P269	Plutonium Mass Fractions Derived from SGRS Data.	EDF-1609	0	12/20/2000	Bechtel BWT, Idaho
RF-P271	TRU Waste Certification Program for WIPP-WAC (U). Rockwell International.	CO-4500-A	Rev. A	05/24/1983	N/A
RF-P272	MSDSs for products used at RFP	NA	NA	03/26/2004	Unknown
RF-U001	RFO DOW Shipments Buried in Trench 1 (1954)	N/A	N/A	N/A	N/A
RF-U002	RFO DOW Shipment Drums Buried in Trench 1	N/A	N/A	02/21/1954	Rod Thomas
RF-U003	RFO DOW Shipments Buried in Trench 5	N/A	N/A	02/28/2001	Rod Thomas
RF-U004	RFO DOW Shipments (12) Buried in Trench 7	N/A	N/A	03/07/2001	Rod Thomas
RF-U005	RFO DOW Shipments (15) Buried in Trench 9	N/A	N/A	03/14/2001	Rod Thomas
RF-U006	RFO DOW Shipments (8) in Trench 10	N/A	N/A	03/29/2001	R. W Thomas
RF-U008	RFO DOW Shipments Buried in Trench 2	N/A	N/A	02/13/2001	R. W. Thomas
RF-U009	RFO DOW Shipments Buried in Trench 4	N/A	N/A	02/21/2001	R. W. Thomas
RF-U013	Data Book – Solubility of Plutonium in Rocky Flats Residues in Idaho Water	NA	NA	11/18/1969	P.G. Hagan
RF-U014	Analytical Report - Retrieved Drum 06-00056 (IDC 337) returned to RF	NA	NA	11/26/1975	D.I. Hunter

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RF-U015	Sludge from ARCO Shipping Drum – Analysis Report	NA	NA	11/27/1973	K.J. Grossaint
RF-U016	Analytical Report on 14 Drums of laundry sludge returned to Rocky Flats from Idaho Storage-Analytical Report	NA	NA	12/1/1975	D.I Hunter, K.J. Grossaint
RF-U017	Packaging Material Weights (Table 1.1, Waste Packaging Components and Weights)	4-119-569-NDT	0	9/13/1996	NA
RF-U018	Packaging Material Weights (Table 1.1, Waste Packaging Components and Weights)	NA	NA	11/12/1971	R.E. Giebel
RF-U019	Engineering Evaluation – 741 First-stage sludge in ICC-17C 55-gal drums.	NA	NA	12/4/1967	F.E. Adcock
RF-U020	Shipping Boxes	B-7683-71	A	7/6/1964	NA
RF-U021	Rocky Flats Plant Neptunium Program (transmitted via 5/15/01 letter to Rod Thomas from Ed Vejvoda)	NA	NA	04/01/2001	Ed Vejvoda, LATA
RF-U022	Additional 1969 Fire Waste Information attached to letter to Rod Thomas	NA	NA	02/16/2001	Ed Vejvoda, LATA
RF-U026	Rocky Flats to INEEL Shipping and Loading Record Search for the 960's and Early 970's.	NA	Interim	12/11/1998	E. Vejvoda
RF-U028	Sampling Plan for the Rocky Flats Sites.	NA	NA	09/05/1986	John B. Murphy, et al

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RF-U038	Memo to W. M. Bean Re: Industrial Hygiene Report for October, 1960	NA	NA	11/11/1960	Unknown
RF-U042	Industrial Hygiene Report for November, 1960, To-W.M.Bean	N/A	N/A	12/09/2004	E.E. Hicks
RF-U043	DJO-4554 Solid Waste Disposal Studies To L.A. Matheson, - & J.G. Epp cc to K.W. Calkins, L.C. Farrell	DJO-4554	N/A	12/28/1960	S. R. Pocsik
RF-U044	Title Unknown-Intended recipient unknown-Possibly to G.E. White-No indication of document number	N/A	N/A	07/30/1963	E.S. Ryan
RF-U045	Monthly Progress Report-Industrial Hygiene-Report-To W.M. Wright Atten: G. T. Andrews	N/A	N/A	03/04/1963	J.E. Hill
RF-U046	Industrial Hygiene Monthly Report-Report-To Unknown	U046	N/A	08/01/1963	S.E. Hammond
RF-U047	Water in Building 74 Sludge-Interoffice report-To J.G. Epp	N/A	N/A	08/15/1963	G.E. White
RF-U048	Waste Disposal Co-ordination Group-Summary Report November 1959-To Mr. L.C. Farrell cc: G.E.White	N/A	N/A	12/10/1959	E.S. Ryan
RF-U049	Industrial Hygiene Report for September, 1959-To W. M. Bean-Report	N/A	N/A	10/07/1959	E.E. Hicks
RF-U050	Industrial Hygiene Monthly Report for October, 1959-Report-To W.M Bean	N/A	N/A	11/12/1959	E.E. Hicks

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RF-U052	Revisions to Portion of Unclassified Document NYO 7830 Pertaining to Rocky Flats Plant Waste Disposal Operations Based on Fiscal Year 1957 Data	NA	NA	N/A	L. C. Farrell & E. S. Ryan
RF-U057	Supplementary Report on Fire in Building 71, September 11, 1957	N/A	N/A	12/10/1957	Unknown
RF-U061	Memo to Mr. L. C. Farre Re: History Report for the Month of December, 1956 - Waste Disposal Co-Ordination Group	NA	NA	01/09/1957	E. S. Ryan
RF-U063	Solid Radioactive Waste Management Practices at the National Reactor Testing Station	NA	NA	11/14/1969	U.S. AEC
RF-U078	1962 Waste Shipment Data	N/A	N/A	N/A	N/A
RF-U095	Study of Disposal of Radioactive Waste, Rocky Flat Colorado.	NA	NA	N/A	N/A
RF-U110	Waste Treatment Process Description	NA	NA	09/27/1951	JWP
RF-U111	Trip Report - Industrial Waste Survey of Rocky Flats Field Office and Plant, July 18-19, 1955	NA	NA	08/19/1955	Everett R. Mathews
RF-U112	Tentative Procedure for Handling Contaminated Solid and Liquid Waste	NA	NA	03/19/1953	L. C. Farrell
RF-U114	Solid Waste Disposal Studies	DJO-4554	N/A	12/28/1960	S.R. Pocsik

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RF-U115	Draft Consolidated Report of Rocky Flats Wastes Shipped to INEEL	INEEL/EX T-03-00	NA	3/6/2003	Ed Vejvoda
RF-U116	Administrative Procedures and Controls in Plutonium Production Areas	N/A	N/A	4/2/1971	N/A
RF-U117	An Evaluation of Fiberglass for Use in Plutonium Fabrication Line	RFP-1725	N/A	5/27/1971	E. F. Lombardi and R. I. Donovan
RF-U118	Thorium Use at Rocky Flats	N/A	N/A	6/2/1976	N/A
RF-U119	History of Curium Processing at Rocky Flats	N/A	N/A	4/26/1977	W. V. Conner
RF-U120	Monthly Progress Report - Industrial Hygiene Operations	N/A	N/A	11/1/1956	E. R. Johnson
RF-U121	Monthly Progress Report - Industrial Hygiene Operations	N/A	N/A	1/1/1957	E. R. Johnson
RF-U122	Industrial Hygiene Report	N/A	N/A	8/1/1958	E. E. Hicks
RF-U123	Monthly Progress Reports - Industrial Hygiene	N/A	N/A	9/4/1964	J. E. Hill
RF-U124	Status Report - Industrial Hygiene, various months	N/A	N/A	4/1/1968	J. E. Hill
RF-U125	Description and recommendation of unwanted chemical disposal	N/A	N/A	N/A	None identified
RF-U126	Liquid Radioactive Waste Management Practices at Rocky Flats	N/A	N/A	2/23/1970	Water Quality Office
RF-U127	Synopsis of oral presentation to be given at the Problems Analysis Meeting	N/A	N/A	5/26/1971	N/A

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RF-U128	Health Physics Status Reports - January, April, July, August, October, November, December, 1968; January - July, 1969; November, December, 1969; June, August - October, 1970.	NA	NA	N/A	C. W. Piftinsgrud
RF-U131	A Report on Radiation Problems Related to Plutonium Fabrication of Operations at RF	N/A	N/A	2/8/1968	Unknown
RF-U132	Status of Liquid and Solid Waste at Rocky Flats Division-Status Report-To Michael J. Sunderland, RFAO, USAEC	N/A	N/A	11/21/1969	C. M. Love
RF-U133	History of Plutonium-contaminated Oil Drum Storage Area	RFP-INV-10	N/A	N/A	Unknown
RF-U134	PU Recovery Processing Systems. Rockwell International	CHOP-9248-80-03	NA	5/1/1980	Rockwell International
RF-U135	Ledger Sheets that Appear to Relate to Waste Shipments to INEEL	NA	NA	N/A	Unknown
RF-U139	Explosion and Fire November 9, 1965 in Building 71, Room 180	Unk	NA	12/01/1965	Unknown
RF-U141	Recent Developments in Plutonium Processing at Rocky Flats	RFP-966	NA	06/05/1967	J. D. Moseley & M. A. Thompson

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RF-U143	Compilation of Incidents Excerpted from the Executive Safety Council Minutes	NA	NA	12/21/1965	E. E. Hicks
RF-U147	Production Prototype Volatile Plutonium Fluoride Reprocessing System	RF-21583	NA	12/15/1966	Unknown
RF-U150	Industrial Hygiene Status Report for November 1964	NA	NA	12/14/1964	Unknown
RF-U152	Industrial Hygiene Reports Partial Documents for 1966	NA	NA	N/A	J.E. Hill
RF-U154	Status Report-Industrial Hygiene	N/A	N/A	12/01/1967	J. E. Hill
RF-U155	Authorization No 360024. Justification Re: Incineration Facility -Building 71.	NA	NA	02/18/1965	Unknown
RF-U157	Memo to Joshel, Bassler, Bowman, et. al. Re: Construction Project Data Sheet Replacements to Plutonium Chemical Recovery Facility	NA	NA	03/05/1970	R. L. Delnay
RF-U161	Sorting of Solid Radioactive Wastes	NA	NA	06/01/1970	P.D. Fairchild, J.L. Lawless, P. Ruhter, etal.
RF-U163	Restoration of Booster Exhaust System No. 1	NA	NA	10/20/1969	J. A. Geer
RF-U167	Decontamination Log Book Pages from 1969 Fire	MF-RF-WD-15	NA	11/18/1988	NA
RF-U169	WasteOScope Database Download; RFP Pre-71 Disposals.pdf	NA	NA	1/15/2004	NA
RF-U171	Tritium Work at Rocky Flats	N/A	N/A	10/1/1973	JFW

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RF-U172	Radioactive Waste Disposal Dow Chemical Company, Rocky Flats Division	NA	NA	N/A	NA
RF-U173	Crated Fire Waste Shipped	N/A	N/A	10/10/1969	N/A
RF-U174	Proposal for the Disposition of Rocky Flats Barrels	N/A	N/A	N/A	N/A
RF-U175	Transportation of Combustible Radioactive Waste	N/A	N/A	N/A	Various
RF-U176	Summary of Wastes Shipped to Idaho Falls from Rocky Flats	N/A	N/A	3/7/1973	N/A
RF-U178	Tritium at Rocky Flats	N/A	N/A	N/A	N/A
RF-U179	Movement of Liquid Waste Documents	N/A	N/A	N/A	E.S. Ryan, Waste Co-Ordinating Group, M.E. Maas, W
RF-U180	Bomb Reductions of Plutonium Hexafluoride to Plutonium Tetrafluoride	NA	N/A	N/A	J. D. Navratil
RF-U181	Justification for Parylene License	N/A	N/A	3/23/1970	R. O. Adams
RF-U182	Radiation Instruments Group, Monthly Report June 1956	N/A	N/A	7/9/1956	R. G. Maras
RF-U183	Question and Answers Regarding Contaminated Firefighting Equipment	N/A	N/A	N/A	N/A
RF-U185	Alkali Metal Carbonates of Plutonium	RFP-1192	N/A	8/16/1968	J. D. Navratil, J. M. Cleveland

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RF-U186	Appendix A. Incineration at Rocky Flats - Appendix B. Actinide Recovery at Rocky Flats Plant (RFP)	RFP-2667	N/A	N/A	N/A
RF-U187	Handwritten excerpt from the Bldg. 771 SAR	N/A	N/A	N/A	N/A
RF-U188	Procedures for Removing Aluminum Shim	NA	NA	1/14/1970	NA
RF-U189	Excerpts from Operating Procedure for FR System Anion Columns	N/A	N/A	5/25/1961	B. D. Troyer
RF-U190	Flame Spectrophotometric Determination of Lead in Plutonium Process Solutions	RFP-1358	N/A	4/10/1969	A. J. Johnson and G. A. Shepherd
RF-U192	Glovebox Gloves	RFP-1677	N/A	3/26/1971	R. E. Giebel
RF-U193	Flammability of Leaded Dry Box Gloves	RFP-1354	N/A	2/18/1969	T. C. Johnson and J. W. Lindsay
RF-U194	A Comparison of Methods to Reduce Plutonium Hexafluoride to Plutonium Tetrafluoride - Lab Study	RFP-1707	N/A	11/20/1971	R. O. Wing and R. J. Nau
RF-U195	A Double Crucible System for One-Gram Scale Plutonium Reductions	RFP-1273	N/A	10/10/1968	W. V. Conner, D. L. Baaso, and S. G. Proctor
RF-U196	Pilot Plant Experience on Volatile Fluoride Reprocessing of Plutonium	RFP-1351	N/A	4/8/1969	M. A. Thompson, R. S. Marshall, R. L. Standifer
RF-U197	An Investigation of Plutonium Chemistry in Ethyl Acetate Solution	RFP-1712	N/A	4/30/1971	G. H. Bryan, J. M. Cleveland, R. J. Sironen

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RF-U198	Ammoniates of Plutonium (III) and (IV) Halides	RFP-1727	N/A	5/25/1971	J. M. Cleveland, G. H. Bryan, R. J. Sironen
RF-U200	Preparation of Plutonium(III) Formate	RFP-1822	N/A	N/A	Larry R. Crisler
RF-U201	Metallographic Preparation of Plutonium	RFP-1184	N/A	6/4/1968	A. L. Rafalski
RF-U202	Preliminary Report on the Electron Metallography of Alpha Plutonium	RFP-374	N/A	3/30/1964	N/A
RF-U203	Annealing of a Cold-Rolled Pu/1 WT % Ga Alloy	N/A	N/A	N/A	S. Beitscher
RF-U204	A Model for the Safe Storage of Fissile Solutions	N/A	N/A	N/A	S. J. Altschuler and C. L. Schuske
RF-U205	Investigation of Hydraulic Spindle Drive Motor on Ex-Cell-O Model 922 Numerical Control Lathe	RFP-377	N/A	4/8/1964	N/A
RF-U206	A Laboratory Ignition System	RFP-397	N/A	N/A	M. A. Thompson
RF-U207	A Spectrochemical Analysis of Impurities in Plutonium using a Modified Sodium Fluoride Carrier Distillation Method	RFP-838	N/A	11/21/1966	Gerald A. Schreiber and Charles W. Barrick
RF-U208	Kinetics of the Reaction between Plutonium (III) and Xenon Trioxide	RFP-857	N/A	12/1/1966	J. M. Ceveland
RF-U209	Infrared Spectra of Plutonium Ammine Complexes	RFP-1724	N/A	8/10/1971	Roger S. Cichorz

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RF-U210	The Recovery of Electrical Resistivity in Pu-1 w/o Gallium after Plastic Deformation	RFP-1285	NA	2/5/1969	W. N. Seery
RF-U211	Simplifications Used for Rocky Flats Drum and Small Package Counters	RFP-1858	N/A	3/1/1972	R.A. Harlan, J.L. Lawless, R.N. Chanda, R.A. Deal
RF-U212	Can and Drum Counter Calculations	RFP-1274	N/A	10/21/1968	N/A
RF-U213	PIGMA WELDING - A Method for Reducing Weld Porosity	RFP-355	N/A	1/10/1964	Robert B. Barker
RF-U214	Industrial-Type Operations as a Source of Environmental Plutonium	RFP-1756	N/A	7/20/1971	S. E. Hammond
RF-U216	Environmental Air Monitoring for Particulates Using a Nylon Screen	RFP-1791	NA	10/13/1971	I. B. Allen
RF-U217	The Rolling Texture of Pu-3.4 Atomic Percent Gallium	RFP-1278	NA	2/10/1969	R. L. Moment and J. E. Schindler
RF-U218	Tensile Properties of Hot-Formed Ingot-Sheet Beryllium	RFP-1525	N/A	11/18/1970	D. V. Miley & R. P. Brugger
RF-U219	Surface Chemistry Studies in Plutonium	RFP-1287	NA	11/15/1968	R. O. Adams
RF-U220	The Restricted Release of Plutonium; Part I - Observational Data	RFP-1539	N/A	6/29/1970	D. C. Hunt
RF-U221	A Mass Spectrometric Investigation of the Thermal Desorption of Nitric Oxide from Plutonium Dioxide	RFP-1350	N/A	N/A	J. L. Stakebake & C. A. Chambers

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RF-U223	Neutron Interrogation of Low-Specific-Activity Wastes With a Reactor	RFP-1710	N/A	6/25/1971	R. A. Harlan, D. R. Cartwright, R. A. Deal, Chanda
RF-U224	Measurement of Sticking Probabilities of Gases Adsorbed on Metal Films	RFP-1695	N/A	7/1/1971	Richard O. Adams & Larry E. Musgrave
RF-U225	Recovery and Recrystallization in Beryllium Foil	RFP-1719	N/A	9/14/1971	A. W. Brewer, J. G. Avery & F. J. Fraikor
RF-U226	Radiation Chemistry of Nitric Acid Solutions	RFP-1299	N/A	12/19/1968	F. J. Miner, A. R. Kazanjian, A. K. Brown, et al.
RF-U227	Continuous Pu Peroxide Precipitation at Rocky Flats	RFP-2606	N/A	N/A	R. Monte Greinetz & Clyde C. Perry
RF-U228	Tensile Properties of Rocky Flats Division Ingot-Sheet Beryllium from -194 degrees C to 700 degrees C	RFP-1194	NA	5/1/1968	S. Laitscher and A. G. Grimes
RF-U229	Thin Beryllium Sheet Fabrication with low Mircoinch Surface Finish	N/A	N/A	N/A	Robert J. Bouchard
RF-U230	The Effect of Niobium and Uranium on the Determination of Iron by Atomic Absorption Spectroscopy	RFP-1552	N/A	1/9/1970	Ann C. Ficklin
RF-U231	Beryllium Braze-Welding Porosity and Arc Parameter Studies	RFP-287	NA	10/1/1963	R. B. Barker

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RF-U232	The Tensile Properties of Rocky Flats Division Ingot-Sheet Beryllium from Room Temperature to 250 degrees C	RFP-1205	NA	9/18/1968	S. Beitscher
RF-U233	Metallographic Technique for a Bright Field Etch of Beryllium Grain Structure	RFP-947	N/A	5/11/1967	V. K. Grotzky
RF-U235	Vacuum Deposition of Thick Aluminum Films for Beryllium Joining	RFP-1306	NA	5/7/1969	R. L. Beno
RF-U237	The Effects of Annealing on the Microstructure and Mechanical Properties of 0.100-inch-Thick Ingot-Source Beryllium	RFP-1831	NA	N/A	David L. Ferguson
RF-U238	LEED-Auger Analysis of the Beryllium (0001) Surface	RFP-1556	N/A	8/7/1970	E. J. Lejeune, Jr.
RF-U239	Electron-Beam Fusion Welding of Beryllium	RFP-2621	N/A	N/A	R. P. Campbell, R. D. Dixon & A. L. Liby
RF-U240	Determination of Impurities in Beryllium Metal by X-Ray Fluorescence	RFP-1549	N/A	9/30/1970	C. E. Michel & R. S. Haines
RF-U241	Spectra and Structures of Some Uranium (IV) Cyclopentadienyls	RFP-1280	NA	11/8/1968	Melvin L. Anderson and Larry R. Crisler
RF-U242	An Organic Coating for U-4.2 wt % Nb	N/A	N/A	N/A	R. L. Riegel
RF-U243	Controlled Potential Coulometric Determination of Uranium and Neptunium in Uranium-Neptunium Alloys	RFP-950	NA	4/17/1967	C. E. Plock

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RF-U244	The Stress-Corrosion Cracking Behavior of the U-4.2 wt% Nb Alloy Aged 80 Hours at 260 degrees C	RFP-1824	NA	12/28/1971	James M. Macki and Robert L. Kochen
RF-U245	Mechanical Properties of Uranium-Base Niobium Alloys	RFP-1703	NA	4/29/1971	Ross J. Jackson and Joseph F. Boland
RF-U246	Criticality Calculation and Measurements on Enriched Uranium Metal-Solution Combinations	RFP 1580	N/A	11/6/1970	Robert E. Rothe, D. C. hunt
RF-U247	A Criticality Analysis of Enriched Uranium Metal Spheres Undergoing Dissolution	RFP-1718	N/A	N/A	D. C. Hunt & R. E. Rothe
RF-U248	ATMX Railcar - Nuclear Safety Evaluation	RFP-1601	N/A	4/28/1971	J. D. McCarthy
RF-U249	ATMX-600 Railcar - A New Concept in Radioactive Waste Shipments	RFP-1950	N/A	4/26/1971	Frank E. Adcock
RF-U250	Beryllium Recrystallization Texture	RFP-1465	N/A	1/30/1970	Marilyn S. Werkema
RF-U251	Ad Hoc Review of Rocky Flats Waste Problems	N/A	N/A	4/9/1971	Gordon C. Facer
RF-U252	Modification Hydrogen Storage-Distribution System	325612	N/A	10/6/1970	N/A
RF-U253	Liquid Wastes, Both Sanitary and Process, Leaving the Rocky Flats Plant Site	N/A	N/A	6/8/1953	J. Epp
RF-U254	Summary - Drum Field Activity	NA	NA	8/19/1970	K. W. Calkins

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RF-U255	Solubility of Plutonium Dioxide Microspheres in Nitric Acid	RFP-1190	N/A	9/8/1968	P. G. Hagan & F. J. Miner
RF-U279	Surface Chemistry Studies on Plutonium	RFP-1287	N/A	12/2/1968	R. O. Adams
RF-U281	Retardation of Plutonium Oxidation by a PuO Surface Film	RFP-1694	NA	7/19/1971	D. T. Larson and D. L. Cash
RF-U283	Trip Report on Industrial Health Survey of Rocky Flats Plant, Trip Conducted July 17-19, 1971	N/A	N/A	7/17/1961	Everett R. Mathers
RF-U285	Structure of Beryllium Films Deposited at High Rates	RFP-1309	N/A	N/A	R. J. Pinkney & T. Van Vorous
RF-U286	Vacuum Induction Casting of Beryllium	RFP-340	NA	2/4/1964	J. L. Frankeny
RF-U287	Spark Machining of Beryllium	RFP-1462	N/A	2/5/1970	A. W. Brewer
RF-U288	Sludge Packaging in 55-Gallon Drums	NA	NA	N/A	Unknown